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Trademarks and the patent premium value: Evidence from medical and cosmetic products

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ABSTRACT

The determinants of the premium value of patents for medical and cosmetic products are analyzed with respect to a complementary IP strategy such as trademarks. I discuss a novel method and database to gauge combinations of patent and trademark pairs regarding the same innovative project. The premium value is computed through a model of renewal decisions for the patent cohorts 1985–1990 that have been designated in the U.K. and Germany. After taking into the account several firm characteristics and patent indicators typically used in the literature, I find ample evidences that patent and trademark pairs are featured by higher valuations.

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1. Introduction

Much of literature on patent valuation has attempted to devise indicators that can proxy the intrinsic value of an underlying technological invention [1]. However, as Teece [2] argued the value the innovator can extract from a patent depends in significant extent also on the appropriability conditions and complementary assets which are required for the commercial translation of that invention. More in general, the innovator can put in place strategies in order to ameliorate the conditions that directly affect the value of an invention [3]. With the exception of few works the role that the innovator's strategic behavior plays in determining the value of patents has been overlooked by previous literature [4]. This paper aims to build on this gap and analyzes how trademark strategies affect patent valuation.

The proposed analytical framework carries over research on entrepreneurial finance that has stressed the role of intellectual property as a quality signal [5,6]. Similarly to Block et al. [7] I argue that trademarks by enhancing the signaling function of patents and expanding their breadth of protection increase the value of the patented R&D. In this context I introduce a novel concept namely patent and trademark pair, when the output of the invention process is protected by a combined IP strategy represented by patenting and

also filing a trademark. I argue that patent and trademark pairs have a significant signaling value and hence they are featured by higher valuations. I corroborate this view by assessing the premium value of patents for medical and cosmetic products using an ad-hoc dataset on renewal decisions. I opted to limit the analysis solely to medical and cosmetic products because of the importance hold by formal IP strategies in the pharmaceutical industry.

In advancing this task I develop a new method and database integrating several sources: bibliographic information from patent and trademark records, patent renewal and opposition decisions, demographic information on the patenting firms, and others. The context is constituted by the universe of the European firms who have filed at least one European Patent Convention (EPC) application for medical and cosmetic products from 1985 to 1990. The new method for defining patent and trademark pairs is given by a string matching algorithm which integrates bibliographic information on two levels. First, it considers the patenting firm when I have drawn from a database previously developed by Thoma et al. [8], that provides a direct link of the business companies with their patent and trademark portfolios. A subsequent layer of integration of the pairs is based on the analysis of the textual description of the legal documents. Because patents and trademarks are very rich information sources regarding the technological and commercial activities of a firm, their combination allows to uniquely assess to what extent the patent portfolio of a company has been actively translated in commercial activities and to measure its economic potential.

The ad-hoc dataset on patent valuation is made up of annual renewal decisions and archival information on historical fee costs

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for patent designations in the U.K. and Germany, whose renewal decisions have been observed from 1985 to 2010. By adopting the approach of Schankerman [9] and Grönqvist [10] I compute dollar estimates on the premium value of patent protection in term of the purchasing power parity (PPP). This dataset allows to assess the valuation of patent and trademark strategies and to analyze the determinants of patent value when multiple IP strategies are jointly combined. In the regression analysis I take into the account several firm demographic characteristics which correlate with the value of patents such as firm's size and experience, country of origin, growth of R&D investment, primary business activity, listing in financial markets, and others.

I find that the patent and trademark pair strategy affect the premium value of patents even after having controlled for opposition decisions and other patent value indicators typically used in the literature. One patent and trademark pair for medical and cosmetic products is worth on average about US PPP \$ 536 thousand and \$ 124 thousand for patents designating Germany and the U.K. respectively. The most conservative estimate of the value impact of the pairing strategy is about PPP \$ 11 thousand regardless of the designation decision.

2. Theoretical framework

Recent literature has analyzed firm performance with respect to the combination of IP strategies of patents and trademarks, positing the hypothesis that trademarks are a proxy of the marketing and commercialization ability of a firm. Helmers and Rogers [11] show that the trademark stock yields two percentage point higher impact on firm survival as compared to patents. Buddelmeyer et al. [12] claim that trademarks are positively associated with survival both over the short term and the long run, while patent stock positively affects survival only in the latter case. Helmers and Rogers [13] find that trademarks impact also firm growth after having controlled for several demographic and market characteristics, whereas a positive impact of patenting on growth is traced solely in the manufacturing and R&D intensive sectors, and when the most valuable filing strategies are taken into account – such as patents having international breadth.

A full-fledged sectoral investigation of the impact of patenting and trademark strategies is constituted by Greenlagh and Rogers [14], who claim that technological trajectories given by the so-called Pavitt's taxonomy can disentangle the differential impact of the two IP strategies on firm market value. Greenlagh and Rogers focus on the population of the UK listed firms that have reported R&D investments in their accounts during 1989–2002, and they elaborate a Tobin's Q ratio approach to measuring the market valuation of a firm. With the exception of the software industry and other high value added services, the trademark stock contributes positively and significantly to the Tobin's Q beyond the investment in R&D and intangibles, whereas patents affect market value in science based industries and those led by specialized suppliers.

Sander and Block [15] extend the Tobin's Q analysis by considering a panel made up by the top one thousand global firms over the period 1996–2002. This study is among the first attempts in considering indirect indicators for the valuation of trademarks in the same fashion of those used for patents, such as the breadth of protection and opposition decisions. They find that the size of trademark portfolio contributes significantly to market value, after having controlled for the effect of patenting and size of operative activities. Furthermore, a significant impact is shown by the trademark indicators although some caveats are in order with respect to patenting: the Tobin's Q is correlated with the number of opposition actions undertaken by the focal firm but not those received and with only one dimension of the trademark breadth

given by the number of jurisdictions where the protection is sought.

Korkeamäki and Takalo [16] analyze how patents and trademarks of the Apple's iPhone product platform affect the market capitalization of the firm and that of its network of suppliers, service providers, and competitors. Their approach consists in an event study using daily data on stock market value and some key events such as the publication of patent applications, granting decisions, and filing of trademarks. They find that the iPhone related capabilities and resources account for about 15% of the total Apple's market capitalization, and patents and trademarks constitute about one fourth of the overall iPhone's market value. There is also a positive effect on the market capitalization of the Apple's suppliers, but not on that of its competitors and service providers.

The combination of patent and trademark strategies have been analyzed also in the context of the pre-money valuation by venture capitalists (VCs). Block et al. [7] argue that trademarks can constitute a quality signal between the inventor and the potential financier in order to reduce information asymmetries. To corroborate this hypothesis they analyze the US venture backed start-ups from 1998 to 2007, which have obtained at least one financial round at the seed or early investment stage. They confirm that the combination of patents and trademarks affect the pre-money valuation of start-ups, although they argue that the signaling intensity decreases with the size of the trademark portfolio and in the latter rounds of financing, when the financier could assess the growth potential of a start-up also with other mechanisms.

These results are line with the entrepreneurial finance literature which has claimed that the value of patents goes beyond the mere protection of the intellectual property [5,6]. It has been argued that VCs assess the quality of start-ups with the mean of their patent portfolios [17,18]. Patenting attracts financing from prominent VCs who can contribute with a larger share of non financial capital [17], though patents are valuable signals for new investors but not old ones [19], only patents held by the inventor prior to first round of financing have the largest signaling value [20], and the intensity of the signal decreases with the size of the patent portfolio [21]. Furthermore, Cockburn and Macgarvie [22] have claimed that patents increase the external financing during an IPO or acquisition, although they are not valuable signals for private investors [19] and other entrepreneurial financiers except VCs [23].

Nevertheless the entrepreneurial finance literature has been seldom debated how the company valuation is affected when patent and trademark strategies are jointly combined by the same firm [7]. An additional gap in the literature is constituted by the fact that the unit of analysis is the firm level, and the potential reinforcing effect of other IP strategies on the valuation of a single patent can be inferred only indirectly. In other words previous literature has not analyzed how marketing and commercialization activity directly linked with a patented invention affects its valuation. There is scarce evidence on the determinants of patent value when trademark strategies are combined with respect to the same innovative project although complementary investments in marketing and commercialization are essential in order to yield economic success and value to an invention [2,24,25].

Because trademark strategies have the typical goal to build brand awareness and publicity among consumers [26], the commercial potential of a patented invention is enhanced in several ways when it is paired with a trademark filing. Trademark strategies anticipate the commercial translation of a technology when it requires novel complementary assets with respect to the incumbent's business model [3]. More in general, an IP strategy which is articulated as a patent and trademark pair (hereafter PTP) signals to customers, competitors and investors in an industry about the market success of an invention project, and therefore it is

associated with higher economic return and valuation of the underlying invention. Secondly, patent strategies which are combined with trademarks facilitate communication across technological producers and consumers by establishing a trust relationship [27] and reducing uncertainty about product performance [28], which in turn directly affects the financial return the innovator obtains by the patent. A PTP strategy can be used to signal product quality not only in the sale and distribution phase but also in advertisement and publicity activities. In fact, brand names play a critical role for the commercial success of a new product launch, because consumers use preconceived beliefs with respect to what categories of brand names could be associated to specific product types [29]. In this direction, by increasing the information available to consumers about product categories trademarks facilitate the integration of the invention phase with commercialization [28].

Lastly, from a legal point of view trademarks perpetuate the commercial success of a patented product beyond the statutory limit of the patent right if the consumers still perceive a differential value of the branded product after patent expiration. Indeed, the validity of trademarks can be prolonged without an end, although the owner has to demonstrate that the mark is continuously used in commercial activities. Managing the IP rights both during filing, renewals and legal disputes has relevant costs, but the innovator can scale up the investment by combining several IP strategies together. Trademarks increase the bargaining power of the innovator during technology licensing and trading [30]. In conclusion, trademarks ease the knowledge transfer even in the non business sector by improving the innovator's reputation [31].

3. Patent and trademark pairs

3.1. A case study: AMINEXIL and L'OREAL

Patents and trademarks are very informative on the timing of the technological and commercial activities of the firm. In patents priority date documents when the invention processes (R&D investments) have taken place, whereas in trademarks the filing date can approximate the timing when a product or service started to be commercialized. Hence, while patents can be considered an output variable of the R&D process, trademarks typically are filed at the inception of the investments in marketing and brand building [32]. The intervening period from patent filing to trademark filing indicates the average time lag needed by a company to translate an idea from laboratory to market. Previous survey evidence has shown that four out of five companies complete the name branding process during the product development phase, which typically gives birth to the filing of a trademark [29].

A quintessential example of combined strategies of patents and trademarks is the AMINEXIL product by the L'OREAL Corporation, which is a cosmetic treatment against the hair loss. The product is based on a new class of organic chemical compounds, called diaminopyrimidines. It was launched in the market in May 2006, when a mark was filed at the US Patent and Trademark Office (USPTO serial number 78883916 – AMINEXIL), which was officially registered by the patent office in about three months.¹ The wordmark of the trademark is exactly labeled AMINEXIL and the so called good and services description explicitly mentions the term diaminopyrimidine. With respect to the patent protection L'OREAL had filed an application (serial number 2006/097359 – Hair and/or eyelash care composition containing AMINEXIL) through the PCT

system some months before the registration of the mark. The title and abstract of the patent describe the functionality and composition of AMINEXIL with the same names and words: the title includes the wordmark AMINEXIL, whereas diaminopyrimidine reads in the abstract. Thus the US mark 78883916 and the PCT patent 2006/097359 are clearly directed to obtain protection for the same innovative project, being that an invention or product targeted to final consumers.

The case of AMINEXIL shows how we can define a patent and trademark pair. The time-to-market of this product is very limited, around one year. The managers of L'OREAL confirm that the patent and trademark pair strategy is deliberate and not an isolated example [33]. Patenting inventions related to a given product, and contemporaneously filing a trademark regarding the same product is a typical IP strategy in the cosmetic industry. The management also monitors the competitors' IP strategies with particular focus on patents in order to gauge the average time-to-market of new products. They say that patents are a unique source of information to understand the dynamics of new products in the industry.

3.2. Matching algorithm

To identify a patent and trademark pair I semantically compared and matched patent titles with wordmarks. In this task I devised a matching algorithm relying on string similarity analysis which accounts for differences due to the position of the same word between otherwise identical strings (e.g. AMINEXIL diaminopyrimidine as compared to diaminopyrimidine AMINEXIL). In particular I implemented the string similarity J index proposed by Thoma et al. [8], which computes the fraction of common words after breaking up the strings into words at the blank spaces and it reads as the following:

$$J(X, Y) = \frac{|X \cap Y|}{|X \cup Y|} \cong \frac{2|X \cap Y|}{|X| + |Y|} \quad (1)$$

where $X \cap Y$ computes the number of common words between strings X and Y while $X \cup Y$ computes the total number of distinct words. To reduce the computational complexity the second term of the Eq. (1) has been approximated, and the denominator is stylized as the sum of all words, including those words that are contained in both strings. This may result in some double counting and thus the numerator is multiplied by two in order to preserve a comparable scale.

To account for frequent words I normalize each word i by its statistical weight w_i in the dataset

$$w_i = \frac{1}{\log(n_i) + 1} \quad (2)$$

where n_i is the frequency of the token in the dataset. Thus, the weighted J^w index is equal to the following expression:

$$J^w(X, Y) = \frac{2 \sum_{k|x_k \in X \cap Y} w_k}{\sum_{i|x_i \in X} w_i + \sum_{j|y_j \in Y} w_j} \quad (3)$$

Where $x_i \in X$ and $y_j \in Y$ and w_i and w_j are the weights inversely correlated with the frequency of tokens x_i and y_j in the dataset; the terms x_k and w_k are respectively the k th token and relative weight belonging to the intersection set $X \cap Y$.

Box 1 depicts some examples of patent and trademark pairs which have been matched using the algorithm proposed by Eq. (3). As it can be denoted the PTP strategy is pursued by firms of different sizes (large firms vis-à-vis small and medium ones), by private owned firms or those publicly listed in financial markets,

¹ L'OREAL had adopted the AMINEXIL name as wordmark since 1996 but that mark was already abandoned when the application 78883916 was filed at the USPTO.

Box 1

Examples of patent and trademark pairs.

Patent title – wordmark	Patenting firm
PRRS VACCINES (EP1838343) – INGELVAC PRRS (US78961723)	BOEHRINGER INGELHEIM VETMEDICA (DE, large firm*) ECO ANIMAL HEALTH (GB, large firm*)
AIVLOSIN FOR THE TREATMENT OF DISEASE DUE TO BRACHYSPIRA PILOSICOLI OR ORNITHOBA (EP1641469) – AIVLOSIN (US78419667)	
ANTITUMOUR TREATMENTS WITH METXIA-P450 AND CYCLOPHOSPHAMIDE OR 5T4 VACCINE (EP1725252) – METXIA (US75381002)	OXFORD BIOMEDICA (GB, listed firm)
NEW SYNBIOTIC USE (EP1715876) – SYNBIOTIC 2000 (US78188920)	SYNBIOTICS (SE)
ULTRAPURE ORAL FLUDARA FORMULATION WITH A FAST RELEASING ACTIVE SUBSTANCE (EP1455760) – FLUDARA (US74028100)	SCHERING (DE, large* and listed firm)
PEPTIDE FRAGMENTS OF COLOSTRININ (EP1240193) – COLOSTRININ (US76227611)	REGEN THERAPEUTICS (GB)
THERAPEUTIC ANTI-COLD AGENT CONTAINING ISOMALT AS AN ACTIVE INGREDIENT (EP1079839) – ISOMALT (US75423821)	SÜDZUCKER MANNHEIM OCHSENFURT (DE, large* and listed firm)

Notes: My elaboration from different sources and web search last accessed on January 18, 2015. Large firms(*) are those with more than 250 employees.

and by firms originating from multiple countries. The examples of Box 1 are similar to the case study, having same names and words both in the patent title and wordmark: from a statistical point view (see Eq. (2)) these words are discriminating tokens like AIVLOSIN, ISOMALT, COLOSTRININ, etc. SYNBIOTIC is an outstanding example of a PTP strategy: not only a single discriminating token is used both in the patent title and wordmark, but also the company name itself is labeled with the exact same wording.

4. Dataset

Because of the particular importance that formal IP strategies have in the pharmaceutical industry I limited the patent valuation analysis on medical and cosmetic products. With about fifteen percent of the annual sales devoted to R&D investments the pharmaceuticals industry has been the top R&D doer for several decades [34], and the industry is characterized by an extensive patenting activity [35]. Trademark strategies are in turn of quintessential importance because drug labeling and naming are regulated by public authorities, who have the goal to protect consumers from medication errors spurring from potential product name confusion. The drug approval process is articulated in several stages involving international and national regulators and the costs of identifying a suitable name are very significant. Von Graevenitz [36] compares different estimates from primary sources regarding drug name creation costs providing a range between US \$ 100 thousand to 700 thousand, and in some cases costs amount to several millions. Thus analyzing the impact of trademark strategies on patent valuation with respect to medical and cosmetic products provides an unique setting for understanding the usage of combined IP strategies.

The dataset of patents and trademarks is built up by integrating several primary and secondary sources. Firstly, from the EPO Worldwide Patent Database and the associated Patent Register [37] I have drawn the patent indicators, patent classifications, priority and filing dates, and opposition and renewal decisions. A fuller description is presented by Thoma [38] in this review, where the reader can find those aspects that are not discussed in this paper. Secondly, from the USPTO CASSIS Database I have extracted bibliographic information on US trademarks [39]. Thirdly, demographic and financial information on innovating firms originates from the Amadeus business directory (amadeus.bvdinfo.com).

4.1. Patents for medical and cosmetic products

In order to define patents for medical and cosmetic products I have relied on the technology grouping elaborated by the

Observatoire des Sciences et des Techniques [40] which is made up of 30 categories. Patent documents are matched to a category on the basis of the international patent classification (IPC) codes assigned during the examination independently of the assigned number of codes. In the case of the medical and cosmetic products the identified IPC codes are twofold: “preparations for medical, dental, or toilet purposes” (A61K) and “specific therapeutic activity of chemical compounds or medicinal preparations” (A61P).

4.2. Composite index

To account for the heterogeneity of patent value I devised a composite index combining several uni-dimensional indicators according to the methodology presented by Thoma [38]. This approach relies on the maximum likelihood factor analysis for the computation of the composite index and the analyzed uni-dimensional indicators are the following:

- i) Patent family given by the number of patents that share the same priority filing.
- ii) Patent family weighted by the GDP of the country where the protection is sought.
- iii) Number of claims in the frontpage of a patent.
- iv) Forward citations received within five years from priority year.
- v) Backward citations, excluding non patent references.
- vi) XY backward citations in the application search report.
- vii) PCT route dummy, indicating whether the patent concerns an international filing.
- viii) Supplementary search report dummy.

4.3. Trademark dataset

Bibliographic information on US trade and service marks is drawn from the SGML files of the USPTO trademark database [39]. This data source collects complete bibliographic information on US marks since the inception of the office, including date of filings, priority, registration, cancellation, wordmark, goods and services, sectoral classification, and others. Furthermore, I harmonized and integrated trademarks with the patent dataset described in Thoma et al. [8], which encompasses the universe of the European firms who have filed at least one EPC patent application during the period 1978–2009. The USPTO trademark dataset includes a substantially longer and wider coverage of filings during the 1990s than the

European Office for Harmonization in the Internal Market (OHIM), that started its activity only in 1996.

4.4. Demographic and financial variables

In the multivariate econometric analysis I control for the demographic characteristics of the patenting company, in order to take into the account several factors at the firm level, that in turn could have an impact on patent value. In particular by matching patents to the Amadeus business directory [8] I built the following control variables at firm level:

- Country of origin: dummies for the country where the firm has been incorporated;
- Listed firm: dummy variable whether the firm is publicly listed in financial markets;
- Size: binary variable with the positive outcome when the firm has more than 250 employees, zero otherwise;
- Cohort dummies: binary variables for business experience according to the year when a firm was founded: between 1971 and 1980, 1981 and 1985, 1986 and 1990, and after year 1990, with those founded prior to 1971 the left-out category.
- Primary business activity: dummies for the main activity code of the firm classified in four industries, that is chemicals, pharmaceuticals, R&D specialized firms, and the other types of firms constitute the left out category.
- Growth of R&D investment: lagged growth of R&D personnel over five year window. The counts of R&D personnel are measured according to the methodology discussed in Harhoff and Thoma [41].

5. Patent valuation

To assess the valuation of a patent and trademark pair I relied on renewal data. For patents kept in force, renewal fees are considered as lower bound revenues that the patent ensures to the owner, and more specifically they concern the minimum level of incremental premium value that the patent protection generates as compared to the non patenting strategy [9]. Previous studies have argued that the premium value is significantly correlated with the intrinsic asset value of a patent (for an extensive survey see Bessen and Meurer [42]), and hence it can be concluded that the renewal approach can give broader insights on the valuation of patents.

Drawing on actual data at the patent level, I computed the premium value using a similar model as in Schankerman [9] and Grönqvist [10]. The models of this kind assume that the innovator maximizes the benefits derived from the protection strategy by choosing how many years to keep a patent in force. In particular,

the net benefits of a patent from cohort j in age t are represented as current returns R_{tj} minus the costs of renewal fees C_{tj} . Thus the agent optimizes the discounted value on T

$$\max_{T \in [1, 2, \dots, \bar{T}]} V(T) = \sum_{t=1}^T (R_{tj} - C_{tj})(1+i)^{-t} \tag{4}$$

where \bar{T} is the statutory limit to patent protection and i is the discount rate, which is typically assumed at the level of ten percent. The optimal patent maintenance T^* is the first age when $R_{tj} - C_{tj} < 0$, otherwise it coincides with the statutory limit. Renewal fees, C , are non-decreasing in age, whereas returns, R , are non-increasing in age meaning that in each time t the returns can be expressed as function of initial returns R_{0j} . Assuming that the benefits from patents decay with a time invariant rate d , then the agent will renew the protection in time t solely when $R_{0j} \geq C_{tj} \prod_{\tau=1}^t (1 - d_{\tau})^{-1}$.

If $F(R_{0j}, \theta_j)$ denotes the cumulative distribution of initial returns, where θ_j indicates a vector of parameters, then the proportion of patents from cohort j renewed in age t is $P_{tj} = 1 - F(R_{0j}, \theta_j)$, and the log of the initial returns is distributed as $r_{0j} \sim N(\mu_j, \sigma_j)$ with mean μ_j and standard deviation σ_j . The owner will renew the patent protection if and only if

$$\frac{r_{0j} - \mu_j}{\sigma_j} \geq \frac{\ln C_{tj} - t^* \ln(1 - d) - \mu_j}{\sigma_j} \tag{5}$$

which implies that the proportion of patents in cohort j that drops out by age t is given by $y_{tj} = 1 - P_{tj} = \Phi(z_{tj}, \theta_j)$ where $\Phi(\cdot)$ is the standardized normal distribution function with $z_{tj} = \ln C_{tj} - t^* \ln(1 - d)$.

For the computation of dollar estimates of the premium value imposed by Eq. (4), I analyze the historical fee schedules for the cohorts 1985–1990 in the U.K. and Germany, whose renewal decisions have been observed from 1985 to 2010. Limiting the analysis to these economies does not constitute a serious drawback because they represent a sufficiently large market to attract the lion's share of designation and renewal decisions at the European level. By December 2010 about 91.3% and 95.1% of the European patents have designated the U.K. and Germany respectively.

Since a deflator for business investment is not available for the overall period, the renewal fees have been deflated using a production index for services with the 2005 as base year. This year has been also the time reference for the exchange rate in PPP US dollars. The decay rate is assumed to be fifteen percent, and the moments of the distribution has been estimated parametrically. Then I drew fifty thousand pseudo-random variables from a lognormal distribution, and calculate V for each of them using Eq. (4). I have not included the granting fees by considering age three of a patent as

Table 1
Descriptive statistics.

	Germany			United Kingdom		
	Mean	Standard deviation	Median	Mean	Standard deviation	Median
Log (Patent premium)	9.604	2.218	9.597	8.832	1.672	8.686
Patent trademark Pair – J index	0.023	0.059	0.000	0.023	0.059	0.000
D (patent trademark pair)	0.046	0.210	0.000	0.045	0.208	0.000
Composite index	0.262	0.755	0.175	0.263	0.745	0.174
D (Opposition)	0.082	0.274	0.000	0.082	0.275	0.000
D (No US patent)	0.086	0.280	0.000	0.087	0.282	0.000
D (No trademark)	0.261	0.439	0.000	0.261	0.439	0.000
D (Large firm)	0.717	0.450	1.000	0.722	0.448	1.000
D (Listed firm)	0.311	0.463	0.000	0.313	0.464	0.000
R&D investment 5 years growth	0.775	0.746	0.526	0.773	0.738	0.527
R&D investment 5 years growth squared	1.157	2.300	0.277	1.143	2.270	0.277

Notes: Sample size: n = 4 696 for Germany; n = 4 486 for the U.K; n = 4 769 for the overall dataset.

Table 2
Pairwise correlations: pooled sample.

	1	2	3	4	5	6	7	8	9	10	11
1. Log (Patent premium)	1.000										
2. patent trademark pair – J index	0.028	1.000									
3. D (patent trademark pair)	0.018	0.800	1.000								
4. Composite index	0.291	–0.054	–0.063	1.000							
5. D (Opposition)	0.119	0.035	0.032	0.105	1.000						
6. D (No US patent)	0.042	–0.089	–0.057	0.017	0.054	1.000					
7. D (No trademark)	–0.004	–0.225	–0.129	0.042	–0.013	0.158	1.000				
8. D (Large firm)	0.015	0.221	0.134	–0.030	–0.026	–0.072	–0.447	1.000			
9. D (Listed firm)	–0.013	0.376	0.275	–0.036	–0.009	–0.160	–0.389	0.419	1.000		
10. R&D invest. 5 years growth	0.043	–0.050	–0.060	0.071	0.048	0.168	0.074	–0.083	–0.155	1.000	
11. R&D invest. 5 years growth squared	0.049	–0.067	–0.065	0.067	0.058	0.170	0.083	–0.076	–0.149	0.932	1.000

Notes: Coefficients above 0.028 are statistically significant at five percent level (N = 4769).

the inception of the renewal fee schedule. For the 1990 cohort the patent value mean has been estimated in about PPP \$ 106 thousand and \$ 15 thousand for patents designating Germany and the U.K. respectively, whereas the estimates of the median values have yielded \$ 21 thousand and \$ 5 thousand.

6. Results of the multivariate analysis

To assess the valuation of a patent and trademark pair I regressed a series of linear equations on the log protection value of patents for medical and cosmetic products obtained from Eq. (4). I limit the analysis only to business companies, excluding sole inventors and non business organizations. Secondly, I have not considered those patents for which I could not identify the business company who have filed the patent application. Thirdly, I discarded those patents with missing demographic information regarding the patenting company, because it is not available from the business directories (see Section 4.4). The final sample size is

composed of 4696 and 4486 patents designating Germany and the U.K. respectively.

Tables 1 and 2 report the descriptive statistics and the correlation results of the PTP strategy with the patent value indicators and firm characteristics. I considered two types of variables related to patent and trademark pairs. On the one hand, I computed the string similarity *J* index as stylized by Eq. (3). Secondly, to ease the interpretation of the multivariate analysis I transformed the *J* index into a binary variable, when it is below or above a certain threshold: I consider as the positive outcome only when the *J* index equals the top quartile of the relative distribution in terms of string similarity. As it can be denoted from Table 1 patent and trademark pairs constitute a rare IP strategy, since only 4.5% of the patents are paired with a trademark. This strong skewness in the use of a PTP strategy is coherent with the value distribution of inventions: most innovations fail, but a bunch of them are extremely successful. The PTP *J* index is positively and significantly correlated with the premium value of patents and the opposition decisions. The majority of

Table 3
Log linear regression results with clustered standard errors. Dependent variable: log value of patent rights (US 2005 PPP \$).

	Germany			United Kingdom		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Coeff. s.e.	Coeff. s.e.	Coeff. s.e.	Coeff. s.e.	Coeff. s.e.	Coeff. s.e.
Patent trademark pair – J index		1.728 [0.694]**			1.266 [0.560]**	
D (patent trademark pair)			0.414 [0.180]**			0.335 [0.114]***
Composite index	0.798 [0.057]***	0.801 [0.057]***	0.801 [0.057]***	0.501 [0.046]***	0.504 [0.046]***	0.504 [0.046]***
D (Opposition)	0.604 [0.141]***	0.587 [0.141]***	0.591 [0.141]***	0.476 [0.115]***	0.464 [0.115]***	0.466 [0.115]***
D (No US patents)	0.090 [0.196]	0.101 [0.196]	0.096 [0.196]	0.063 [0.150]	0.071 [0.150]	0.068 [0.150]
D (No trademark)	–0.243 [0.145]*	–0.230 [0.145]	–0.242 [0.144]*	–0.220 [0.110]**	–0.209 [0.111]*	–0.218 [0.109]**
D (Large firm)	0.393 [0.159]**	0.366 [0.157]**	0.377 [0.157]**	0.319 [0.135]**	0.297 [0.135]**	0.304 [0.135]**
D (Listed firm)	–0.038 [0.123]	–0.101 [0.121]	–0.084 [0.121]	–0.039 [0.101]	–0.084 [0.102]	–0.074 [0.102]
R&D investment 5 years growth	–0.294 [0.158]*	–0.309 [0.155]**	–0.299 [0.155]*	–0.239 [0.121]**	–0.251 [0.119]**	–0.245 [0.119]**
R&D investment 5 years growth squared	0.089 [0.048]*	0.093 [0.048]*	0.091 [0.048]*	0.082 [0.038]**	0.085 [0.038]**	0.084 [0.038]**
D (Chemical firm)	–0.155 [0.186]	–0.158 [0.185]	–0.160 [0.184]	–0.151 [0.147]	–0.150 [0.147]	–0.153 [0.146]
D (Pharmaceutical firm)	–0.153 [0.143]	–0.136 [0.142]	–0.134 [0.142]	–0.155 [0.114]	–0.142 [0.115]	–0.139 [0.115]
D (R&D specialized firm)	–0.025 [0.180]	–0.030 [0.181]	–0.023 [0.180]	–0.063 [0.160]	–0.066 [0.161]	–0.062 [0.160]
Constant	8.492 [0.909]***	8.500 [0.913]***	8.493 [0.910]***	8.004 [0.749]***	8.008 [0.752]***	8.003 [0.750]***
Application year dummies (6)	Yes	Yes	Yes	Yes	Yes	Yes
Geographic origin dummies (17)	Yes	Yes	Yes	Yes	Yes	Yes
Cohort dummies (5)	Yes	Yes	Yes	Yes	Yes	Yes
F-test primary business activity (3)	0.45	0.38	0.39	0.65	0.55	0.55
F-test geographic origin (17)	10.17***	11.53***	11.14***	10.11***	11.63***	11.18***
F-test cohorts dummies (5)	1.32	1.34	1.29	0.81	0.83	0.80
F-test all firm charact. (31)	6.87***	7.85***	7.50***	6.67***	7.89***	7.52***
Observations	4696	4696	4696	4486	4486	4486
Adjusted R2	0.120	0.122	0.121	0.095	0.097	0.097

Notes: 1) *** indicates statistically significant at 1% level; **5% level and * 10% level.

2) Standard errors are reported in square brackets.

3) The clustering estimator is computed at the firm level.

patents are invented by large firms having at least 250 employees, and one third of them are invented by publicly listed firms. A typical firm holds patents both in the U.S. and Europe, and in three out of four cases its IP portfolio has also trademarks.

The results of the multivariate analysis are reported in Table 3. The regressions for patents designating Germany are given by Models 1–3, while the other three models regard the UK designations. I have included several control variables defined at the firm level, such as country of origin, listing in financial markets, size, experience as proxied by the cohort dummies, primary business activity, and the growth of R&D investment with its squared term. The standard errors are clustered using the robust estimator at the firm level, in order to take into the account potential omitted factors. In all regressions there is also a dummy whether the focal firm has not filed any patent or trademark at the USPTO. These variables account for the potential selection bias deriving from the fact that I am considering only trademarks filed under the US legislation and not other systems. I find that the dummy for no trademark stock enters significantly at five percent level only in the regressions regarding the UK designations, which suggests a potential improvement of the statistical fit when the analysis includes information on trademark counts from the national offices where the patenting firms originate from.

Patents of large sized firms are featured by higher valuations, which is consistent with previous literature that have claimed that small firms may often lack the complementary assets to develop and successfully commercialize an invention [42,43]. In particular I find that the bigger premium value of the large firms is PPP \$ 536 thousand in Germany and \$ 93 thousand in the United Kingdom. Quite interestingly it can be denoted an U shaped relationship with respect to the R&D investment growth [44]. While the first order statistical effect of the growth of R&D investment is negative, its squared term has the converse sign. Put differently increasing the R&D investment is associated on average with lower expected returns, although some extremely valuable inventions are patented by those firms whose R&D investment has achieved a certain scale.

Model 2 and 5 measure the impact of the pairing strategy in terms of the string similarity J index, whereas Models 3 and 6 include it as binary variable. I find that the PTP strategy is positively and significantly correlated with the premium value in all specifications which confirms the signaling hypothesis. The joint use of patents and trademarks constitute a signal for competitors, investors, and commercial partners that the underlying focal invention is highly valuable from a commercial point of view. In particular, one additional PTP generates an increase of the log premium value with about 41.4 and 33.5 percentage points in Germany and the U.K. respectively. The coefficients of the composite index and opposition decisions show no significant variations when the PTP strategy is considered (The Wald test is insignificant even at ten percent level). Thus it can be concluded that the composite index and the PTP measures approximate distinct dimensions of the premium value, and more generally it confirms the validity of the pairing strategy in predicting the patent valuation as compared to the indicators adopted by the previous literature [1].

In absolute numbers one PTP is associated with about PPP \$ 536 thousand bigger value for a patent designating Germany and \$ 124 thousand for an UK designated patent. In other words for small firms combining patents and trademarks for a given innovative project outplays their premium value disadvantage as compared to the large ones. The computation of a 95% confidence interval confirms that the lower limit estimate of the value impact of the PTP strategy is about PPP \$ 11 thousand irrespectively of the country of designation. The differences in the mean values could be explained not only with higher valuation of patents in the German legislation but also with a bigger market potential of that system.

7. Conclusions

In this paper I have analyzed how trademark strategies which are combined with patenting on the same innovative project affect the premium value of patents. This kind of IP strategy is defined as patent and trademark pair. I claim that the pairing strategy can function as signal for competitors, investors, and commercial partners regarding the economic value of the patented invention. I confirm this view by analyzing the premium value of patents for medical and cosmetic products. The premium value of patents has been computed with the mean of an ad-hoc dataset of renewal decisions and historical renewal fees in the U.K. and Germany. Future research could assess the valuation of patent and trademark pairs in other contexts.

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