WHY PATENT APPLICATIONS FAIL: QUANTIFYING THE ROLE OF ECONOMIC FORCES

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Abstract

This paper introduces a new economic perspective on why patent applications fail. Using new data based on the content of patent office communications in 4,590 patent applications filed simultaneously in Europe, Japan, and the United States, it estimates that a third of non-granted applications are withdrawals likely caused by economic factors. Econometric models find that the economic factor is significantly more prevalent at the EPO and when the same invention is granted elsewhere. The prevalence of economic withdrawals questions the use of grant rates as indicators of examination stringency and underscores the need for broader applicant-based measures.

O34, O31, P14, L24

1. INTRODUCTION

In 1474, the Venetian patent statute first put into law that “new and ingenious devices” could be granted exclusive rights, laying the foundation for the modern patent system, which aims to protect “novel and non-obvious inventions”. However, the rigor with which patent offices assess these two criteria remains a controversial topic fueled by numerous stakeholders, many of whom uphold the European Patent Office (EPO) as the “gold standard” in patent examination quality.

While the literature on examination quality addresses various aspects of the patenting process, the most used proxy to measure the stringency of patent office has been the grant rate. Over the past decade, official reports have usually depicted the EPO as the most stringent patent office, with an average grant rate of 55% compared to just above 70% for the American and Japanese offices.[1] However, these public statistics are based on the share of published grants among all outcomes reached in a given year; a biased approach that compares cohorts from different time periods and disregards applications with pending outcomes. In 2022, a more coherent “single-cohort” approach was provided by the EPO, but the office acknowledges that grant rates are influenced by many factors, including the quality of the applications (due to heterogenous inventions quality or applicant experience) and “commercial factors” such as fees or market strategies.[2]

The scientific literature partially tackles these issues by comparing the outcomes of “patent families”: sets of applications from different patent offices that cover the same underlying invention. Despite controlling for procedural routes and legal frameworks, significant differences persist, raising concerns over inconsistencies both across and within patent offices.

These discussions have prompted both private companies and patent offices to work on quality charters in the hopes of establishing common ground.

Nevertheless, grant rates remain inherently biased indicators of office rigor. As hinted in the 2022 EPO Annual Report, the outcome of an examination process is the result of a complex and dynamic negotiation between the patent office and the applicant. Notably, Cohen et al. (2000) cautioned that the objectives of the inventor are not always aligned with the success of its own application. For example, one could apply solely to protect its innovation during a few years, without seeking the realization of a patent. Also, some applicants may want to limit their losses by withdrawing at the first signs of trouble from the patent office while others may fully invest in the process, driven by expectations of long-term returns.

Additionally, the decreasing maintenance rates of granted patents over time suggest that economic forces influence the willingness of inventors to maintain their patent active. Hall and Harhoff (2004) even argue that renewal fees primarily serve to filter out low-value patents. By transitivity, these economic forces should already play a role prior to the final outcome.

This paper seeks to introduce a new dimension to the discussion about the rigor of patent offices by highlighting the role of the economic factor in patent examination outcomes. It contributes to the literature by providing the first empirical analysis that quantifies the proportion of failed applications that can be attributed to economic forces across three major patent offices (European, Japanese, and American). To achieve this, it presents an extension to the database from Petit et al (2023), which tracks key examination stages and the content of office communications for over 4.500 paired international applications at the EPO, JPO, and USPTO – belonging to over 1.530 triadic patent families.

The paper is structured as follows: the next section is devoted to background information with a summary of the patent examination process and a literature review. Section 3 outlines the methodology including the model, data source, and variables. The results are displayed and discussed in section 4, followed by conclusions and policy implications in section 5.

2. BACKGROUND

2.1. Patentability criteria and examination outcomes

To protect an invention, one must start by defining the scope of protection sought through a set of claims: independent claims state essential features, supported by dependent claims for additional embodiments of the invention. The application must be filed at a patent office: this first filing is called the priority. After around 18 months, the application is made public and categorized into one or several technology classes. Patent offices are then responsible for assessing whether the invention fulfills the patentability requirements. Four main criteria are examined (for each claim individually).

Novelty. The invention must be new in the sense that it should not be part of the prior art (which consists of everything that has been made available to the public up to the priority date).[3]

Inventive step. The invention should not be obvious to a person skilled in the art (it must involve a sufficient inventive step).[4]

Industrial application. It must be possible to manufacture or use the invention in any kind of industry (in the broad sense, including agriculture).[5]

Legality. The invention should not fall under one of the excluded domains (for example: aesthetic creations, scientific theories, immoral inventions, methods for treatment of the human body,…). These exceptions vary across countries.

During the search and examination phase, patent offices search for prior art, examine it, then publish reports in which they explain if the claims respect the patentability criteria.[6] The applicant can present additional explanations or modify its claims through official and public replies. This correspondence between the office and the applicant usually takes several years during which the invention is often called "patent pending". The process terminates with one of the following outcomes.

Grant. If the application meets the patentability criteria, the office grants the patent. However, the patent does not necessarily contain the same set of claims as initially submitted by the applicant. This is also where several new patenting fees are introduced: their structure and timing vary across offices. [7]

Refusal. If the application does not meet the patentability criteria, the office can refuse the patent. However, it is very difficult to identify definitive refusals consistently across several offices. In some cases, refusals are non-final opinions to which the applicant can still reply (with potentially modifications to its submission), while other offices only publish refusals when they are definitive and overturning them implies a more constraining appeal process.[8]

Withdrawal. The applicant can decide to withdraw from the process at any time. Withdrawals usually occur for two reasons. First, the applicant might lose faith in its ability to overcome the patentability issues put forth by the office - rightfully so or not. Second, the applicant might lose faith in the economic prospects associated with its potential patent. The expected return on investment might become negative as the market opportunities shift, or the costs of maintaining the application soar. The applicant could also simply have exhausted its financial resources.

Since the line between withdrawals and refusals is difficult to draw consistently across patent offices, this paper refers to them jointly as *failed* applications. Contrarily, granted applications are also labelled *successful*, or *accepted* applications.

Finally, it is worth noting that the protection provided by a patent is limited to the office jurisdiction. If one seeks to extend its intellectual property protection internationally, it can file applicants in several regional offices under the Paris Convention or submit a single international application through the Patent Cooperation Treaty (PCT). [9]

2.2. Literature review

In 2007, Webster et al. show that the same invention might get different outcomes for applications filed at different patent offices, even in domains that are not controversial, and even for international families starting with a single PCT submission.[10] Most researchers suggest that these discrepancies are the result of heterogenous examination quality either across or even within offices. Several studies imply that lower grant rates at the EPO could be the result of a more stringent examination practice (van Pottelsberghe (2011), de Saint-Georges and van Pottelsberghe (2013), Gimeno-Fabra and van Pottelsberghe (2021)). Nonetheless, Palangkaraya et al. (2011) finds a probability of almost 10% that an invention that should have been a refusal is granted at the EPO and the JPO. Additionally, Burke and Reitzig (2007) finds that examiners and opposition divisions at the EPO make contradictory opinions based on the same information, and de Rassenfosse et al. (2020) estimate that, amongst the 5 biggest patent offices, about 10% of granted patents are below each office's own standard. Moreover, the individual impact of the examiners has also been highlighted by Cockburn et al (2003), Jaffe and Lerner (2004), Frakes and Wasserman (2017), and Lemley and Sampat (2012). Finally, another stream of the literature argues that outcome inconsistencies are caused by a home bias towards domestic inventors (Webster et al. (2014), de Rassenfosse and Raiteri (2016), de Rassenfosse et al (2019), Kotabe (1992), Liegsalz and Wagner (2013)). Petit et al. (2021) challenges this conclusion since they found that the patent examination process leading up to that outcome presented no significant differences for local inventors compared to foreign ones.

The first problem with outcome-based studies lies in the way failed applications are treated. In some studies, a "granted vs not granted" approach is used, considering withdrawals and refusals as equal. In others, a "granted vs refused" methodology is preferred, but the process used to identify refusals across different patent examination processes is usually unclear. One major contribution in that regard is the concept of "induced withdrawals" introduced by Lazaridis and van Pottelsberghe (2007): when applications occur right after a communication from the office, one can suspect that its content discouraged the applicant. Webster et al. (2014) apply this idea to define *quasi-refusals* as applications that were withdrawn after an EPO report that challenges the novelty or inventiveness of the invention. However, this wider definition of office refusals is limited to the EPO and doesn't differentiate between weak or strong challenges to patentability.

The second problem of outcome-based research is that it ignores the fact that the outcome of the patent examination process is a biased representation of the rigor of the patent office because it is impacted by the applicant strategies. For example, Palangkaraya et al (2011) argue that applicants use private knowledge on the quality of the patent to delay or hasten the request of examination in several patent offices. Henkel and Jell (2010) further estimate that more than 50% of filings at the German patent office suffer from applicant induced delays. Moreover, Harhoff and Wagner (2009) reveal that applicants at the EPO accelerate proceedings for their most valuable patents (but delay it when a withdrawal or refusal is imminent). Christie et al (2016) also capture the fact that applicants at the USPTO see the greatest change in the morphology of their claims throughout the process (compared to the European and Australian offices). More recently, when discussing the impact of reforms on the patent examination process, Matcham and Schankerman (2023) highlight that "it is critical to incorporate both the agency's decision-making and the endogenous responses of applicants being screened".

In addition, researchers highlight the importance of economic factors in determining the applicant strategies at key stages of the examination process. Before the examination, de Rassenfosse and van Pottelsberghe (2012) find that the demand for patents at the EPO is significantly correlated with its fee policy. Before the grant, Lazaridis and van Pottelsberghe (2007) estimate that 10% of EPO applicants drop out after having received an "intention to grant" from the office, right before enduring translation and renewal fees that come with a granted patent. This proves that market forces play a key role in the outcome of a patent application. Additionally, Cohen et al (2000) argue that the applicants' motivation extends beyond the future profits expected from a patented innovation (e.g.: patent blocking, prevention of copying, use in negotiations, …), and Graham et al (2009) present patenting patterns that are highly industry, technology, and context specific. Guellec et al (2012) also suggest that some filings are strategically submitted to block competitors, especially amongst the withdrawn applications. Finally, there is plenty of literature showing that renewal decisions post-grant primarily depends on whether the expected benefits outweigh the renewal costs or not (Pakes and Schankerman (1984), Lanjouw and Schankerman (2004), Gambardella et al (2008), Bessen and Meurer (2008), Bloom and Van Reenan (2002)). Reflecting the economic value of patents (and therefore filtering out low-value ones) is in fact presented as the primary purpose of renewal fees (Hall and Harhoff (2004), Cornelli and Schankerman (1999), van Zeebroeck (2011), van Zeebroeck and van Pottelsberghe (2011)).

This paper contributes to the literature by providing the first empirical analysis that quantifies the role of economic forces in patent applications that are not granted by the EPO, the JPO, or the USPTO.

3. METHODOLOGY

3.1. Model and definitions

To quantify the role of economic forces in patent applications that failed at the EPO, the JPO, or the USPTO, the first subsection sets a strategy to categorize failures based on their suspected cause. In the second subsection, a multinomial logistic regression is created to model the relative prevalence of each failure type and test if it correlates with heterogeneous outcomes in the same patent family.

3.1.1. All failures are not equal

Three types of *failed* applications are introduced based on the content of the patent office reports and its exchanges with the applicant. The classification methodology is illustrated in Figure 1.

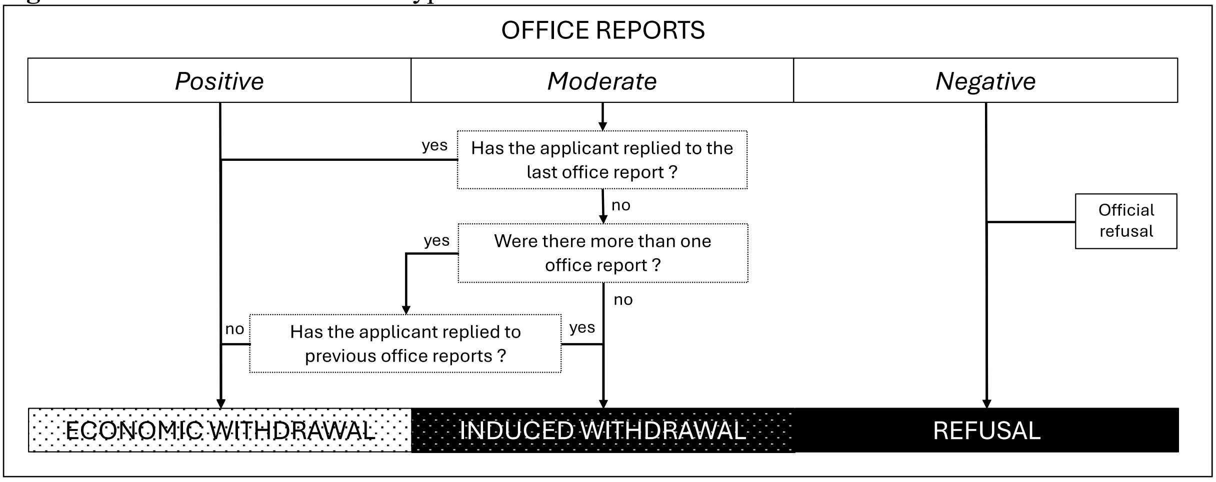
The most straightforward type of failure is a *refusal.* In this paper, refusals are assumed to be explicit (formal and definitive) or implicit rejections. The latter are characterized by withdrawn applications that received office reports strongly contesting the patentability of the invention (*negative* reports). This broader definition ensures consistency across different patent offices.

In contrast, *economic withdrawals* are defined as applications that were withdrawn because of reduced market opportunities, lack of financial resources, or the end of a strategic filing. The main assumption is that a withdrawal is economically driven if it occurs while patent office reports don't contest the patentability of the invention (*positive* reports).

In the case where the office reports are neither positive nor negative (*moderate* reports), the reply behavior of the applicant is examined to help classify the failed application. If the applicant replies to the office report and withdraws from the process before the office's response, it is assumed to be due to economic factors (since no new information regarding the patentability was provided).[11] On the contrary, if the applicant withdraws without replying to the office report, it is assumed that he was discouraged by its content (albeit *moderate*). This situation is qualified as an *induced withdrawal*, unless the applicant was already unresponsive to prior office reports (in such cases, the withdrawal is less likely to be related to the content of that last office communication).

The methodology to qualify office reports as *moderate* or *negative* is based on what is common for granted applications in each patent office.

Figure 1. Classification of failure types



Note: Office reports are positive if they do not contest the patentability of the invention, *moderate* if they challenge it to a degree that is common for successful applications, and *negative* if the contestation is abnormally high.

3.1.2. Modelling relative prevalence

The probability that invention *i* at patent office k (1 for EPO, 2 for JPO, 3 for USPTO) failed for reason *j* (1 for *economic withdrawals*, 2 for *induced withdrawals*, 3 for *refusals*) is denoted π_{ij}^{k} . The relative probability of each reason compared to the baseline refusals, $\frac{\pi_{ij}^{k}}{\pi_{i3}^{k}}$, is modeled separately in each office against the variable $GRANTS_i^k$, a set of control variables, $\mathbf{z}_i^{k\prime}$, and other unobserved factors, ε_{ij}^{k}, assumed to be random and independently identically distributed.

$$log\left(\frac{\pi_{ij}^{k}}{\pi_{i3}^{k}}\right) = \alpha_j^k + \beta_j^k GRANTS_i^k + \delta_j^k \mathbf{z}_i^{k\prime} + \varepsilon_{ij}^{k},\ j \neq 3 \qquad \text{(eq. 1)}$$

$GRANTS_i^k$ represents the number of applications covering the same underlying invention that are granted by another patent office. For example, rejecting the null hypothesis that $\beta_1^1 \leq 0$ means that the relative probability that a failed application is an *economic withdrawal* is significantly higher when other patent offices granted the same underlying invention.

The pooled model is also used to include invention fixed effects. In this case, the probability that application *a* (which covers invention *i*) failed for reason *j* is denoted π_{ij}, and α_j controls for unobserved invention characteristics.

$$log\left(\frac{\pi_{ij}}{\pi_{i3}}\right) = \alpha_j + \beta_j GRANTS_{ij} + \delta_j \mathbf{z}_i' + \varepsilon_{ij},\ j \neq 3 \qquad \text{(eq. 2)}$$

3.2. Data

To compare patent examination outcomes at the EPO, JPO, and USPTO without introducing selection bias related to the quality of the invention itself, this paper uses triadic patent families (sets of three patent applications at the EPO, JPO and USPTO that share the same priority). The sample of patent applications is sourced from Petit et al. (2023), which provides detailed information regarding the examination process of triadic patent families. The sample is particularly useful as it includes families with priority filings from 2003 and 2006, ensuring that no applications are still pending. Additionally, this sample encompasses both PCT and non-PCT applications and offers a balanced representation across various technology classes.

However, this database lacks information regarding the content of the office reports and the behavior of the applicants. To address this gap, a team of ten MSc students was recruited and trained to work as research assistants over several months to manually collect the missing data. Specifically, each office communication was reviewed and analyzed to determine the extent to which the office contested the patentability of the application. The timeline of exchanges between the applicant and the office was also documented.

Out of the 1.628 patent families of the dataset retrieved from Petit et al (2023), 98 were excluded due to the unavailability of the office communications from one of the three offices at the time.[12] The remaining 1.530 patent families are evenly split between the priority years 2003 (768 families) and 2006 (762 families), with a larger share of PCT applications (1.016 families). In terms of technology classes, the distribution is as follows: 10% A, 14% B, 17% C, 7% D, 2% E, 17% F, 17% G, 16% H. In total, 4.590 patent examination processes were codified into the extended dataset.

As illustrated in Table 1, only half the patent families in the dataset have homogenous outcomes (41% are granted in all three offices, while 13% fail to obtain patents in any of them). Notably, 12% of the inventions successfully patented at the USPTO are not granted at the other two offices. In contrast, only 7% of the inventions that are granted at the EPO face this situation.

3.3. Variables

In the first subsection, failed applications are classified based on the suspected cause of failure: *economic withdrawals*, *induced withdrawals*, or *refusals.* These categories serve as the dependent variables in equations (1) and (2). To achieve this, the strategy laid out in Figure 1 leverages information from office reports and applicant exchanges timeline. It then contrasts this data with typical patterns observed in applications successfully granted by the patent offices. In the second subsection, independent variables are defined.

3.3.1. Dependent variable: failure type

The main element of the classification strategy outlined in Figure 1 involves determining the extent to which patent offices challenge patentability. In practice, three variables are collected in each office report: the number of claims examined, the number of claims cited as suffering from a lack of novelty, and the number of claims cited as suffering from a lack of inventiveness.[13] Since the sample taken from Petit et al. (2023) only includes applications for which the three patent offices performed a substantive examination, there should be no *legality* issues and little "*industrial application*" problems (both of these criteria would have been spotted earlier in the application process). Moreover, a withdrawal that occurs due to a lack of industrial applicability later in the process is very similar in essence to a withdrawal for economic reasons. Hence, ignoring such patentability issue is not problematic in this investigation. Since novelty and inventiveness carry equal importance in the examination of an application, a joint variable, *patentability issues*, is created as the sum of the number of claims lacking novelty and the number of claims lacking inventiveness. For example, two patentability issues can mean that two separate claims have novelty issues, or that the same claim suffers from both a lack of novelty and inventive step.

Table 2 displays the sample mean of each variable in both the first and the last office communications, as well as across the entire application process. Notably, at the JPO, there is a higher prevalence of inventive step issues compared to the other two offices, where both criteria are more evenly balanced. On average, 71% of independent claims in JPO applications suffer from inventive step issues, while only 27% lack novelty. Additionally, it is worth noting that patentability issues tend to diminish as the process progresses. For example, at the EPO, the percentage of independent claims facing patentability challenges decreases from 90% in the first office report to 69% in the last one.

Table 1. Patent examination outcome distribution

Number of failed applications in the same patent family	All applications 4 590		Granted by EPO 944		Granted by JPO 997		Granted by USPTO 1082	
0	1 896	*(.41)*	632	*(.67)*	632	*(.63)*	632	*(.58)*
1	1 275	*(.28)*	243	*(.26)*	286	*(.29)*	321	*(.30)*
2	831	*(.18)*	69	*(.07)*	79	*(.08)*	129	*(.12)*
3	588	*(.13)*						

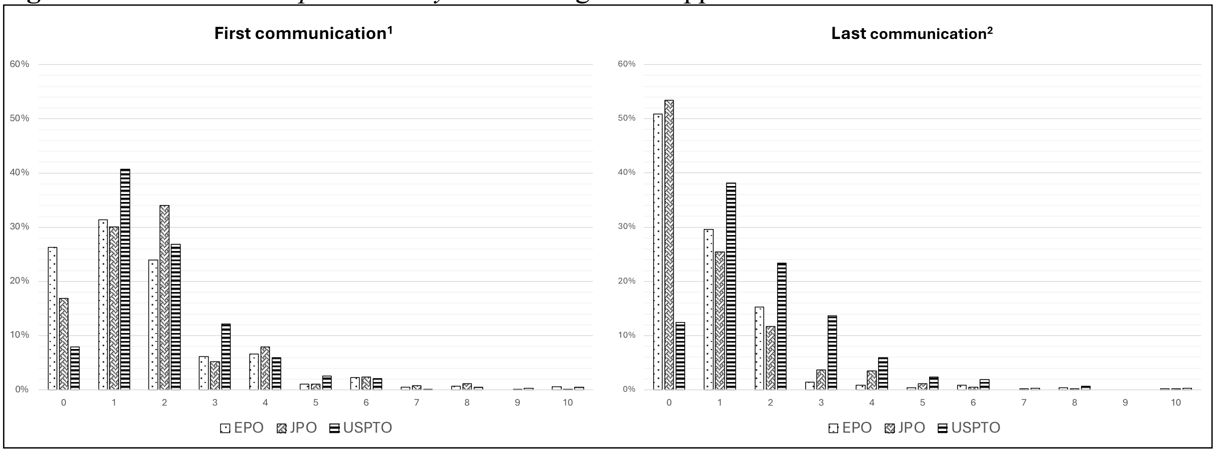
Note: percentages are in parentheses. The 4.590 applications are grouped into 1.530 triadic patent families that cover the same underlying invention (three applications per family).

Table 2. Content of office communications

	All claims						Independent claims					
	EPO		JPO		USPTO		EPO		JPO		USPTO	
In the first communication[1]												
Number of claims examined	14		16		16		2.0		2.0		2.0	
with a lack of novelty	6	*(.40)*	4	*(.21)*	7	*(.41)*	1.2	*(.56)*	0.6	*(.30)*	1.2	*(.55)*
with a lack of inventive step	5	*(.35)*	10	*(.69)*	8	*(.47)*	0.7	*(.34)*	1.5	*(.76)*	0.8	*(.42)*
Patentability issues	11	*(.76)*	14	*(.90)*	14	*(.88)*	1.9	*(.90)*	2.1	*(1.0)*	2.0	*(.98)*
In the last communication[2]												
Number of claims examined	12		14		14		1.6		1.8		2.0	
with a lack of novelty	3	*(.22)*	2	*(.14)*	4	*(.24)*	0.6	*(.36)*	0.3	*(.18)*	0.7	*(.33)*
with a lack of inventive step	4	*(.28)*	8	*(.59)*	9	*(.57)*	0.6	*(.33)*	1.1	*(.64)*	1.1	*(.55)*
Patentability issues	7	*(.51)*	10	*(.72)*	13	*(.81)*	1.2	*(.69)*	1.5	*(.83)*	1.8	*(.89)*
Throughout the entire process[3]												
lack of novelty		*(.32)*		*(.18)*		*(.32)*		*(.46)*		*(.27)*		*(.43)*
lack of inventive step		*(.33)*		*(.65)*		*(.52)*		*(.34)*		*(.71)*		*(.50)*
Patentability issues		*(.64)*		*(.82)*		*(.84)*		*(.80)*		*(.98)*		*(.93)*

Note: values represent the office mean for each variable, in the entire sample of 4.590 applications (over 1.530 triadic families). Relative values are in parentheses (they represent the % of claims with each issue).
(1) First communication from the office (for PCT applications: it corresponds to the first in the regional phase, after the ISR)
(2) Last communication before the end of the process (whether it be a grant, a withdrawal, or a refusal).
(3) Only the percentages are provided as the absolute values directly depend on the number of communications.

Figure 2. Distribution of *patentability issues* for granted applications.



Note: Patentability issues are the number of independent claims with a lack of novelty and/or inventive step. The distribution represents the percentage of granted applications in each case (out of the 944 granted at the EPO, 997 granted at the JPO, and 1082 granted at the USPTO).
(1) First communication from the office (for PCT applications: in the regional phase, after the ISR)
(2) The sample is limited to the granted applications that have more than one office report prior to the grant decision (484 at the EPO, 431 at the JPO, and 587 at the USPTO).

To set a baseline, the distribution of *patentability issues* is studied within the limited sample of applications that were granted by the patent office. This paper focuses specifically on issues found in independent claims because they represent the core elements of the invention and are more consistent across different patent offices. Figure 2 shows the distribution of *patentability issues* in the first and last communications of the office for granted applications (cumulated distributions are available in A1). Overall, it is very rare for successful applications to encounter more than two *patentability issues* in the last office report before the grant decision at the EPO and JPO. This is however more common for a first office report, or at the USPTO.

Based on these distributions, Table 3 presents the thresholds used to define *positive*, *moderate* and *negative* office reports. Since a *positive* office report is one that does not contest the patentability of the invention, it requires zero patentability issues. Also, if the office publishes an intention to grant prior to the application withdrawal, it is automatically considered as a *positive* report, irrespective of the actual number of patentability issues potentially present in prior reports. It is worth noting that the thresholds depend on whether the report is at the beginning or the end of the examination process.

The second element of the strategy from Figure 1 relates to the office-applicant exchanges timeline. Four variables are computed in each application: the last event before the final office decision or applicant withdrawal, the number of office communications, the number of replies from the applicant, and whether it contains amendments on the claims or not. Table 4 presents the distribution for the entire sample as well as the subsample of granted applications. It appears that the last event before the grant decision is a reply from the applicant in the vast majority of granted applications (79% at the EPO, 92% at the JPO, 85% at the USPTO). Also, it is worth noting that successful applicants reply to almost all the office communications (at least 89%). These two elements confirm the intuition behind the strategy laid out in Figure 1. The percentage of replies containing amendments does not present significantly different values for granted applications, which also confirms that it could not be included in Figure 1.

3.3.2. Independent variables

The main variable of interest in equations (1) and (2) is $GRANTS$, a variable that represents the number of applications covering the same underlying invention that are granted by other patent offices. Since the model runs on failed applications, and because triadic patent families are used, it can take a value of 0, 1 or 2. Also, to avoid the constraint that going from 0 to 1 grant has the same impact than 1 to 2 grants, $GRANTS$ is included as a factor variable. This implies that failed applications are split into three separate categories based on what happened to the two applications covering the same invention in the two other offices: they also fail ($GRANTS$=1), one of them is successful ($GRANTS$=1) or both of them are granted ($GRANTS$=2).

To minimize bias in the estimations, several control variables are included.

DOM is a dummy variable that is equal to 1 if the application is domestic, 0 if it is foreign to the patent office. To characterize an application as domestic or foreign, this paper uses the origin of the first filing of the patent family.[14] This is an important variable because the first office where the applicant files is usually either the most important one (in terms of future market prospects) or the one that the inventor knows best. In this sample, there are respectively 34%, 31% and 27% domestic applications at the EPO, JPO, USPTO.

Table 3. Categorization thresholds for office reports

Office reports	patentability issues					
	First communication[1]			Last communication[2]		
	EPO	JPO	USPTO	EPO	JPO	USPTO
Positive[3]	0	0	0	0	0	0
Moderate	1-2	1-2	1-2	1	1	1-2
Negative	3+	3+	3+	2+	2+	3+

Note: Patentability issues are the number of independent claims with a lack of novelty and/or inventive step.
(1) First communication from the office (for PCT applications: first report in the regional phase, after the International Search Report - unless there are no additional office report, then the ISR is used as proxy).
(2) Only if there are more than one office report.
(3) This also includes non-PCT applications with no office report before the failure (it is treated as a 0 patentability issues), and applications that received an "intention to grant" from the office before the failure (whatever the number of patentability issues presented in prior office reports).

Table 4. Last event distribution

	All applications						Granted applications					
	EPO		JPO		USPTO		EPO		JPO		USPTO	
N	1530		1530		1530		944		997		1082	
Application[1]	133	*(.09)*	60	*(.04)*	109	*(.07)*	92	*(.10)*	60	*(.06)*	100	*(.09)*
Office communication	442	*(.29)*	506	*(.33)*	433	*(.28)*	106	*(.11)*	20	*(.02)*	62	*(.06)*
Applicant reply	955	*(.62)*	964	*(.63)*	988	*(.65)*	746	*(.79)*	917	*(.92)*	62	*(.85)*
Amendments ratio[2]	.92		.95		.94		.92		.95		.95	
Number of office communications	1.8		1.7		2.4		1.8		1.5		2.2	
Reply ratio[3]	.76		.73		.89		.89		.99		1.03	

Note: number of applications in each case. Relative values per office are in parentheses.
(1) In this case, the application was granted or failed without any office report (for PCT applications: no additional regional office report after the international search report).
(2) Percentage of replies provided by the applicant that contain amendments.
(3) Number of replies provided by the applicant divided by the number of office communications.

$TYPE$ is a factor variable that separates applicants into three types: public institutions - including academia - and individual inventors ($TYPE = 0$), private companies with less experience ($TYPE = 1$), and private companies with more experience ($TYPE = 2$). A private company is defined as having more experience if there have more than one application to its name in the sample (and less experience if there is only one). In this sample, the distribution is respectively 8% (0), 33% (1), and 59% (2). This factor variable works as a proxy for the economic profile of the applicant and controls for availability of financial resources.

To control for systematic office differences (such as the legal context, examination practices and standards), k is added as a factor variable in the pooled model. It is equal to 1 for EPO, 2 for JPO and 3 for USPTO applications.

The binary variable PCT identifies applications that are filed through the Patent Cooperation Treaty. This variable is necessary as the procedural route chosen has an impact on the reasons why an application might fail. For example, since PCT applications are allowed more time to file subsequent regional applications, uncertain applicants that wish to delay the process while maintaining IP protection might be more inclined to choose this path.

$CLAIMS$ is measured as the number of claims in the application. It controls for the scope of protection sought by the applicant and represents a good proxy for heterogenous drafting styles (van Zeebroeck et al (2009)).

To include the technology class the application belongs to, the international patent classification system is used: the factor variable $IPC1$ is included to categorize applications according to their IPC 1-digit class. This is useful to control for applicant patenting strategies (they are very dependent on the industry according to Cohen et al (2000) and Graham et al (2009)) and examination processes (which are also broadly organized around technology classes).

Finally, $P06_i$ indicates whether the priority date of the application is from 2006 or 2003.

4. RESULTS

4.1. Failure types

The thresholds outlined in Table 3 are applied to all the failed applications from the sample. Table 5 shows that the last office reports are mostly categorized as *negative* for failed JPO applications, and predominantly *moderate* for failed USPTO applications. Notably, over a third of the unsuccessful applications at the EPO received *positive* office reports before their exit (in the sense that the patentability of the invention was not challenged). This proportion goes down to 14% at the JPO and 11% the USPTO (11%).

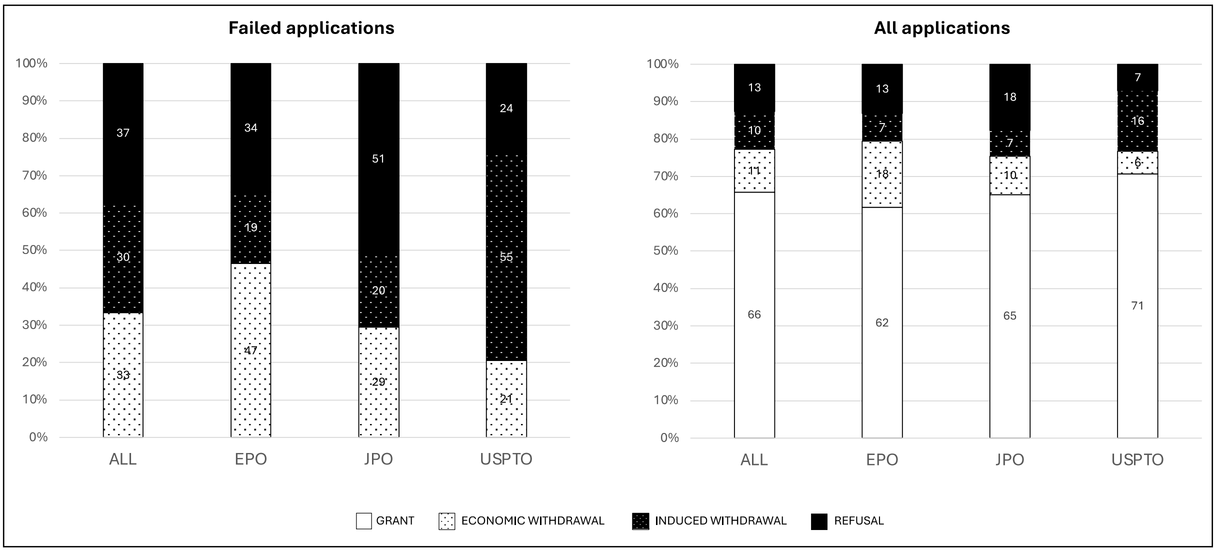
Figure 3 presents the distribution of failure types by applying the strategy described in Figure 1 to all the failed applications from the sample. It shows that a third of all failed applications are estimated to be due to economic forces, with up to 47% for failed EPO applications down to 21% for failed USPTO applications. The primary cause of failure at the EPO, JPO and USPTO is, respectively, *economic withdrawals, refusals,* and *induced withdrawals.* It is also worth noting that failures that are not assumed to be *economic* represent 20% of all EPO applications compared to 25% at the JPO, and 23% at the USPTO. All these proportions are relatively stable across technology classes and application type (see annexes A2 and A3).

Table 5. Nature of last office report for *failed* applications

	ALL failed applications		Failed EPO applications		Failed JPO applications		Failed USPTO applications	
Last office report	**1568**		**587**		**533**		**448**	
Positive	343	*(.22)*	217	*(.37)*	76	*(.14)*	50	*(.11)*
Moderate	670	*(.43)*	194	*(.33)*	186	*(.35)*	290	*(.65)*
Negative	555	*(.35)*	176	*(.30)*	271	*(.51)*	108	*(.24)*

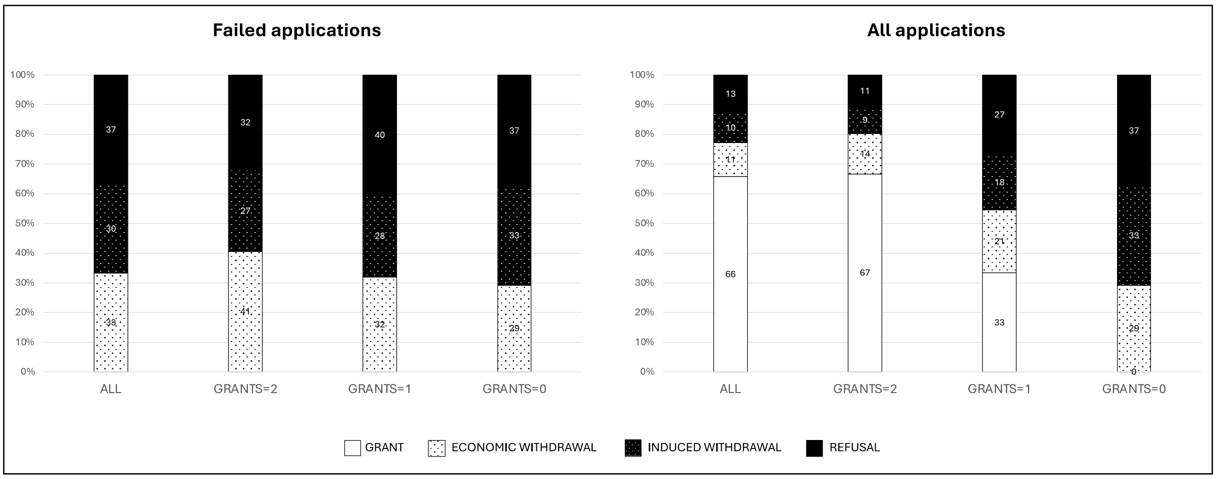
Note: Distribution of type of office reports according to strategy from Table 4, proportions are in parentheses. The last office reports prior to the failures are used.

Figure 3. Distribution of failure types by office



Note: the left-hand graph represents the estimated proportion of each failure type across all failed applications, and depending on the patent office it was submitted to. The right-hand graph illustrates the estimated outcome for all 4.590 applications (1.530 inventions with simultaneous applications at the EPO, the JPO and USPTO). Failure types are assigned following the strategy from Figure 1 and thresholds from Table 3.

Figure 4. Distribution of failure types by outcome in the patent family



Note: the left-hand graph represents the estimated proportion of each failure type across all failed applications, depending on whether the same invention is granted by the other two offices in the same triadic patent family or not. The right-hand graph illustrates the estimated outcome for all 4.590 applications (1.530 inventions with simultaneous applications at the EPO, the JPO and USPTO). Failure types are assigned following the strategy from Figure 1 and thresholds from Table 3.

In Figure 4, the distribution of failure types is displayed across the number of grants that the same invention received in the other two offices. The results estimate that 41% of all failed applications are *economic withdrawals* when the same invention is granted by the two other offices, against 29% when it also failed in the other two offices.

4.2. Multinomial logistic estimates

Table 7 presents the parameter estimates of the multinomial logistic regression for the pooled model (eq.2) and for each office separately (eq.1). For example, column (1) estimates that the probability that a failed application is qualified as an *economic withdrawal* rather than a *refusal* is 57% higher when the same invention is granted by the two other offices (compared to the case where all three applications fail). This effect is particularly strong for failed JPO applications, with a probability to withdraw for economic reasons estimated to be more than twice as high for isolated failures (see column (5)). On the contrary, failed applications at the USPTO are significantly less likely to be categorized as *economic withdrawals* when the same invention is granted in one of the two offices (see column (7)). It is also worth noting that the relative probability for a failed application to be explained by economic forces is significantly lower at the JPO and the USPTO, despite controlling for applicant- and invention-related characteristics.

Table 7. Multinomial logistic RRR estimates on *failed* applications

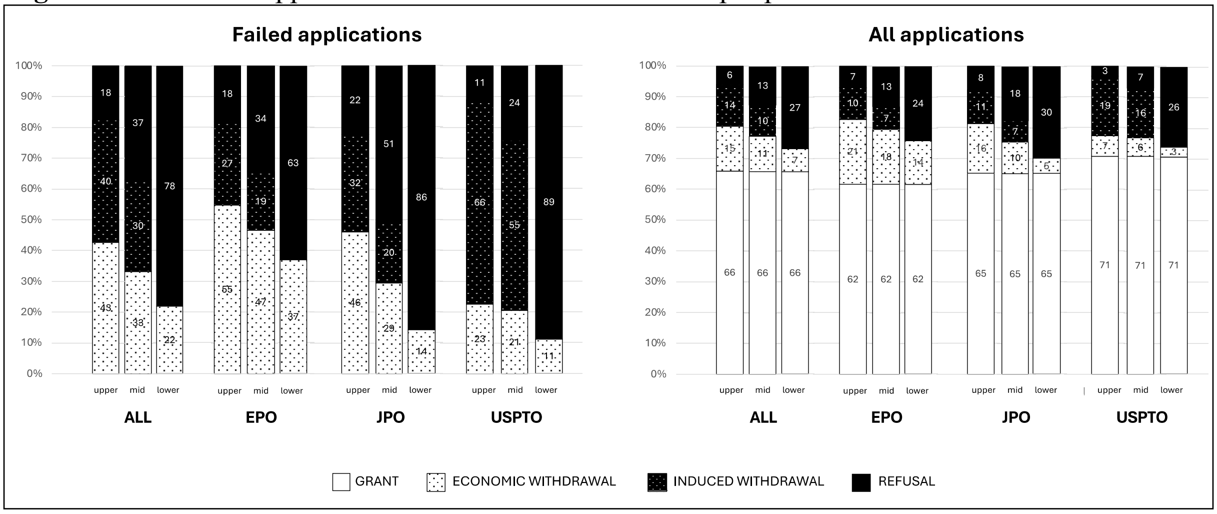
Relative risk ratios	**(eq.2) ALL**		**(eq.1) EPO**		**(eq.1) JPO**		**(eq.1) USPTO**	
baseline: *refusals*	(1) *Economic withdrawal*	(2) *Induced withdrawal*	(3) *Economic withdrawal*	(4) *Induced withdrawal*	(5) *Economic withdrawal*	(6) *Induced withdrawal*	(7) *Economic withdrawal*	(8) *Induced withdrawal*
GRANTS==0								
GRANTS==1	1.01	*0.79	1.17	0.85	1.25	0.96	**0.45	***0.47
	(.152)	*(.124)*	*(.280)*	*(.252)*	*(.308)*	*(.266)*	*(.158)*	*(.134)*
GRANTS==2	***1.57	0.99	*1.45	0.92	***2.30	1.12	1.17	0.95
	(.253)	*(.173)*	*(.364)*	*(.288)*	*(.608)*	*(.354)*	*(.466)*	*(.331)*
DOM	1.20	1.17	*1.43	**1.84	1.40	**1.92	*0.63	***0.46
	(.185)	*(.190)*	*(.346)*	*(.526)*	*(.447)*	*(.652)*	*(.214)*	*(.134)*
TYPE[3]==0								
TYPE[3]==1	0.87	*0.72	0.71	1.04	1.01	0.65	0.83	*0.48
	(.204)	*(.184)*	*(.262)*	*(.486)*	*(.368)*	*(.280)*	*(.571)*	*(.264)*
TYPE[3]==2	0.98	0.80	0.85	0.96	1.12	0.84	0.93	0.56
	(.225)	*(.199)*	*(.301)*	*(.438)*	*(.403)*	*(.348)*	*(.634)*	*(.306)*
PCT	1.06	*0.80	1.13	1.07	1.22	0.79	0.78	**0.58
	(.153)	*(.122)*	*(.245)*	*(.297)*	*(.305)*	*(.220)*	*(.281)*	*(.173)*
P06	0.96	1.08	0.84	1.09	1.03	1.31	1.12	1.02
	(.122)	*(.148)*	*(.166)*	*(.269)*	*(.219)*	*(.321)*	*(.340)*	*(.259)*
CLAIMS	***0.99	***0.97	*0.99	*0.99	0.99	**0.98	*0.99	***0.97
	(.005)	*(.006)*	*(.008)*	*(.010)*	*(.007)*	*(.010)*	*(.010)*	*(.011)*
IPC1 == A								
IPC1 == B	0.88	*0.66	1.37	0.63	1.01	0.71	***0.23	**0.33
	(.236)	*(.186)*	*(.626)*	*(.338)*	*(.434)*	*(.365)*	*(.143)*	*(.175)*
IPC1 == C	0.80	**0.55	0.90	*0.45	0.91	0.60	**0.38	**0.40
	(.196)	*(.146)*	*(.367)*	*(.219)*	*(.362)*	*(.289)*	*(.216)*	*(.208)*
IPC1 == D	0.78	0.77	0.90	0.86	1.12	0.80	**0.32	0.50
	(.241)	*(.246)*	*(.490)*	*(.515)*	*(.541)*	*(.464)*	*(.211)*	*(.291)*
IPC1 == E	0.49	0.50	1.75	0.00	0.00	1.71	0.00	*0.11
	(.380)	*(.397)*	*(2.12)*	*(.002)*	*(.001)*	*(1.90)*	*(.001)*	*(.156)*
IPC1 == F	0.95	0.93	1.21	0.61	0.91	1.08	0.56	0.86
	(.250)	*(.254)*	*(.537)*	*(.317)*	*(.379)*	*(.499)*	*(.364)*	*(.505)*
IPC1 == G	***0.42	***0.43	***0.37	***0.31	0.84	*0.48	***0.16	***0.29
	(.103)	*(.110)*	*(.144)*	*(.136)*	*(.340)*	*(.234)*	*(.094)*	*(.148)*
IPC1 == H	***0.54	***0.49	*0.56	***0.33	0.79	1.38	***0.18	***0.13
	(.139)	*(.133)*	*(.226)*	*(.156)*	*(.343)*	*(.639)*	*(.108)*	*(.074)*
k==EPO								
k==JPO	***0.42	**0.70						
	(.059)	*(.119)*						
k==USPTO	***0.61	***4.10						
	(.106)	*(.698)*						
Intercept	**2.12	**2.10	*2.17	1.29	*0.41	0.72	**6.87	***48.7
	(.760)	*(.809)*	*(1.22)*	*(.873)*	*(.227)*	*(.454)*	*(6.42)*	*(39.6)*
GRANTS effect[1]	.007	.255	.334	.867	.005	.890	.025	.016
Identical GRANTS effect[2]	.005	.197	.364	.813	.017	.632	.018	.040
N	1568	1568	587	587	533	533	448	448

Asterisks denote one-sided statistical significance at *10%, **5%, and ***1%.
(1) P-value of the Fisher test on whether at least one of the *GRANTS* coefficients is significant.
(2) P-value of the Fisher test on whether the impact of *GRANTS==1* is identical to that of *GRANTS==2*.
(3) 0 for public institutions (incl. academia) or individuals, 1 for private companies with less experience, 2 for private companies with more experience

4.3. Robustness and limitations

One of the limitations of this empirical strategy relates to the intertwined nature of the patentability process and the economic forces. If the scope of the application is reduced because some of it is not patentable, this in turn decreases future economic prospects. A withdrawal in such a case could both be considered economic and related to patentability issues. However, since the methodology presented above does not treat these cases as *economic*, the proportion of economic withdrawals is more likely underestimated. To mitigate this problem, two alternative classification methods are considered to set a lower and an upper bound to the estimated proportion of *economic withdrawals* (the estimation from the main results is referred to as "mid" for mid-range). For the lower estimate, failed applications are assumed *economic* in only two situations: either the patent office never challenged the patentability of the invention, or it did but then published an intention to grant the patent. In this lower estimate, no distinction is made between *induced withdrawals* and *refusals*. The upper estimate is aligned with the main methodology except that office reports need to challenge patentability more strongly to be considered *negative* (see A5 for the alternative thresholds: for example, an EPO report with two patentability issues in the last communication is considered *moderate* instead of *negative*). As illustrated in Figure 5, these two alternative estimations are consistent with the one presented in the main results: 22 to 43% of all failed applications could be explained by economic forces (37-55% at the EPO, 14-46% at the JPO, and 11-23% at the USPTO).

Figure 5. Lower and upper bound of economic withdrawals per patent office



Note: Upper, midrange and lower estimates of the economic withdrawal proportion. The midrange estimates are the same as in Figure 3. The lower estimates do not distinguish refusals from induced withdrawals (the black box comprises the two).

Furthermore, since the distinction between *induced withdrawals* and *refusals* is also subject to debate, a binary approach is considered: failures are either classified as *economic* or not. Here, the multinomial logistic regressions are replaced by logit models (using odds ratios instead of relative risk ratios). Table 8 presents the logit estimates for the three estimations of *economic withdrawals*: they are consistent with prior analyses, with slightly more statistical significance. This is not surprising since multinomial models are more complex than logistic ones.

With regards to the econometric results from Table 7 and 8, some omitted factors could have generated bias. Firstly, one could suspect that the timing of the exit with regards to the fee structure of the office might be an indicator of a failure that is explained by economic factor. However, since fees are directly dependent on the office procedures, the risks should be mitigated by the office dummies in the pooled model (eq.1), as well as the fact that the econometric model is estimated separately in each office (eq.2).

Another missing element is the length of the process. A few proxies were considered such as the number of office communications and applicant replies, the time passed before the first and last office communications as well as the total duration of the examination process (mean values are available in A4). The trend shows that granted applications have less office communications and shorter examination processes. While a longer examination process (in terms of time passed or applicant-office exchanges) is more likely to result in a failed application, distinguishing whether it could be attributed to economic forces or not is more difficult. For example, it could be the result of a long negotiation process with patentability challenges that are difficult to overcome (and therefore be attributable to a *refusal*). However, the longer the examination lasts, the more costs add up, creating a potential imbalance in the expected return of the patent and making it more likely for the failure to be *economic*. Overall, the conflicting interpretations of these time variable might cancel out, which would mitigate the omitted variable bias.

Table 8. Logistic odds ratios on *failed* applications: upper, lower, and mid-range estimations

	ECONOMIC WITHDRAWALS											
	ALL			**EPO**			**JPO**			**USPTO**		
Odds ratios	(1) UPPER	(2) MID	(3) LOWER	(4) UPPER	(5) MID	(6) LOWER	(7) UPPER	(8) MID	(9) LOWER	(10) UPPER	(11) MID	(12) LOWER
GRANTS==0												
GRANTS==1	1.09	1.13	1.09	**1.46	1.29	1.23	1.01	1.27	***2.23	0.80	0.78	***0.36
	(.505)	*(.354)*	*(.588)*	*(.076)*	*(.227)*	*(.346)*	*(.969)*	*(.304)*	*(.017)*	*(.430)*	*(.380)*	*(.012)*
GRANTS==2	***1.43	***1.59	**1.43	**1.45	**1.52	*1.45	**1.71	***2.24	***3.57	1.23	1.23	*0.58
	(.009)	*(.001)*	*(.030)*	*(.094)*	*(.057)*	*(.104)*	*(.021)*	*(.001)*	*(.000)*	*(.479)*	*(.493)*	*(.182)*
DOM	1.06	*1.19	1.05	1.12	1.21	1.03	0.96	1.08	0.88	1.23	1.11	0.97
	(.636)	*(.198)*	*(.744)*	*(.600)*	*(.353)*	*(.890)*	*(.868)*	*(.783)*	*(.756)*	*(.441)*	*(.696)*	*(.931)*
$TYPE^3$==0												
$TYPE^3$==1	1.10	0.94	1.18	*0.59	*0.63	0.71	*1.56	1.14	***4.44	1.70	1.46	1.01
	(.636)	*(.772)*	*(.511)*	*(.116)*	*(.152)*	*(.297)*	*(.162)*	*(.713)*	*(.020)*	*(.318)*	*(.485)*	*(.988)*
$TYPE^3$==2	1.06	1.03	1.31	0.74	0.80	0.95	1.21	1.17	***4.42	1.60	1.42	0.99
	(.751)	*(.893)*	*(.263)*	*(.342)*	*(.470)*	*(.861)*	*(.541)*	*(.644)*	*(.020)*	*(.369)*	*(.507)*	*(.988)*
PCT	1.03	*1.20	**1.40	0.84	1.17	*1.40	1.12	1.31	1.07	1.31	1.16	**2.09
	(.821)	*(.161)*	*(.027)*	*(.390)*	*(.433)*	*(.100)*	*(.605)*	*(.253)*	*(.813)*	*(.331)*	*(.597)*	*(.079)*
P06	0.96	0.90	0.96	0.83	*0.76	0.88	0.93	0.96	1.21	1.23	1.10	0.81
	(.713)	*(.336)*	*(.738)*	*(.299)*	*(.112)*	*(.475)*	*(.700)*	*(.842)*	*(.474)*	*(.386)*	*(.702)*	*(.526)*
CLAIMS	*0.99	1.00	1.00	*0.99	0.99	0.99	0.99	0.99	**1.01	1.00	1.00	1.01
	(.188)	*(.336)*	*(.250)*	*(.135)*	*(.303)*	*(.481)*	*(.221)*	*(.449)*	*(.044)*	*(.738)*	*(.887)*	*(.421)*
IPC1 == A												
IPC1 == B	1.06	1.11	1.40	**2.27	**1.87	**1.93	0.69	1.11	0.85	0.72	*0.56	1.15
	(.799)	*(.643)*	*(.201)*	*(.032)*	*(.096)*	*(.084)*	*(.315)*	*(.806)*	*(.761)*	*(.438)*	*(.187)*	*(.796)*
IPC1 == C	1.14	1.05	*1.37	**1.84	1.30	1.50	0.83	1.03	1.24	0.87	0.79	1.05
	(.522)	*(.831)*	*(.197)*	*(.078)*	*(.443)*	*(.251)*	*(.581)*	*(.934)*	*(.641)*	*(.726)*	*(.549)*	*(.921)*
IPC1 == D	0.95	0.89	1.00	1.14	0.97	1.53	1.11	1.18	0.75	0.55	0.55	0.48
	(.850)	*(.654)*	*(.997)*	*(.768)*	*(.937)*	*(.345)*	*(.801)*	*(.709)*	*(.631)*	*(.231)*	*(.227)*	*(.314)*
IPC1 == E	0.72	0.68	0.85		3.74	1.99						
	(.624)	*(.589)*	*(.846)*		*(.272)*	*(.515)*						
IPC1 == F	1.11	1.01	0.96	**2.30	*1.66	1.33	0.73	0.87	*0.46	0.76	0.62	0.86
	(.643)	*(.973)*	*(.893)*	*(.026)*	*(.168)*	*(.453)*	*(.372)*	*(.717)*	*(.142)*	*(.508)*	*(.267)*	*(.791)*
IPC1 == G	0.78	**0.66	*0.67	1.09	0.71	0.72	0.74	1.01	0.70	*0.52	**0.42	*0.42
	(.211)	*(.049)*	*(.110)*	*(.798)*	*(.289)*	*(.337)*	*(.387)*	*(.972)*	*(.474)*	*(.130)*	*(.048)*	*(.155)*
IPC1 == H	*0.73	*0.74	*0.70	0.98	0.90	0.69	**0.54	0.70	0.52	0.91	0.70	1.15
	(.155)	*(.190)*	*(.184)*	*(.949)*	*(.768)*	*(.315)*	*(.095)*	*(.372)*	*(.216)*	*(.822)*	*(.436)*	*(.810)*
k==EPO												
k==JPO	***0.64	***0.45	***0.27									
	(.000)	*(.000)*	*(.000)*									
k==USPTO	***0.21	***0.27	***0.20									
	(.000)	*(.000)*	*(.000)*									
Intercept	1.25	0.83	***0.32	1.49	0.97	*0.45	0.83	***0.25	***0.19	***0.17	**0.24	***0.12
	(.375)	*(.257)*	*(.116)*	*(.720)*	*(.465)*	*(.225)*	*(.391)*	*(.133)*	*(.016)*	*(.111)*	*(.159)*	*(.098)*
N	1568	1568	1568	587	587	587	529	529	529	445	445	445

Asterisks denote one-sided statistical significance at *10%, **5%, and ***1%.

Moreover, the size of the applicant is not included in the models, despite its potential to control for the availability of financial resources. This variable is particularly challenging to incorporate for international companies due to their complex organizational structures with various branches and subdivisions. Having included the experience of the applicant should however help mitigating this bias: an applicant that submits a higher number of inventions is more likely to possess extensive financial means.

Finally, one of the concerns that could be raised is about the sample: its size and the potential for external validity. Because the analysis is limited to triadic patent families, the results might not be applicable to the entire population of patent applications. However, because international applications are usually of higher economic value, and because this sample has a particularly high proportion of private companies as applicants, one would suspect that the economic factor is underestimated. An applicant would indeed be less likely to drop out of a process if he has vast financial resources or if the invention has high financial stakes. Ideally, future research could aim to adapt the methodology introduced in this paper so that it can be based on information available in PATSTAT rather than having to be manually collected. This would allow for an extended sample size, both in terms of volume and diversity of applicants. It could also include additional patent offices. Such an extended database could also allow for more dynamic models where the number of grants would only consider decisions that occurred prior to the failure of the application.

5. CONCLUDING REMARKS

This paper introduces a new dimension to the discussion about the rigor of patent offices by highlighting the important role of economic forces. Around a third of non-granted applications might have failed due to economic reasons, with a significantly higher proportion at the EPO: 47% compared to 29% at the JPO, and 21% at the USPTO. Distinguishing between economic and non-economic failures challenges the assumption that lower grant rates at the EPO might be a sign of more stringent examination standards. In fact, this paper estimates that the proportion of applications that were either refused or induced to withdraw because of strong patentability issues is lower at the EPO compared to its Japanese and American counterparts.

Furthermore, this paper finds that the probability for a failed application to be due to economic forces rather than caused by challenges to the patentability of the invention is significantly higher when the same invention succeeds in other patent offices. At the JPO, this relative probability is estimated to double if the EPO and USPTO applications are successful compared to the situation where the three applications fail. The fact that an isolated failure is more likely caused by economic elements than by patentability issues suggests that heterogenous outcomes across patent offices that process the same invention should not necessarily be seen as an indicator of varying stringency levels.

Also, even after controlling for invention- and applicant- related characteristics, this paper finds that the probability to fail because of economic forces is significantly higher at the EPO. However, it does not provide answers as to why it is the case. Possible explanations include a smaller market size, higher procedural costs, or a longer examination process. For future research to investigate these factors, adding a time dimension would be useful.

Finally, as any other public information, grant statistics reported by patent offices or results published by researchers can quickly take a life of their own, often losing the necessary caveats attached to them. This, in turn, creates a general perception of the patent system that can potentially become a self-fulfilling prophecy, altering applicant behavior and affecting both the demand and outcomes of patent examination processes. These concerns reinforce the need for increased transparency form both patent offices and applicants when an application fails. Patent office reports could publish more accessible conclusions, helping to clarify the severity of the patentability challenges. Additionally, requiring applicants to provide justifications upon withdrawal would better illuminate applicants' strategies and constraints. The "Notice of Abandonment" document within the USPTO process is a good starting point: it gives the applicant the opportunity to detail the reasons behind their exit. These improvements would significantly support further research on patent examination outcomes and assist applicants in making informed strategic decisions.

FOOTNOTES

[1] This average is computed based on the grant rates published in the last 12 annual IP5 Statistics reports.

[2] In the EPO Quality Report 2022, an annex to the EPO Annual Report 2022.

[3] See Art.54 of the European Patent Convention (Part II, Chapter 1), Art.29(1) in the Examination Guidelines for Patent and Utility Model in Japan (Part III, Chapter 2), and Art.102 of the United States Code Title 35 (Part II).

[4] See Art.54 of the European Patent Convention (Part II, Chapter 1), Art.29(1) in the Examination Guidelines for Patent and Utility Model in Japan (Part III, Chapter 2), and Art.102 of the United States Code Title 35 (Part II).

[5] See Art.57 of the European Patent Convention (Part II, Chapter 1), Art.29(1) in the Examination Guidelines for Patent and Utility Model in Japan (Part III, Chapter 2), and Art.101 of the United States Code Title 35 (Part II).

[6] At the EPO, the European search report is published at the same time as the application, then, if the applicant still requests the examination, the office might provide additional communications. At the JPO, the patentability is assessed after the request for examination, through "Notices of Reasons for Refusal" or in "Decisions to Refuse". At the USPTO, the office evaluates the patentability in "Non-Final Rejections" and "Final Rejections".

[7] At the EPO, the applicant first pays granting fees (translation and validation in national offices) then annual renewal fees starting in the third year of the patent and increasing over the years. At the JPO, the applicant must pay registration fees then annual renewal fees starting in the third year and increasing over the years. At the USPTO, the applicant must pay issue fees then renewal fees are collected after 3.5, 7.5 and 11.5 years.

[8] A “Decision to refuse” is rare at the EPO, but definitive in the sense that the regular examination process ends and the applicant must submit an appeal to try to overturn it. This decision must follow a strict process with multiple levels of accountability. At the JPO, a “Decision to Refuse” is not as definitive: in many instances, granted applications received a “decision to refuse” and were still allowed to reply and potentially modify their claims without entering a separate appeal procedure. At the USPTO, a “Final Rejection” is also rarely truly final as the applicant still has opportunities to reply and move the process forward (for example via a “request for continued examination”). It is very common to see more than one “Final Rejection” document in the same application process, even for granted patents, without having introduced an official appeal process.

[9] The Paris Convention for the Protection of Industrial Property provide the applicant a period of 12 months after the initial filing during which he can submit additional applications in other regional offices to protect the same invention, with the same priority date. The Patent Cooperation Treaty (PCT) allows the applicant to submit a single application, for which an International Search Authority is chosen to search for prior art and write an International Search Report and a preliminary and non-binding opinion on patentability. During a period of 31 months after the priority date, this same application can be transferred to regional offices.

[10] Controversial domains are subject matters that are legally patentable in some offices but not in others (for example, software and business methods are patentable at the USPTO but not at the EPO and JPO). The various outcomes of these domains is directly linked to heterogenous legal system rather than office stringency levels or applicant interests.

[11] The same reasoning applies to PCT applications that are withdrawn between the ISR and the first regional office communication since the applicant already had a first opinion on patentability before submitting its subsequent regional filings.

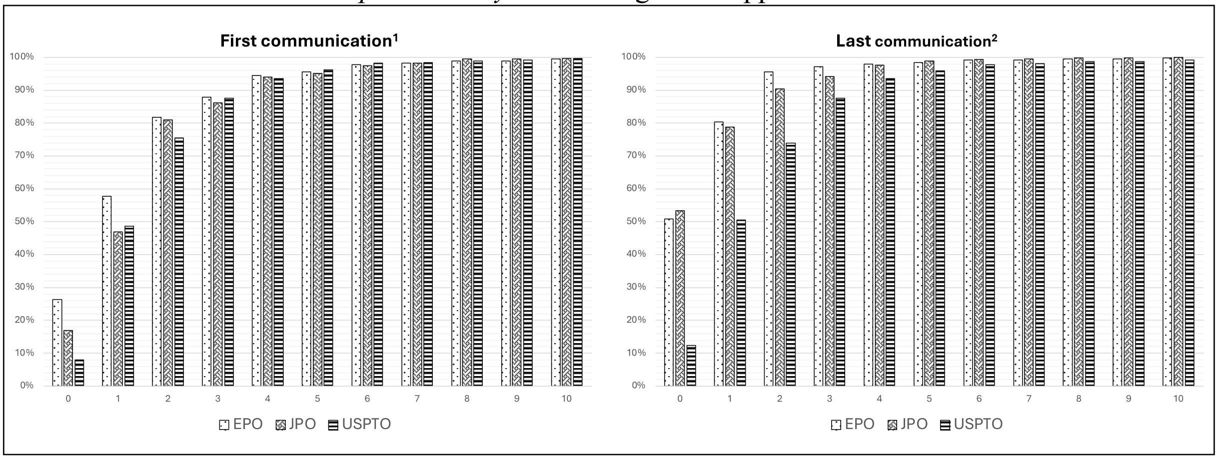
[12] In Petit et al. (2023), the first sample is composed of 2.400 patent families. After dropping out duplicates, unavailable Global Dossier files, and families where one of the three patent offices had no substantive communication, the final dataset comprises 1.628 families.

[13] Novelty is described in “art.54” at the EPO, “art.29(1)” at the JPO, and “art.35(102)” at the USPTO. If no European Search Opinion appears in the EPO dossier, “X” citations are used instead. Inventive step is described in “art.56” at the EPO, “art.29(2)” at the JPO, and “art.35(103)” at the USPTO. If no European Search Opinion appears in the EPO dossier, “Y” citations are used instead even though they do not represent inventive step issues but rather documents that need to be taken in combination with others to contest patentability. Since European Search Opinions are usually available, this should not be too problematic.

[14] For European filings, all EPC country codes are treated as domestic to the EPO.

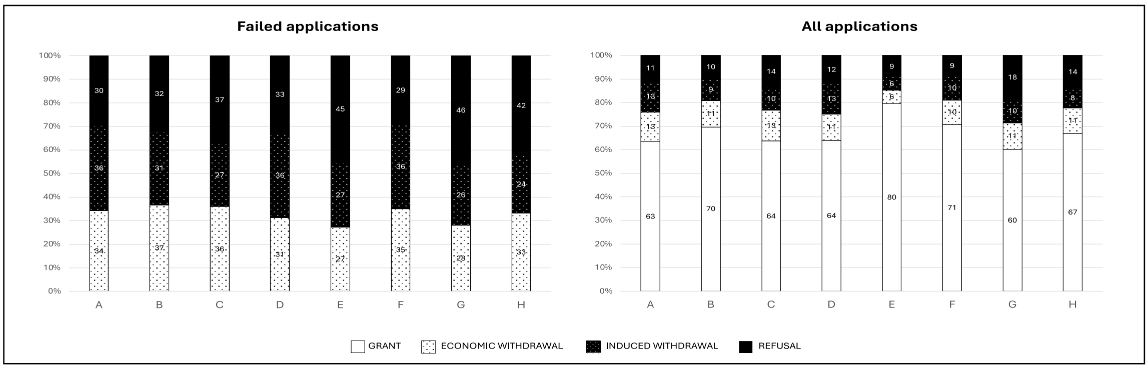
ANNEXES

A1. Cumulated distribution of *patentability issues* for granted applications.



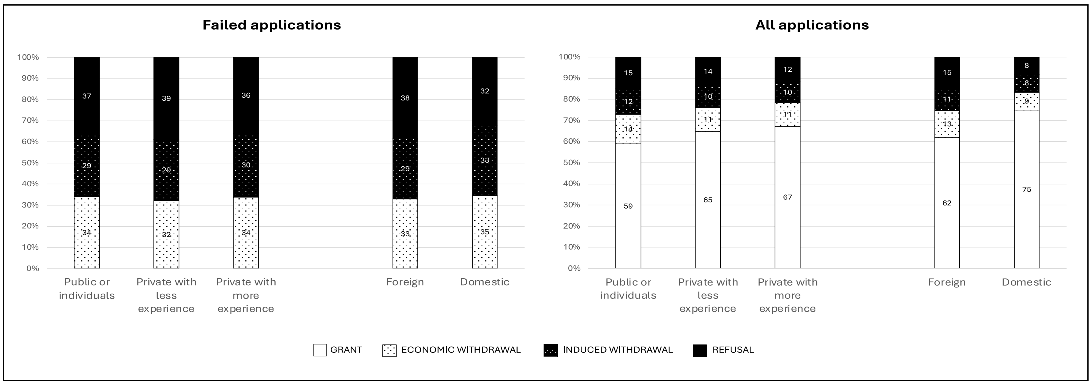
Note: Patentability issues are the number of independent claims with a lack of novelty and/or inventive step. The distribution represents the percentage of granted applications with each value or less (out of the 944 granted at the EPO, 997 granted at the JPO, and 1082 granted at the USPTO).
(1) First communication from the office (for PCT applications: in the regional phase, after the ISR)
(2) The sample is limited to the granted applications that have more than one office report prior to the grant decision (484 at t

A2. Distribution of failure types by IPC technology class



Note: the left-hand graph represents the estimated proportion of each failure type across all failed applications, and depending on the technology class it belongs to (IPC). The right-hand graph illustrates the estimated outcome for all 4.590 applications (1.530 inventions with simultaneous applications at the EPO, the JPO and USPTO). Failure

A3. Distribution of failure types by applicant type



Note: the left-hand graph represents the estimated proportion of each failure type across all failed applications, and depending on applicant characteristics (type and origin). The right-hand graph illustrates the estimated outcome for all 4.590 applications (1.530 inventions with simultaneous applications at the EPO, the JPO and USPTO). Failure types are assigned following the strategy from Figure 1 and thresholds from Table 3.

A4. Time variables

	All applications			Granted applications		
Mean values	EPO	JPO	USPTO	EPO	JPO	USPTO
N	1530	1530	1530	944	997	1082
Number of office communications	1.8	1.7	2.4	1.8	1.5	2.2
Number of applicant replies	1.4	1.2	2.3	1.6	1.5	2.2
Number of years to first office communication	3.9	5.5	4.0	3.7	5.4	3.8
Number of years to last office communication	5.6	6.0	5.0	5.3	5.8	4.7
Number of years to end of the process	7.0	6.3	5.5	6.7	6.2	5.1

A5. Alternative categorization thresholds for office reports

	patentability issues					
	First communication[1]			**Last communication[2]**		
Office reports	EPO	JPO	USPTO	EPO	JPO	USPTO
Positive[3]	0	0	0	0	0	0
Moderate	1-4	1-4	1-4	1-2	1-2	1-3
Negative	5+	5+	5+	3+	3+	4+

Note: Patentability issues are the number of independent claims with a lack of novelty and/or inventive step.
(1) First communication from the office (for PCT applications: first report in the regional phase, after the International Search Report - unless there are no additional office report, then the ISR is used as proxy).
(2) Only if there are more than one office report.
(3) This also includes non-PCT applications with no office report before the failure (it is treated as a 0 patentability issues), and applications that received an "intention to grant" from the office before the failure (whatever the number of patentability issues presented in prior office reports).

BIBLIOGRAPHY

Bessen, J. and Meurer, M.J., "Do patents perform like property?", *Academy of Management Perspectives* 22:3 (2008), 8–20.

Bloom, N. and Van Reenen, J., "Patents, Real Options and Firm Performance", *Economic Journal* 112:478 (2002), C97–C116.

Burke, P. and Reitzig, M., "Measuring patent assessment quality – analyzing the degree and kind of (in)consistency in patent offices' decision making", *Research Policy* 36:9 (2007), 1404–1430.

Cockburn, I., Kortum, S. and Stern, S., "Are all patent examiners equal? Examiners, patent characteristics, and litigation outcomes", in *Patents in the Knowledge-Based Economy* 19 (2003), 52–53.

Cohen, W.M., Nelson, R.R. and Walsh, J.P., "Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not)", *NBER Working Paper* No. 7552 (2000).

Cornelli, F. and Schankerman, M., "Patent Renewals and R&D Incentives", *RAND Journal of Economics* 30:2 (1999), 197–213.

Christie, A., Dent, C. and Liddicoat, J., "The examination effect: a comparison of the outcome of patent examination in the US, Europe and Australia", *J. Marshall Rev. Intell. Prop. L.* 16 (2016), i.

De Rassenfosse, G. and van Pottelsberghe de la Potterie, B., "On the price elasticity of demand for patents", *Oxford Bulletin of Economics and Statistics* 74:1 (2012), 58–77.

De Saint-Georges, M. and van Pottelsberghe de la Potterie, B., "A Quality Index for Patent Systems", *Research Policy* 42:3 (2013), 704–719.

De Rassenfosse, G. and Raiteri, E., “Technology protectionism and the patent system: Strategic technologies in China”, *Research Policy* 45:7 (2016), 1387–1396.

De Rassenfosse, G., Dernis, H., Guellec, D., Picci, L. and van Pottelsberghe de la Potterie, B., “The worldwide count of priority patents: A new indicator of inventive activity”, *Research Policy* 48:4 (2019), 1061–1075.

De Rassenfosse, G. and Hosseini, R., “Discrimination against foreigners in the U.S. patent system”, *Journal of International Business Policy* 3 (2020), 349–366.

Frakes, M.D. and Wasserman, M.F., “Is the time allocated to review patent applications inducing examiners to grant invalid patents?”, *Review of Economics and Statistics* 99:3 (2017), 550–563.

Gambardella, A., Harhoff, D. and Verspagen, B., “The Value of European Patents”, *European Management Review* 5:2 (2008), 69–84.

Gimeno-Fabra, L. and van Pottelsberghe de la Potterie, B., “Decoding patent examination services”, *Economics of Innovation and New Technology* (2020). 10.1080/10438599.2020.1766183.

Graham, S.J., Merges, R.P., Samuelson, P. and Sichelman, T., “High Technology Entrepreneurs and the Patent System”, *Berkeley Technology Law Journal* 24:4 (2009), 1255–1328.

Guellec, D., Martinez, C. and Zuniga, P., “Pre-emptive patenting: securing market exclusion and freedom of operation”, *Economics of Innovation and New Technology* 21:1 (2012), 1–29.

Hall, B.H. and Harhoff, D., “Post-Grant Reviews in the U.S. Patent System – Design Choices and Expected Impact”, *Berkeley Technology Law Journal* 19:3 (2004), 989–1015.

Harhoff, D., Hoisl, K., Reichl, B. and van Pottelsberghe, B., “Patent validation at the country level”, *Research Policy* 38:9 (2009), 1423–1437.

Henkel, J. and Jell, F., “Patent Pending – Why faster isn’t always better”, *SSRN Working Paper* (2010), 1738912.

Jaffe, A.B. and Lerner, J., “Patent Prescription: a radical cure for the ailing US patent policy”, *IEEE Spectrum* 41:12 (2004), 38–43.

Kotabe, M., “A Comparative study of US and Japanese patent systems”, *Journal of International Business Studies* 23:1 (1992), 147–168.

Lanjouw, J.O. and Schankerman, M., “Patent Quality and Research Productivity”, *Economic Journal* 114:495 (2004), 441–465.

Lazaridis, G. and van Pottelsberghe de la Potterie, B., “Economic incongruities in the European patent system”, *World Patent Information* 29:3 (2007), 268–269.

Lemley, M.A. and Sampat, B., “Examiner characteristics and patent office outcomes”, *Review of Economics and Statistics* 94:3 (2012), 817–827.

Liegsalz, J. and Wagner, S., “Patent examination at the State Intellectual Property Office in China”, *Research Policy* 42 (2013), 552–563.

Matcham, W. and Schankerman, M., “Property Rights for Innovation: a Structural Model of Patent Screening”, *SSRN Working Paper* (2023), 4519999.

Palangkaraya, A., Webster, E. and Jensen, P.H., “Misclassification between patent offices”, *Review of Economics and Statistics* 93 (2011), 1063–1075.

Petit, E., van Pottelsberghe de la Potterie, B. and Gimeno-Fabra, L., “Are patent offices substitutes?”, *Research Policy* 52:8 (2023), 104823.

Petit, E., van Pottelsberghe de la Potterie, B. and Gimeno-Fabra, L., “Global patent systems: revisiting the national bias hypothesis”, *Journal of International Business Policy* (2021), 1–12.

Pakes, A. and Schankerman, M., “The rate of obsolescence of patents”, in *R&D, Patents, and Productivity* (1984), 73–88.

Van Pottelsberghe de la Potterie, B., “The Quality Factor in Patent Systems”, *Industrial and Corporate Change* 20:6 (2011), 1755–1793.

Van Zeebroeck, N., van Pottelsberghe de la Potterie, B. and Guellec, D., “Claiming more: the increased voluminosity of patent applications”, *Research Policy* 38:6 (2009), 1006–1020.

Van Zeebroeck, N., “Long Live Patents”, *Review of Economics and Institutions* 2:3 (2011).

Van Zeebroeck, N. and van Pottelsberghe de la Potterie, B., “Filing strategies and patent value”, *Economics of Innovation and New Technology* 20:6 (2011), 539–561.

Webster, E., Palangkaraya, A. and Jensen, P.H., “Characteristics of international patent application outcomes”, *Economics Letters* 95 (2007), 362–368.

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