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Determinants of Patent Withdrawals: Evidence from a Sample of Italian applications with the EPO

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Abstract

This paper analyses the propensity to withdraw European patent applications within a regional sample of Italian applicants. The procedure for obtaining a granted patent from the EPO is composed of a series of sequential and selective steps imposing additional costs to the applicants. Accordingly, we argue that early withdrawals - i.e. those occurring before the proper examination process begins - should be treated separately from late withdrawals. Our findings show the probability of an early withdrawal is higher for applicants with lower resources and competencies and rises with the number of backward citations added by EPO examiners to the original application. Late withdrawals, instead, are negatively affected by one factor only: the size of patent family, which approximates the sunk costs born by applicants in order to extend the geographical scope of patent protection. Such a limited explanation suggests that the (unobserved) interventions of EPO examiners are likely to play a significant role in inducing late withdrawals.

Keywords: Patent withdrawals; Applicants' features; Patent quality; Patent examination.

JEL codes: O31, O34.

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1. Introduction

A patent application published by the EPO provisionally confers upon the applicant the same protection degree that is conferred to a granted patent¹. However, in order to obtain a permanent and perfected right to exclude others from exploiting the invention, a patent grant is needed. Some applicants may be content to have their applications published as, in this way, they create prior art and prevent that the inventions will be patented by competitors. Although the diffusion of this ‘strategic’ practice² is not negligible, it can be safely assumed that the ultimate goal of the large majority of applicants is to get a granted patent.

To do so, they must go through various sequential steps before obtaining the final decision from the patent office. The examination process at the EPO involves a long time: at best, it can last three years but, due to the staggering increase in number and size of patent applications³, the delay in the granting process can be much longer.

The subsequent steps required to obtain a granted patent from the EPO can be summarized as follows (cf. Haroff and Wagner, 2006; Lazaridis and van Pottelsberghe, 2007):

1. By 18 months after an application is filed, the EPO search office in The Hague sends to the applicant a search report, and the process is transferred to the Munich office. This report, in particular, describes the state of prior art that might affect the patentability of the invention. At the same time, the application is published in the EPO Bulletin as well as in its Web site.
2. In order to advance through the process, the applicant must file the request for the examination and pay the examination fees. If she does not comply with these requirements within 6 months of receipt of the search report, the application is *deemed to be withdrawn*. Alternatively, the applicant can explicitly withdraw her application.
3. In the other cases, the applicant requests for the examination and pays the relevant fees.

¹“A European patent application shall, from the date of its publication under Article 93, provisionally confer upon the applicant such protection as is conferred [to granted patents] by Article 64, in the Contracting States designated in the application as published” (Article 67(1) EPC). In addition, “every State shall ensure at least that, from the date of publication of a European patent application, the applicant can claim compensation reasonable in the circumstances from any person who has used the invention in the said State in circumstances where that person would be liable under national law for infringement of a national patent” (Article 67(2) EPC).

² This is one of the possible ways to implement the strategy of ‘defensive publishing’. For a recent study on this topic see Henkel and Pangerl (2008).

³ On these issue see Archontopoulos et al. (2007).

During the examination procedure, she can receive one or more communications from EPO examiners asking for additional information, revisions and/or cancellations of the claims included in the patent application. If the applicant (i.e. her patent attorney) does not reply to those letters within 6 months or does not show up when an oral proceeding is fixed, the application is deemed to be withdrawn. Obviously, also in these phases the applicant can pro-actively withdraw her application.

4. At the end of the examination process, the EPO informs the applicant whether the patent is refused or *intended to be granted*. In the latter case, the applicant must pay a final set of fees and provide the translations of the patent document. Again, if these obligations are not fulfilled in a due time the patent is deemed to be withdrawn.

Lazaridis and Van Pottelsberghe (2007) consider the patent applications filed with the EPO from 1985 to 2004 and, neglecting those with pending decisions, they show that the share of refusals is 5% while the average granting rate is 60%. Thus, about 35% of the filed applications do not reach the final stage because they are (explicitly or implicitly) withdrawn by the applicants. Accordingly, there are good reasons for analyzing the motivations behind such a diffuse behaviour.

It must be stressed that, before the 2000 reform, in the US only the patent granted by the USPTO could be disclosed so that it was not possible to break down the non-granted patents into refusals and withdrawals. This is the main reason why, in the literature, there are many studies concerned with the determinants of patent grants while the phenomenon of patent withdrawals has been so far examined by a limited number of works concerned with EPO applications.

This paper is focussed upon the determinants of early and late withdrawals arising from a regional sample of Italian applicants who filed 312 patent applications to the EPO over the period 1991-2005. We show that the probability of an early withdrawal is higher for applicants with lower resources and competencies and increases with the number of backward citations added by EPO examiners to the original application. Late withdrawals, instead, are negatively affected by the extent of patent families only. Such a limited explanation suggests that, for late withdrawals, the (unobserved) interventions of EPO examiners are likely to play a significant role.

The work is organized as follows. Section 2 reviews the main contributions to the topic of patent withdrawals. Section 3 describes our sample of EPO applicants and applications and compares its rate of patent withdrawals with that arising in Europe. In section 4, after illustrating the variables

used as determinants of patent withdrawals, we perform a Probit regression analysis for both early and late withdrawals. Section 5 concludes with a discussion of our findings.

2. Motives to withdraw a patent application

As a general starting point, we can assume that a patent withdrawal occurs when the ex-ante expectations of the applicant, concerned with the potential value of her invention, are disappointed. In this sense, it can be taken as a ‘failure’, whose extent, however, should not be overstated. In fact, as far as the withdrawal choice is fast, the application cost is not particularly high and such a step is necessary to discover whether the invention is valuable or not, the losses for the applicant could be relatively small and, in presence of technological uncertainty, unavoidable. It could be argued that a poor self-selection of applicants could increase the workload of patent offices and, then, generate relevant social costs. However, and again, when the decision to withdraw is taken before starting the proper examination process, also the extent of social losses should not be exaggerated. Accordingly, in addressing the determinants of patent withdrawals the timing of the choice becomes a crucial issue.

The motives to withdraw a patent application could refer to the features of applicants, the quality of the invention for which a patent protection is sought and, last but not least, the ‘toughness’ of patent examiners.

Starting from the applicants’ characteristics, Iversen and Kaloudis (2006) analyse the domestic patenting activities of Norwegian firms and show that the success rate (measured in terms of granted patents) is significantly different between independent inventors (24%), Small and Medium Sized Enterprises (47%), and large companies (65%). Conversely, the applications are more often withdrawn by SMEs and independent inventors (33%) than large enterprises (17%). To explain these high rates of ‘failure’, the authors stress that small enterprises: a) tend to overestimate the value of their inventions; b) are less able to mobilise the complementary assets and funds required to bring the new ideas to the market; c) do not have adequate knowledge of the patent system. Moreover, they also add that the withdrawals by small applicants could be due induced the litigation threats posed by larger companies.

Haroff and Wagner (2006) focus, instead, on the applications’ features. They analyse the duration of the process leading to the three possible outcomes concerned with EPO patent applications:

grants, withdrawals and refusals. With respect to withdrawals, they find that the extent of forward citations is positively associated with a late withdrawal while an early one occurs when the application contains a high number of backward citations added by the EPO examiners. In particular, using the labels adopted by the EPO, the citations of type X can undermine the claimed novelty and inventive step of the invention while those of type Y are particularly relevant if combined with other documents.

In their already mentioned work, Lazaridis and van Pottelsberghe (2007) distinguish the withdrawals taking place after the receipt of the first search report from those occurring during the examination process. They contend that the latter, accounting for 17% of total applications, are determined by the ‘toughness’ of the communications drawn by EPO examiners and, thus, should be considered as ‘induced withdrawals’. Accordingly, since the examiners have the power of discouraging the less valuable applications, the refusal propensity of the EPO is largely underestimated when compared with that of the USPTO.

By considering a broad set of variables as determinants of patent withdrawals, Schneider (2008) analyses the applications filed to the EPO by Danish applicants from 1978 to 1997. He assumes that an applicant decides to withdraw a patent application when becoming aware that the latter has a high probability of being refused. However, the timing of the decision can be rather different so that, in line with the previous definition, early withdrawals, occurring after the search report is available, must be treated separately from late withdrawals, taking place during and after the examination process. Using a Trivariate Probit regression, Schneider jointly estimates the probability of a request for examination (against an early withdrawal), that of arriving to the final decision (against a late withdrawal) and, finally, the probability of a patent grant (against a refusal). The principal findings are that the number of backward citations added by EPO examiners increases the probability of both early, late withdrawals and refusals. However, the X type citations are particularly effective in reducing the propensity to request for a patent examination. Other applications’ features - such as the number of states adhering to the European Patent Convention (EPC) that are designated in the application - do not exert a significant impact. Moving to the applicants’ characteristics, their stock of EPO applications - used by the author to approximate their experience - reduces both the probability of an early withdrawal and a refusal. The legal status of the company, as a proxy of firm size, becomes significant only for explaining

the probability of arriving to the final decision, which is higher for stock listed companies. Finally, if the patent attorney acts as legal representative both the chances of early and late withdrawals are reduced.

Although effective in distinguish the different influence that some factors may exert on patent withdrawals, Schneider's analysis is limited by the use of rough proxies for the nature of applicants and, above all, by the exclusive use of applications' features observed at the date of filing (i.e. time invariant). For instance, the forward citations received by the applications are not taken into account. Although the applicants do not observe them when they decide whether to go through the examination process or not, forward citations can signal that the invention has some intrinsic value. Similarly, the number of countries originally designed in the EPO application does not really measure the family size. The latter should include the *effective* number of states in which patent protection is sought by paying the renewal application fees (for the members of the EPC) or by filing further applications (for those outside the EPC).

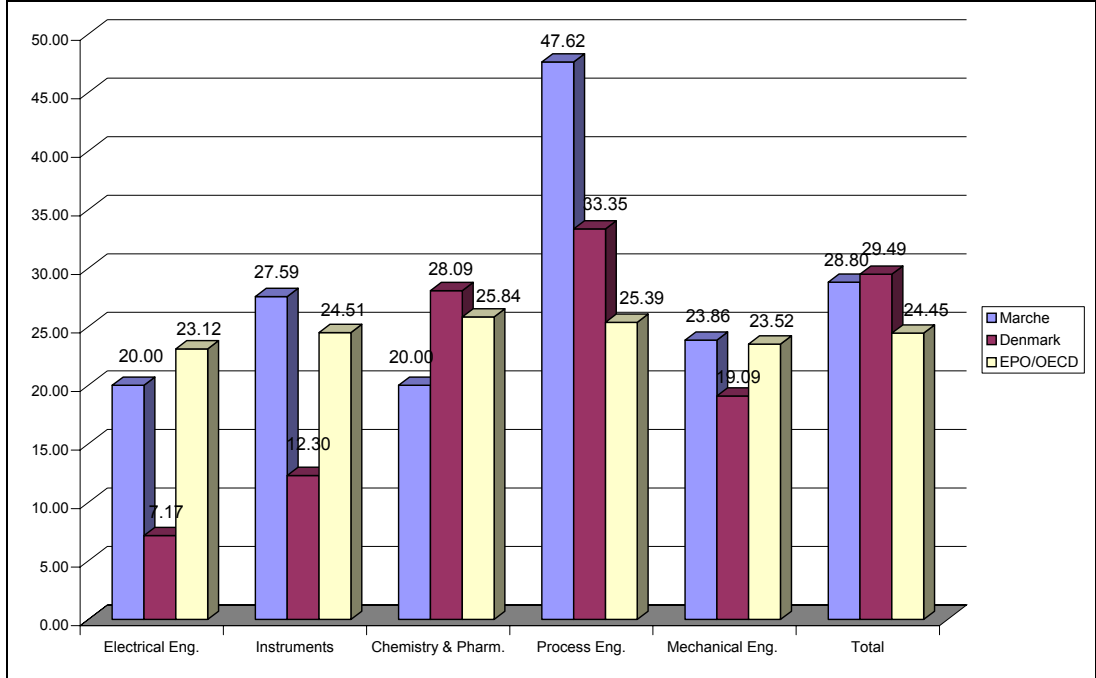
3. Patent withdrawals: evidence from a regional sample of Italian applicants and inventors

Our empirical analysis is concerned with a sample of Italian applicants and inventors residing in the Marche region (located in the east side of central Italy). The initial reference population, obtained from the CESPRI-Bocconi database, was composed of 509 inventors who, over the period 1991-2006, have contributed to 743 patent applications filed with the EPO. To get information on both applicants' and inventors' characteristics we carried out a survey on a sample of 106 inventors participating in 312 applications (42% of all the EPO applications attributed to Marche). The findings arising from the above survey have been examined in two previous papers: the first one (Schettino and Sterlacchini, 2007) analyses the features of applicants and inventors while the second (Schettino et al., 2008) is devoted to the quality of their patent applications. In the present paper we use both types of information with a view to explaining the propensity to withdraw EPO applications.

According to the discussion developed in previous sections, the applications that do not reach the proper examination phase can be classified as early withdrawals while the late ones take place during and after the examination process. Thus, an early withdrawal may occur within about two

years of the filing date while for observing a late withdrawal at least five years from the filing date are required (see section 1). Because the applications' status was observed in the last quarter of 2007, to analyse the extent of early withdrawals in our sample, we considered 288 applications (out of the original 312) filed with the EPO from 1991 to 2004. Instead, for late withdrawals we examined 200 applications that went through the examination process and were concerned with the period 1991-2002.

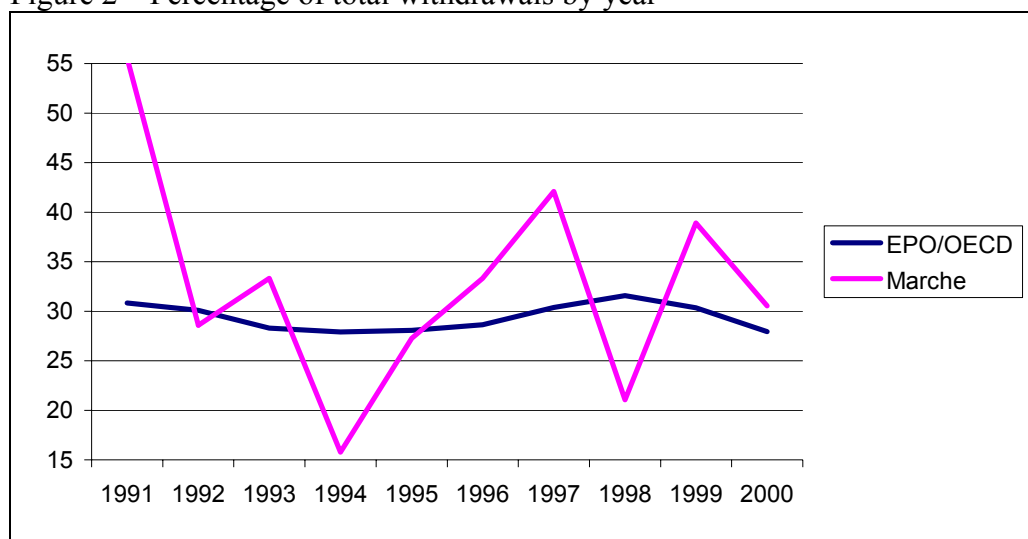
Figure 1 – Percentage of total withdrawals by broad IPC class



Source: CESPRI-Bocconi for Marche applications; Schneider (2008) for Danish applications; OECD/EPO patent citations database (cf. Webb et al., 2005) for total EPO applications.

In figures 1 and 2 the withdrawal propensity in our sample is compared with those arising from Danish (Schneider, 2008) and total EPO applications (contained in the OCED-EPO patent citations database; cf. Webb et al., 2005). Because such a comparison refers to total withdrawals, both Marche and total EPO applications refer to the period 1991-2000, while those concerned with Denmark to 1978-1997.

Figure 2 – Percentage of total withdrawals by year



Source: CESPRI-Bocconi and OECD/EPO patent citations databases.

Figure 1 shows that the percentage of withdrawals in our sample is almost the same of that recorded in Denmark and lower than that referring to total EPO applications. Looking at the broad IPC classes in which patents are usually classified, it emerges that, for Marche applications, patent withdrawals are particularly concentrated in the field of Process engineering, while for the other fields the distribution is very similar to that concerned with the whole set of EPO applications. In the case of Denmark, low percentages of withdrawals are recorded in the classes of Electrical engineering and Instruments. Taken together, these findings suggest that, by restricting the analysis to national or regional contexts, it is more likely that the occurrence of patent withdrawals is sector-specific, reflecting the technological specialization and knowledge-base of each geographical area.

By observing the phenomenon over time, figure 2 shows that the trend arising from total EPO applications fits quite well with that concerned with Marche applications. In both cases, there is a reduction of patent withdrawals over 1991-95, followed by an increase in 1996-98 and, then, a decrease over 1999-2000. Obviously, dealing with small numbers, the withdrawal propensity of Marche applications is characterised by quite erratic annual variations.

4. Determinants of early and late withdrawals

According to the survey presented in section 2, the determinants of patent withdrawals can be

classified into two main groups concerned, respectively, with the features of applicants and/or inventors and those of their patent applications. Moreover, as documented in the previous section, the impact of the above characteristics must be controlled for sector-specific effects.

With respect to the applicants/inventors' features, thanks to our survey, we were able to use a wide set of potential explanatory variables (see, for details, Schettino and Sterlacchini, 2007). With regard to the inventors we got information on their age, gender, level of education and importance ascribed to patent and scientific literature. As far as applicants are concerned we know whether they are independent inventors or working in firms of different size (either as owners or employees), the extent of their portfolio of EPO applications and the location of patent attorneys they use as consultants. Finally, with respect to patent applications, the EPO and OECD/EPO databases allowed us to obtain information on the number of backward and forward citations, claims and patent families, i.e. the usual indicators employed for approximating the quality of patented inventions (see, for a survey, Schettino et al., 2008). It must be specified that we were able to separate from the others the backward citations (labelled with X and Y) added by EPO examiners and undermining the novelty and inventive step of the invention. With respect to forward citations, we did not use a window of five years from the application date but, to preserve all the available observations, we adopted the 'fixed-effects' approach proposed by Hall et al. (2001). Accordingly, the number of citations received by a patent application in a given year is divided by the average number of citations received, in the same year, by all the applications included in our sample.

Tables 1 and 2 show some descriptive statistics for early and late withdrawals by taking into account two important features of the applicants and the main IPC classes in which the patent applications are assigned.

First of all, the share of late withdrawals (22%) is above that of the early ones (14%). With respect to the size of the applicants, independent inventors have a greater propensity to opt for an early rather than a late withdrawal, while the opposite occurs for the firms with less than 100 employees. In general, the firms with a number of employees equal or greater than 100 tend to withdraw less than their smaller counterparts.

Table 1 - Early withdrawals: 1991-2004

| | No. of early withdrawals | No. of EPO applications | Share of early withdrawals |
|-------------------------------------|--------------------------|-------------------------|----------------------------|
| <i>Size of the applicant</i> | | | |
| Independent inventors | 5 | 24 | 21% |
| Firms with 1 to 99 employees | 11 | 78 | 14% |
| Firms with 100 employees or more | 25 | 186 | 13% |
| <i>Location of patent attorneys</i> | | | |
| Only regional | 21 | 76 | 28% |
| Only or also extra-regional | 20 | 212 | 9% |
| <i>Main IPC classes⁴</i> | | | |
| Material processing | 5 | 26 | 19% |
| Thermal processes | 4 | 36 | 11% |
| Instruments | 1 | 27 | 4% |
| Consumer goods | 10 | 89 | 11% |
| Mechanical engineering | 16 | 74 | 22% |
| Miscellaneous class | 5 | 36 | 14% |
| Total | 41 | 288 | 14% |

Table 2 - Late withdrawals: 1991-2002

| | No. of late withdrawals | No. of EPO applications | Share of late withdrawals |
|-------------------------------------|-------------------------|-------------------------|---------------------------|
| <i>Size of the applicant</i> | | | |
| Independent inventors | 3 | 16 | 19% |
| Firms with 1 to 99 employees | 16 | 47 | 34% |
| Firms with 100 employees or more | 24 | 137 | 18% |
| <i>Location of patent attorneys</i> | | | |
| Only regional | 13 | 42 | 31% |
| Only or also extra-regional | 30 | 158 | 19% |
| <i>Main IPC classes</i> | | | |
| Material processing | 9 | 15 | 60% |
| Thermal processes | 7 | 28 | 25% |
| Instruments | 7 | 25 | 28% |
| Consumer goods | 10 | 61 | 16% |
| Mechanical engineering | 5 | 44 | 11% |
| Miscellaneous class | 5 | 27 | 19% |
| Total | 43 | 200 | 22% |

⁴ Technological classes have been recoded as follows: Material Processing=18_IPC30; Thermal Processes=19_IPC30; Instruments=6_IPC30 + 7_IPC30 + 8_IPC30; Consumer Goods=29_IPC30; Mechanical Engineering=21_IPC30 + 22_IPC30 + 23_IPC30 + 24_IPC30 + 25_IPC30 + 26_IPC30 + 27_IPC30 + 28_IPC30; Miscellaneous= 1_IPC30 + 2_IPC30 + 3_IPC30 + 4_IPC30 + 5_IPC30 + 9_IPC30 + 10_IPC30 + 11_IPC30 + 12_IPC30 + 13_IPC30 + 14_IPC30 + 15_IPC30 + 16_IPC30 + 17_IPC30 + 20_IPC30.

An interesting result emerges when the applicants are divided into those using exclusively local patent attorneys and those buying the services of patent attorneys located also or only in other Italian regions. The former applicants record a share of early withdrawals three times higher than that of the latter. Such a remarkable difference (not so evident when late withdrawals are taken into account) does not necessarily imply that regional patent attorneys are less competent than those located in other regions. Instead, it is likely that the applicants making exclusive usage of local consultants do not dispose of enough resources and patenting experience and, then, are not able to search for better or more specific competencies and select among a larger pool of patent attorneys. This reduces the quality of patent applications and increases the probability of an early withdrawal.

Tables 1 and 2 also illustrate the different performance recorded across IPC classes (which have been recoded according to the peculiar distribution arising from our sample of EPO applications). Looking at the shares of early withdrawals the differences are not remarkable, while in terms of late withdrawals the class of Material processing is largely above the others (60% versus an average of 22%). Accordingly, this sector-specific effect cannot be neglected when examining the probability of a late withdrawal.

For a multivariate analysis able to identify the most important determinants of patent withdrawals we used two Probit regressions. The first two reported in table 3 employ a dichotomous dependent variable for the probability of an early withdrawal while the third is concerned with the probability of a late withdrawal.

With respect to the explanatory variables, the applicants' features are captured by three dummy variables, two for the status and size of the applicants⁵ (independent inventors and firms with fewer than 100 employees) and one for the exclusive use of a regional patent attorney. It must be stressed that in a preliminary analysis we included among the independent variables also a set of inventors' characteristics (such as gender, age, level of education and the importance ascribed to different sources of information) but none of them turned out to be significantly associated with patent withdrawals. Thus, the choice of withdrawing a patent application is not influenced by the inventors' ability and experience but seems exclusively affected by the features of their organisations.

⁵ Being strongly correlated with their status and size, the portfolio of EPO applications held by applicants was never

For approximating the quality of patent applications, we used the number of backward citations, distinguished in ‘X and Y’ and ‘others’, and that of forward citations and patent families. In a first attempt we also employ the number of claims but such a variable was never significant.

Finally, we included five dummy variables for the main IPC classes into which our sample of EPO applications is distributed.

Looking at the first Probit estimation (column 1 of table 3), it emerges that the probability of an early withdrawal is significantly higher for the applicants that: a) recur to local patent attorneys only; b) have a greater number of ‘problematic’ backward citations added by EPO examiners; c) search for patent protection in a lower number of countries. However, the latter finding is rather questionable because one cannot be sure about the direction of causality. In effect, the observed size of patent family is not time invariant (and does not necessarily coincide with that arising from the original application) since applicants can progressively enlarge the set of countries for which the patent protection is sought. Accordingly, an early withdrawal reduces, by definition, the possibility of extending the patent in other countries and this can explain, albeit not entirely, the negative impact exerted by patent families. In econometric terms, the latter variable cannot be taken as strictly exogenous with respect to the probability of an early withdrawal and, then, should be dropped from the regression.

By doing so, as it occurs with the second specification (column 3 of table 3), the factors exerting a significant effect on early withdrawals are more numerous. The positive impacts of regional patent attorneys and problematic backward citations are confirmed, but also the status of independent inventor increases the probability of withdrawing a patent application at an early stage. Moreover, although with a lower level of significance, also the applications classified in the field of Material processing and those receiving a lower number of forward citations are more likely to be withdrawn early⁶.

significant when inserted in the Probit regressions.

⁶ Similarly to family size, forward citations are not time invariant. However, the fact that an EPO application is withdrawn does not necessarily reduce the possibility of receiving citations in the future. Moreover, contrary to patent families, there are no problems of endogeneity since forward citations are independent from the applicants’ behaviour.

Table 3 - Probit regressions

| | Early withdrawals | Early withdrawals | Late withdrawals |
|--------------------------------------------|-----------------------------|-----------------------------|-----------------------------|
| Constant | -0.915* (0.507) | -2.303*** (0.472) | 0.872 (0.815) |
| <i>Applicants' features</i> | | | |
| Independent inventors | 0.638 (0.434) | 0.845** (0.432) | 0.062 (0.485) |
| Firms with 100 employees or more | 0.334 (0.299) | 0.418 (0.334) | 0.143 (0.368) |
| Regional patent attorney | 0.617** (0.268) | 0.930*** (0.232) | 0.461 (0.372) |
| <i>Applications' features</i> | | | |
| X and Y backward citations | 0.229*** (0.059) | 0.248*** (0.057) | 0.036 (0.072) |
| Other backward citations | 0.063 (0.056) | 0.063 (0.046) | -0.06 (0.063) |
| Forward citations | -0.039 (0.107) | -0.133* (0.077) | -0.083 (0.082) |
| Patent Family Size | -0.173*** (0.039) | | -0.233*** (0.075) |
| <i>Man IPC classes</i> | | | |
| Material processing | 0.363 (0.496) | 0.785* (0.514) | 2.002*** (0.644) |
| Thermal processes | -0.535 (0.487) | -0.323 (0.453) | 0.144 (0.527) |
| Instruments | -0.756 (0.616) | -0.478 (0.598) | 0.282 (0.467) |
| Consumer goods | 0.012 (0.377) | 0.209 (0.346) | -0.095 (0.404) |
| Mechanical engineering | 0.167 (0.372) | 0.281 (0.330) | -0.398 (0.447) |
| No. of observations | 288 | 288 | 200 |
| Wald χ^2 (Probability > χ^2) | 71.67 (0.000) | 40.98 (0.000) | 46.87 (0.000) |
| Pseudo R ² | 0.30 | 0.19 | 0.36 |
| Log pseudo-likelihood | -82.02 | -95.76 | -66.98 |

***= significant at 0.01 level of confidence; **=significant at 0.05; * = significant at 0.1.

Moving to the determinant of late withdrawals, it emerges that the results are quite different from the previous ones. None of the applicants' features that turns out to be statistically significant while the probability of a late withdrawal decreases with the family size and increases remarkably when the application is classified in the field of Material processing. The latter finding is probably

due to the low knowledge base and patenting experience recorded, within our sample of EPO applicants, in this particular technological area. Such a tentative explanation is supported by the fact that only 7.5% of the total applications considered for the analysis of late withdrawals refers to Material processing (see table 2). Instead, the negative impact exerted by family size indicates that the applicants that have invested more unrecoverable resources for extending the protection of their inventions are less prone to a late withdrawal. It is also possible that, during the long period required for the examination, they have become increasingly aware of the value of their invention and, then, have enlarged the family size. In any event, the number of countries in which patent protection is sought approximates the extent of sunk costs that make less likely the choice of withdrawing a patent application.

5. Concluding remarks

The process required to get a granted patent by the EPO is very long and shaped by a number of sequential decisions that the applicants have to take, also on the basis of the feedbacks received from patent examiners. Each sequential step implies additional and increasing costs. Accordingly, although the withdrawal decision is a failure that implies an economic loss for the applicant, the faster such a decision is taken the lower are the economic losses. In this sense, to withdraw a patent application at an early stage can be viewed as a second best rational choice. Obviously, the first best solution should be that of avoiding the search for patent protection when the invention is not worthy. However, especially for the less experienced inventors or inventive organizations, the cost for this complex ex-ante assessment would probably equate that needed to file a patent application. If there is some truth in the above argument, it should be not surprising that the determinants of early withdrawals are quite different from those shaping the decision to withdraw a patent application at a later stage.

Our study shows that the occurrence of an early withdrawal is particularly affected by two factors. The first mainly refers to the competencies and, above all, the resources that applicants are able to invest in their patenting activity. The fact that independent inventors and those relying exclusively on local patent attorneys have a higher propensity to early withdrawals clearly supports the relevance of the resource- and experience-based explanations (Iversen and Kaloudis, 2002). The second important factor is the quality of patent applications which, in our analysis, is well captured

by the extent of problematic backward citations added by EPO examiners. In line with the results of Haroff and Wagner (2006) and Schneider (2008), we found that when these citations are numerous the applicants are more prone to withdraw their applications early.

With respect to late withdrawals we found that the only behavioural factor affecting their occurrence is the extent of patent family. The higher is the number of countries in which patent protection is sought (i.e. the greater are the sunk costs born by applicants) the lower is the probability of a late withdrawal. In this case, apart from the fact (peculiar to our sample) that late withdrawals are concentrated in a particular technological field, we did not find that other applicants or applications' features play a significant role. Thus, for a better explanation, some additional variables are probably needed. In particular, it would be useful to collect, for each patent application, some measures concerned with the interventions of EPO examiners that can induce late withdrawals (such as those considered, at aggregate level, by Lazaridis and van Pottelsberghe, 2007). Although quite demanding in terms of data mining, this could be an interesting and promising extension of the present study.

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