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Non-practicing entities and transparency of patent ownership in Europe: the case of UK dormant companies

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Abstract

While various studies in the fields of law and economics have analysed the business models of patent aggregators and large non-practicing entities (NPEs) in the US, small NPEs operating in Europe typically escape academic and media attention. Here, to address this imbalance, we specifically identify and characterize the patent portfolios of NPEs registered as dormant companies in the UK and investigate whether they are created for the purpose of acquiring valuable IP assets or launching litigation campaigns. Our econometric analysis – based on more than two hundred NPEs registered as dormant companies in 2019 – supports the second hypothesis. Finally, as an illustrative example of how small NPEs use UK dormant companies to acquire and litigate patents in Europe, we describe the business model of Dragon Green Development Balboa SA, an entity incorporated in the Republic of Panama that controls thirteen UK dormant companies and which is involved in fourteen patent litigation cases in Germany.

Keywords: Dormant companies; Patent litigation; Non-practicing entities; Patent assertion entities; Patent trolls; Patent transparency.

JEL Codes: O31, O34, D23.

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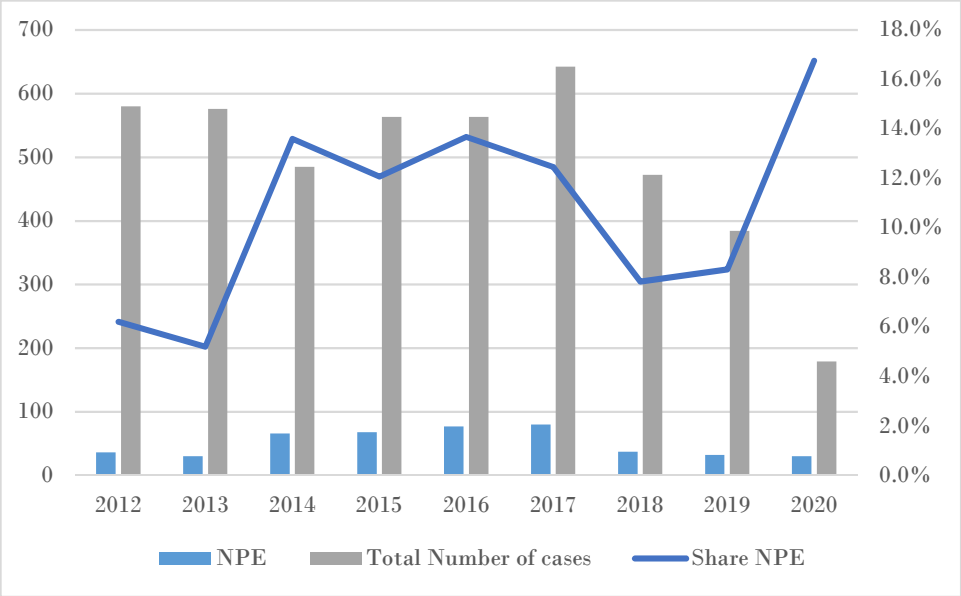
1 Introduction

Technology markets have expanded rapidly over the last 20 years or so and while, in the past, patents were seen merely as a means of protecting an invention, today they are considered marketable assets that can be acquired, held, licensed and sold strategically (Papst, 2012). In parallel with this increase in opportunities for patent monetization, the activity of companies that facilitate the transfer of exclusive rights to inventions has recently undergone a remarkable upsurge (Wang, 2010; Hagiu and Yoffie, 2013). As a result, non-practicing entities (NPEs) have acquired considerable influence, generating controversy in the industries they impact and giving rise to heated debate about the economic role they play in the patent market and their effects on innovation dynamics.

To date, NPEs and the related scholarly literature have been largely US centred (among others, see for example: Chien, 2012; Fischer and Henkel, 2012; Bessen and Meurer, 2013; Schwartz and Kesan, 2013; Caviggioli and Ughetto, 2016; Cohen et al., 2019; Abrams et al., 2019; Kwon and Drev, 2020; Sterzi, 2020). Only recently, the phenomenon has also attracted the same degree of attention in Europe. In the US, a combination of court decisions and legislative changes though have weakened some of the leverage available to NPEs when monetizing their patents. In contrast, in the European patent system, NPEs are emerging as important players (Fusco, 2013; Thumm, 2018) and, today, they account for a substantial and largely unrecognized share of patent infringement suits in Europe (see Figure 1).

Figure 1. Number and share of NPE patent litigations in Europe



Number of cases (left scale axis) and share (right scale axis) of patent infringement suits initiated in Europe since 2012. The share is computed as the total number of cases initiated by NPEs over the total number of cases. The year refers to the year in which the complaint was filed, if available; otherwise, it corresponds to the date of the earliest available document. Figures for 2019 and 2020 are estimates. Source: Based on data from Darts-ip.

Referred to sometimes as patent assertion entities (PAEs) or by the more derogatory term "patent trolls", NPEs do not manufacture, distribute or sell products. Rather, their business consists in monetizing patents either by acting as brokers and aggregators to facilitate matches between the suppliers of diverse technologies and potential acquirers interested in exploiting them, or by asserting patents and negotiating licensing agreements after specific technologies have been adopted by third parties (Chien, 2012).

Whichever business model they choose to adopt, by making use of shell companies to hold patent assets, NPEs benefit from and exploit one of the information frictions that most obviously characterizes the patent system: the lack of patent ownership transparency (Anderson, 2015; Feldman, 2014; Lemley and Shapiro, 2006; Menell and Meurer, 2013; Sterzi, 2020).

Traditionally, in the US, the use of shell companies by NPEs has been widely documented as a prerogative of large patent aggregators that acquire complementary and high-quality IP assets and is justified as a strategy for avoiding the disclosure of key information to competitors (Fisher and Henkel, 2012; FTC, 2016). However, it is less well known that these shell companies can also be used to hold patent assets and to keep them hidden while litigation campaigns are launched. In fact, shell companies not only enable patent holders to keep a patent acquisition unknown until what is deemed the best moment to initiate litigation (usually when a company has made irreversible investments), but they also create additional information asymmetries during the negotiations and in court.

In this paper, we undertake a study of small NPEs registered in the UK as a particular type of shell company: the so-called *dormant company*. As dormant companies, the identified NPEs hold intellectual property (IP) assets, but they do not report any kind of business activity, do not receive any form of income and do not have any employees.

We thus seek to determine whether NPEs make use of dormant companies in order to make competitors unaware of their acquisition strategies and of the true extent of their assets or, rather, to remain invisible while launching litigation campaigns. We address this question by analysing the patents held by the identified NPEs and do so by focusing on two specific patent characteristics – *number of forward citations* and *patent scope* – that are widely used in the literature to assess patent technological quality and the likelihood of a patent being infringed and litigated. Finally, to illustrate how easily UK dormant companies can be used to acquire and litigate patents in Europe, we present the business model developed by Dragon Green Development Balboa SA (DGDB), a company that incorporates the most litigious dormant company identified in our analysis.

The rest of the paper is organized as follows. In the next section, we present the theoretical background to this study, define the NPE business models, describe the main concerns related to a lack of patent ownership transparency and discuss our research hypotheses. In Section 3, we present the methodology used to identify NPEs registered as dormant companies in the UK. Section 4 reports the empirical analysis and section 5 presents the DGDB case study. Finally, Section 6 concludes.

2 Theoretical background

2.1 Literature review

The rise in the number of litigation cases initiated by NPEs has sparked a debate regarding their impact on innovation. The main concern is whether the patent enforcement pursued by NPEs is an efficient mechanism for technology transfer and the creation of new products, or whether it is simply a means of collecting money to avoid costly litigation proceedings. In this respect, the empirical evidence is somewhat conflicting.

On the one hand, some scholars suggest that NPEs behave opportunistically by acquiring low-quality (weak) patents for the sole purpose of litigation (Love, 2013; Feng and Jaravel, 2020) and imposing high costs on the firms they target (Tucker, 2014; Bessen and Meurer, 2013; Cohen et al., 2019). For example, Feng and Jaravel (2020) exploit information from several data sources to assess the relationship between crafting patent rights and several patent outcomes, including patent value, citations and litigation. They show that NPE patent portfolios are disproportionately made up of patents that are granted by "lenient" patent examiners who spend relatively little time reviewing and narrowing patent claims. Similarly, Cohen et al. (2019) find that NPEs disproportionately assert patents just before their expiration dates, which they consider an indication of low-quality lawsuits. Tucker (2014) presents a case study of how the actions of Acacia Research Corporation, a well-known NPE, affect technology sales of US firms in the field of medical imaging technology. By exploiting data provided by the HIMSS Analytics Database, she finds evidence that, relative to similar products made by the same firm but not covered by patents litigated, sales of medical imaging software protected by patents affected by litigation with Acacia fall by around one-third.

On the other hand, some authors find that NPEs provide insurance and liquidity to firms by committing resources to protecting inventors' property rights (Haber and Werfel, 2016) and that they acquire high-quality (strong) patents (Shrestha, 2010; Fisher and Henkel, 2012; Abrams et al., 2019). In particular, Shrestha (2010) examines a sample of fifty-one NPEs and the patents that they chose to litigate, drawn from 500 randomly selected infringement lawsuits filed between 1 January 2000 and 1 October 2008. By comparing the observed sample of NPE-litigated patents (287 patents) to other litigated patents (731 patents), the author finds the former to be of higher quality. Similarly, Fisher and Henkel (2012) conduct an empirical analysis of NPE patent acquisitions. Their sample comprised 392 US patents acquired by known NPEs between 1997 and 2006, which they compare to three control groups of 784 US patents each acquired by practicing firms. They conclude that NPEs procure patents that are of higher quality, harder to substitute for, and robust to legal challenges. However, their sample is based on a few well-known NPEs, so it does not include patent acquisitions by small entities and is unlikely to be representative of the average NPE patent portfolio (Cohen et al., 2019).

The inconclusive nature of the above evidence can be attributed in the main to the heterogeneous business models operated by NPEs (Pénin, 2012; Steensma et al., 2016, Leiponen and Delcamp, 2018). Indeed, the definition of NPEs encompasses both firms that act primarily as independent distributors and patent brokers (acquiring patents from inventors

and licensing the rights to commercializing entities) and firms that assert patents as their primary business model.

In keeping with this, the US Federal Trade Commission Report on Patent Assertion Entities (FTC, 2016, p. 42) identifies two types of NPE business model: "*Portfolio NPEs*" and "*Litigation NPEs*".[1] *Portfolio NPEs* aggregate patents that are often not necessarily used solely for litigation purposes. They act primarily as patent aggregators, identifying and bundling complementary and high-quality (Fisher and Henkel, 2012) IP assets for the purpose of reducing transaction costs: by matching the supply of diverse technologies from multiple providers with the demand of multiple potential acquirers, they reduce the number of transactions that would otherwise be necessary, especially when innovation requires access to multiple fragments of knowledge and has several commercial applications (Steensma et al., 2016). *Litigation NPEs*, in contrast, are small firms that tend to be thinly capitalized, sue potential licensees and usually settle quickly after entering into negotiations with them. They are often accused of asserting patents for the sole purpose of extracting unjustified licensing fees from alleged infringers through the threat of permanent injunction**.** Because of this specialization in patent litigation, they may in fact easily reach a minimum efficient scale in patent assertion so that it is profitable for them to assert low-quality patents (Chien, 2012).

2.2 Patent ownership transparency issues and research hypotheses

Depending on their business model, NPEs can extract value from non-transparency in patent ownership in two main ways. On the one hand, they can use shell companies so that competitors remain unaware of the true extent of their assets and the technologies they target. Feldman (2014) reports the claims of a representative of Intellectual Ventures during the 2012 FTC/DOJ Workshop on patent assertion entities: "*[…] we spend a lot of money and a lot of effort figuring out where to invest. And we don't feel like tipping our hands on our investment policies and our investment intentions to our competitors. Warren Buffett doesn't tell people where he's investing until he's forced to when he's practically ready to take over a company. Disney doesn't tell people when it[']s buying swamp land in Florida that, hey, we're planning to put a theme park over there*".[2] On the other hand, NPEs can use shell companies so as to remain hidden while they launch their litigation campaigns (Feldman and Ewing, 2012; Morton and Shapiro, 2013). The advantages of this are multiple. First, once a patent has been acquired, NPEs can hide the patent away until its use by the alleged infringer becomes widespread. Such a situation is most likely when the parties lack the necessary patent ownership information to evaluate the litigation risk effectively (Menell and Meurer, 2013), thereby enabling patent holders to generate rewards that are often out of all proportion to any contribution they might have made. Second, hiding ownership information may allow NPEs to lure their counterparts into incomplete licenses: companies that receive patent licensing

[1] Note, the US Federal Trade Commission (2016) uses the term "PAE" as opposed to "NPE".

[2] Fed. Trade Comm'n & U.S. Dep't of Just., Patent Assertion Entity Activities Workshop Transcript 62–63 (Dec. 10, 2012), available at http://www.ftc.gov/sites/default/files/documents/public_events/Patent%20Assertion%20Entity%20Activities%20Workshop%20/pae_transcript.pdf.

demands from shell companies find it extremely challenging to dispute the validity of the underlying patents and evaluate the appropriateness of the demand against them[3] and may even end up paying for intellectual property to which they already have rights (Morton and Shapiro, 2013; Anderson, 2015). This concern was made more than evident by the White House in its press release accompanying the 2013 Executive Action (The White House, Press Release, 2013): "*Patent trolls often set up shell companies to hide their activities and enable their abusive litigation and extraction of settlements. This tactic prevents those facing litigation from knowing the full extent of the patents that their adversaries hold when negotiating settlements, or even knowing connections between multiple trolls*."[4]

Thus, in this paper, we investigate whether dormant companies registered in the UK are mainly used by NPEs to hold patents so as to make competitors unaware of the true extent of their assets (Portfolio NPE model) or so as to launch litigation campaigns (Litigation NPE model). In so doing, we focus on two patent characteristics (*number of forward citations* and *patent scope*) that are widely used in the literature to assess, respectively, patent technological quality and the likelihood of a patent being infringed and litigated.

Specifically, we do expect NPEs to use dormant companies in order to make competitors unware of their acquisition strategies and of the true extent of their assets if, by acting primarily as patent aggregators, they acquire high-quality patents. In contrast, we would expect NPEs to use dormant companies in order to keep patents hidden while launching litigation campaigns if they hold patents at high risk of being infringed but that are similar (or lower) technological quality than the average. Accordingly, we formulate the following two hypotheses:

Hypothesis #1

The NPEs identified herein use dormant companies to make competitors unaware of the true extent of their assets: they hold patents that are of higher quality than the average.

Hypothesis #2

The NPEs identified herein use dormant companies to remain hidden while they launch litigation campaigns: they hold patents at high risk of being infringed and litigated, but that are of similar (or lower) technological quality than the average.

[3] The *Xilinx v. Invention Investment Fund I LP* case reported by Feldman (2014, p. 292) is illustrative of this problem. In response to the litigation case brought by Invention Investment Fund, Xilinx filed a declaratory judgement action challenging some of the patents asserted against them. However, some of the parties that Xilinx named were discharged by the judge, for the simple reason that the owners of the patents were not those identified by Xilinx.

[4] http://patentblog.kluweriplaw.com/2013/06/10/u-s-white-house-announces-initiatives-against-patent-trolls/?print=print

3. Methodology for identifying NPEs registered as UK dormant companies

Most of the literature to date has focused its attention on NPE activity by examining the patenting and litigation activity of large, well-known patent aggregators in the US; however, here, we focus on small NPEs operating in Europe. To do so, we opt not to rely on external lists of NPEs provided by specialized IP companies, but rather we propose a new methodology for identifying independent NPEs that are registered as *dormant companies*.

To identify dormant companies, our primary source of information is Orbis Intellectual Property Database (Orbis IP),[5] which identifies companies with "dormant company" status and links global patent data to companies. Orbis IP defines a dormant company as one that is "still registered, but has no significant activity (and no significant accounting transactions during the accounting period)". According to Orbis IP, there were about two million dormant companies active in Europe in 2019, concentrated primarily in the United Kingdom (679,583), Spain (583,098), Romania (129,390) and the Czech Republic (123,399).

Legislation regulating dormant companies differs from country to country, which might in part account for the differences in the numbers of such companies. In France, for instance, companies that do not report any activity for two years can be dissolved,[6] while in the UK companies can remain dormant for any length of time.[7] In Germany, a limited liability company is required to have a minimum capital of €2,000,[8] while in the UK, like any other private company, they are only required to keep capital above zero (Cable, 2013). Moreover, in the UK, unlike in a number of other countries (including Germany), companies are permitted to appoint corporate directors who can protect individuals influencing the company, thus giving rise to problems of accountability and transparency (Cable, 2013).

Here, we opt to focus on UK dormant companies because the UK hosts the largest number of dormant companies in Europe and because the "dormant" status is well defined, it being necessarily accompanied by the filing of dormant accounts at "Companies House", the legal entity that provides dormant status in the UK.[9]

The methodology we use to identify which dormant companies are independent NPEs is described in Figure 2 and comprises five stages. First, we select the 679,583 dormant companies that, according to Orbis IP, were registered in the UK in 2019 (*Step 1 in Figure 2*). Second, we restrict the analysis to the 4,645 companies that hold at least one patent (*Step 2*). Third, we exclude from the analysis university spin-offs and other dormant companies which have never previously acquired at least one patent from a third party, thereby reducing the

[5] The Orbis IP database (compiled by Bureau van Dijk Electronic Publishing, BvD) is a commercial dataset that provides economic and administrative data for more than 360 million companies and information on approximately 115 million patents worldwide, including publication information, ownership, industry, history of transfer, and opposition.

[6] Article R. 123–130 of the French Commercial Code.

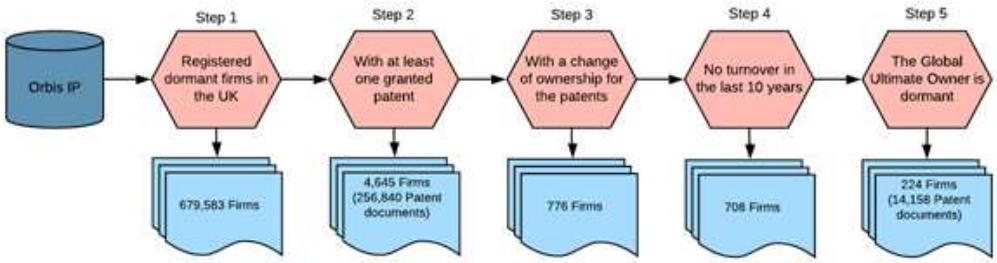
[7] https://www.gov.uk/dormant-company/dormant-for-companies-house

[8] Miller, R. ed., 2007. Annual of German and European Law: Volume II and III. Berghahn Books.

[9] Section 1169 of the Companies Act 2006 states that as long as a private company does not have any significant accounting transactions, it needs only submit to Companies House an unaudited abbreviated balance sheet and certain prescribed notes (https://www.legislation.gov.uk/ukpga/2006/46/section/1169).

sample to 776 dormant companies (*Step 3*).[10,11] Our reason for implementing this restriction is that, although all the companies can be considered *non-practicing entities* (because of their status as dormant companies), we are interested in entities that traditionally acquire patents and generate revenue by asserting them against alleged infringers (patent assertion entities). Fourth, we exclude from the analysis 68 entities that, despite their current status as dormant companies, actively carried out business in the past and can, therefore, be considered as failed enterprises. Finally, it was evident that most of the remaining companies were not independent entities but rather affiliates of large groups consisting of non-dormant companies.[12] Thus, we excluded them from the analysis which left us with a final sample of 224 independent NPEs registered as dormant companies in the UK in 2019 (*Step 5*). The majority of these companies are relatively young (an average age of less than 10 years) and around 25% of them had been created within the last five years. However, 8% of them appeared already as plaintiffs or defendants in patent litigation cases in May 2020,[13] suggesting that their creation was primarily aimed at conducting patent litigation business.

Figure 2. Data identification methodology used to identify NPEs registered as dormant companies in the United Kingdom



The figure shows the steps taken to identify the dormant companies registered in the UK that are NPEs. Own elaboration based on data from Orbis IP.

[10] Orbis IP tracks patent transfers recorded at the various patent offices and updates its information weekly. Moreover, as Orbis IP records the complete corporate structure of the companies, it is able to identify any reassignments made within the company or between inventors and the company: in both cases, we did not consider these as patent transfers in our analysis.

[11] The country in Europe with the second highest number of active dormant companies holding acquired patents is Sweden, with 69 dormant companies registered in 2019.

[12] In so doing, we thus imposed the condition that all companies in the group must be dormant, including the global ultimate owner (GUO). Orbis IP defines a GUO based on the company's shareholding structure and is the shareholder with the highest direct or total percentage of ownership.

[13] Data on patent litigation come from Darts-ip (https://www.darts-ip.com), a data provider of intellectual property cases worldwide, used on a daily basis by leading law firms, corporate counsel, and courts alike.

4. Empirical analysis

4.1 Patent data and main variables

Our sample of 224 NPEs registered as dormant companies in the UK hold a total of 14,158 patent documents[14] (including granted and non-granted applications), of which only 3,348 (24%) are filed at the UK Patent Office, highlighting the international dimension of the phenomenon. The rest of the patent applications are filed primarily at the EPO (9%), USPTO (8%), Chinese Patent Office (7%) and Australian Patent Office (7%) (Figure A1 in Appendix).

In the analysis reported here, we collected patent data from the three patent offices with most applications (i.e., the UK Patent Office, EPO, and USPTO) in order to determine the characteristics of the patents held by the NPEs identified in the analysis. The data come from the OECD Patent Quality Indicators Database (January 2020)[15] for patents filed at the USPTO and EPO, and from PATSTAT (October 2019) and the UK Patent Office (2020) for patents filed at the UK IPO.

As discussed in Section 2.2, in order to test *Hypothesis #1* and *Hypothesis #2*, we focused on two characteristics: *patent quality* and *patent litigation risk*. To measure the technological quality of the patents (*patent quality*), we consider the number of citations received in a given time window (five years from the filing date). Patent citations, extensively used in the literature for assessing patent quality (Trajtenberg, 1990; Albert et al., 1991), are included in the patent document to delimit the scope of the property right and identify the relevant prior art. This means that if patent X cites patent Y, it can be reasonably assumed that Y is a technological antecedent of X and that the knowledge embedded in Y has been developed by X. Such citations are known as "forward citations" and imply that an invention is being used for the creation of new inventions. Hence, a patent that receives a high number of citations can be considered to be of high value.

To proxy the patent litigation risk, we consider *patent scope*, as measured by the number of distinct four-digit International Patent Classification (IPC) classes assigned to an invention, as is common practice in extant research (Squicciarini et al., 2013).[16] Broad scope patents are reported to be significantly more likely to be infringed and litigated (Merges and Nelson, 1990; Lerner, 1994) and can be exploited for the purpose of rent seeking, especially by NPEs (Fisher and Henkel, 2012). Indeed, the scope and, in general, the clarity of patent claim language have been identified by researchers as constituting significant concerns for the quality of the patent system (Churnet, 2012; Wagner, 2009; Petherbridge, 2009; Zimmer, 2008).

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[14] Note that several patent documents may belong to the same patent family.

[15] See Squicciarini et al. (2013) for further information.

[16] Following Squicciarini et al. (2013), for each patent document *P*, the patent scope index was defined as $SCOPE_p = n_p;\ n \in \{IPC_1^4; \dots; IPC_i^4; IPC_j^4; \dots; IPC_n^4\}\ \&\ IPC_i^4 \neq IPC_j^4$, where n_p denotes the number of distinct 4-digit IPC subclasses listed in the patent *p* document.

4.2 Descriptive Statistics

According to the literature (Chien, 2012; Miller, 2018; FTC, 2016; Orsatti and Sterzi, 2018), NPEs are particularly interested in acquiring and monetizing complex technologies, above all in the fields of information technology, telecommunications, and software, where patent boundaries tend to be fuzzier, making inadvertent infringement more likely. This is especially true of large patent aggregators that can exploit the economies of scale typical of monetization activities in the ICT sector, where, in the US, they litigate around 93% of their patents (FTC, 2016); in contrast, small NPEs litigate patents in a wider variety of technological classes, including Pharmaceuticals and Chemistry (FTC, 2016).[17]

Table 1 shows a breakdown by field of technology of the patents held by the NPEs in our sample and all other patents filed at the EPO, USPTO, and UK IPO. Regardless of the patent office considered, we find that the ICT industry is not the main target; on the contrary, the UK NPEs hold a disproportionate number of patents in Chemistry (40% of dormant company patents vs. 26% of all patents filed at the EPO) and Mechanical Engineering (29% vs. 24%). Similar figures are found for patents filed at the USPTO and UK IPO (see again Table 1).

As regards patent characteristics, simple statistics for patent quality and patent scope provide evidence in support of *Hypothesis #2*. More specifically, a simple t-test for mean differences shows that the patents held by NPEs registered as dormant companies in UK always have a significantly broader patent scope than that of other patents (see Table 2). In contrast, we find no support for *Hypothesis #1*: in the case of patent quality, the patents held by NPEs registered as dormant companies received fewer citations at the EPO (0.62 vs. 0.84), and a similar number of citations at the USPTO and UK IPO (see again Table 2).

Table 1. Percentage of patents by technology field

	EPO		**USPTO**		**UK IPO**	
Technology field	**NPE Dormant Company patents**	**Others**	**NPE Dormant Company patents**	**Others**	**NPE Dormant Company patents**	**Others**
Chemistry	39.88	25.78	20.88	16.68	14.69	10.17
Electrical engineering	10.20	28.08	18.88	45.05	16.41	26.75
Instruments	10.20	15.91	19.68	16.56	13.82	13.72
Mechanical engineering	28.59	23.56	31.73	17.20	27.00	25.50
Other fields	11.13	6.68	8.84	4.50	28.08	23.86
Total	*100.00*	*100.00*	*100.00*	*100.00*	*100.00*	*100.00*

[17] Being smaller, litigation NPEs actually face more difficulties exploiting the scale economies typical of monetization activities in the ICT and complex technology sectors, where large patent aggregators collect many patents covering similar technologies.

WIPO (2011) 5 sector classification. The category "Other fields" includes *Consumer goods*, *Civil Engineering,* and *Furniture, Games.* Source: OECD Patent Quality Indicators Database (January 2020) for EPO and USPTO patents and UK IPO and PATSTAT (October 2019) for UK patents. Year of filings: 1990–2015 for EPO and USPTO patents; 2000–2015 for UK-IPO patents.

Table 2. Patent Quality and Scope: Descriptive evidence

	EPO			USPTO			UK IPO		
Variables	**NPE Dormant Company patents**	**Others**	**Diff (*sign.)**	**NPE Dormant Company patents**	**Others**	**Diff (*sign.)**	**NPE Dormant Company patents**	**Other**	**Diff (*sign.)**
Patent Quality	0.62	0.84	-0.22 (**)	9.42	10.78	-1.35	0.05	0.05	0.002
Patent Scope	2.15	1.92	0.24 (***)	2.43	1.94	0.50 (***)	1.96	1.80	0.16 (***)

Patent quality is proxied by the number of forward citations in a five-year period following the filing date and takes into account patent equivalents. Patent scope is proxied by the number of distinct four-digit International Patent Classification (IPC) classes assigned. Summary statistics are based on observations from regression #1, Table 3 for EPO; regression #1, Table 4 for USPTO; and regression #1, Table 5 for UK patents. Sources: OECD Patent Quality Indicators Database, January 2020 (Squicciarini et al., 2013). Citations for UK IPO patents come from DOCDB families ID / PATSTAT (2019). Filing years: 1990–2015 for EPO and USPTO; 2000–2015 for UK IPO. Two-sample t-test with equal variances: *** p<0.01, ** p<0.05, * p<0.1.

4.3 Econometric results

Differences in patent scope and patent quality might reflect distribution differences across technological domains and filing years. To take sectoral and year differences and other observable patent characteristics into account, we therefore estimate probit models[18] – where the dependent variable takes a value of 1 when the patent is held by the NPEs in our sample and zero otherwise. More specifically, among the regressors we include dummies for patent technology classes (WIPO, 2011[19]) and the patent filing years. In the models based on patents filed at the EPO and USPTO, we include other patent characteristics as control variables that may be correlated with the likelihood of observing a dormant company active in the UK as a patent owner. Among these, we include the patent originality, the number of backward citations, patent radicalness, and the number of claims.[20] Correlation matrices are displayed in Table A2 and A3 in the Appendix. Estimate results are shown in Table 3 for EPO patents, Table 4 for USPTO patents, and Table 5 for UK IPO patents.

[18] Results based on logit and OLS models give similar results and are available upon request.
[19] We use the WIPO taxonomy articulated in 35 fields (Squicciarini et al., 2013).
[20] All variables are drawn from the OECD Patent Quality Indicators Database (January 2020). We do not, however, have all these variables for the patents filed at the UK IPO. For reasons of space, we omit from the tables their estimated coefficients; they are, however, available upon request from the authors.

Table 3. Quality and Scope of patents held by NPEs registered as dormant companies in the UK (EPO patents) – PROBIT Estimates

	(1)	(2)	(3)	(4)
	Y=NPE	Y=NPE	Y=NPE	Y=NPE
Patent Quality	-0.022***	-0.0207**	-0.0187**	-0.0115
	(0.00883)	(0.00855)	(0.00835)	(0.00769)
Patent Scope	0.041***	0.041***	0.027***	0.028***
	(0.00711)	(0.00737)	(0.00797)	(0.00965)
Other variables:				
Originality				0.130*
				(0.0712)
Backward Citations				-0.00381
				(0.00262)
Radicalness				0.0733
				(0.0566)
Number of claims				0.00388***
				(0.000568)
Constant	-3.571***	-3.489***	-3.543***	-3.609***
	(0.0186)	(0.0644)	(0.0794)	(0.0869)
Observations	2,811,423	2,811,423	2,808,367	2,495,891
Year FE	NO	YES	YES	YES
Technology FE	NO	NO	YES	YES

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Patent quality is proxied by the number of forward citations in a five-year period following the filing date and takes into account patent equivalents. Patent scope is proxied by the number of distinct four-digit International Patent Classification (IPC) classes assigned. Technology FE: 35 technology classes (2011 WIPO). Filing years: 1990–2015. Sources: OECD Patent Quality Indicators Database, January 2020 (Squicciarini et al., 2013). For reasons of space, we omit the estimated coefficients for the year and technology dummies.

Overall, the econometric results verify the previous outcomes based on simple descriptive statistics, thus confirming *Hypothesis #2*. When considering the models that include all the controls (column 4 in Tables 3 and 4; column 3 in Table 5), our results provide evidence that the patents held by the NPEs registered as dormant companies in the UK hold patents that are broader than the average and, thus, more likely to be infringed and litigated. One (four-digit)

IPC class more assigned to a patent is associated with an increase in the likelihood to observe a NPE patent by 6.1% for USPTO and 2.8% for EPO.[21]

In contrast, we find no support for *Hypothesis #1*: patent quality is not significant (whichever the patent office considered in the analysis), meaning that patents owned by the identified NPEs are similar to the average in terms of technological quality. This result is slightly different from Fischer and Henkel (2012) according to whom NPEs mainly acquire patents of high quality. The reason is that our sample Fischer and Henkel (2012) focus on large and known NPEs and patent aggregators, while we do focus on small and less known NPEs - that, on average, assert patents as their primary business models (Chien, 2012; FTC, 2016).

However, given that, on average, transferred patents are of higher quality and broader scope than their non-transferred counterparts (Serrano, 2010), we suspect that our estimated coefficients can be biased, as NPE patents are generally subject to more trading than the average patent. To control for this possibility, we used the USPTO Patent Assignment Database (PAD, 2017 Version) – which tracks patent ownership changes for all patents filed at the USPTO – to detect and exclude from the analysis any non-dormant company patents that had not been transferred.[22,23] Table A1 in the Appendix confirms the previous results: a broader scope increases the relative probability of a patent being held by the NPEs registered as dormant companies in the UK, as opposed to be other types of assignees, while patent quality plays no role.

Table 4. Quality and Scope of patents held by NPEs registered as dormant companies in the UK (USPTO patents) – PROBIT Estimates

	(1)	(2)	(3)	(4)
	Y=NPE	Y=NPE	Y=NPE	Y=NPE
Patent Quality	-0.000804	-0.000505	-0.000259	0.000228
	(0.0006)	(0.0005)	(0.0004)	(0.0002)
Patent Scope	0.0616***	0.0645***	0.0660***	0.0610***
	(0.00805)	(0.00793)	(0.00802)	(0.00942)
Other variables:				
Originality				0.343***
				(0.132)
Backward Citations				-0.00384***
				(0.000927)

[21] In particular, results based on the USPTO sample (Table 4, model 4) suggest that average patents with a value of patent scope of "7" are two times more likely to be owned by our identified NPEs than patents with a value of patent scope of "3". Margins tables are available upon request by the authors.

[22] We relied solely on the USPTO database as its patent transfers are more complete than those of EPO, which only records reassignments during the grant stage (Ciaramella et al., 2017), and they provide a more complete set of patent controls than UK IPO.

[23] To identify patent transfers at the USPTO, we drew on information contained in the 'assignment' data file in the USPTO Patent Assignment Database (2017) (Graham et al., 2018). The full methodology is described in Sterzi (2020).

Radicalness				0.0866
				(0.0692)
Number of claims				-0.000739
				(0.00109)
Constant	-3.940***	-3.660***	-3.666***	-3.896***
	(0.0249)	(0.0702)	(0.0930)	(0.121)
Observations	3,664,478	3,618,386	3,522,796	3,500,904
Year FE	NO	YES	YES	YES
Technology FE	NO	NO	YES	YES

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Patent quality is proxied by the number of forward citations in a five-year period following the filing date and takes into account patent equivalents. Patent scope is proxied by the number of distinct four-digit International Patent Classification (IPC) classes assigned. Technology FE: 35 technology classes (2011 WIPO).. Filing years: 1990–2015. Sources: OECD Patent Quality Indicators Database, January 2020 (Squicciarini et al., 2013). For reasons of space, we omit the estimated coefficients for the year and technology dummies.

Table 5. Quality and Scope of patents held by NPEs registered as dormant companies in the UK (UK IPO patents) – PROBIT Estimates

	(1)	(2)	(3)
	Y=NPE	Y=NPE	Y=NPE
Patent Quality	0.0157	0.00870	-0.00644
	(0.0371)	(0.0391)	(0.0419)
Patent Scope	0.0523***	0.0611***	0.0517***
	(0.0131)	(0.0133)	(0.0151)
Constant	-2.811***	-3.008***	-3.054***
	(0.0297)	(0.0820)	(0.108)
Observations	138,703	138,703	130,040
Year FE	NO	YES	YES
Technology FE	NO	NO	YES

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Patent quality is proxied by the number of forward citations in a five-year period following the filing date and takes into account patent equivalents. Patent scope is proxied by the number of distinct four-digit International Patent Classification (IPC) classes assigned. Among the controls, we include dummies for the IPC two-digit technology classes and filing years. Sources: PATSTAT 2019 (October) and UK IPO database (2018. Filing years: 2000–2015. For reasons of space, we omit the estimated coefficients for the year and technology dummies.

5. Dragon Green Development Balboa SA: An NPE that uses UK dormant companies for patent litigation

In this section, we present the business model of the company incorporating the most litigious dormant company identified in our analysis, Dragon Green Development Balboa SA (DGDB).[24] DGDB serves as an illustrative example of the fact that NPEs can exploit dormant companies registered in the UK for patent litigation purposes. Although DGDB may not be representative of all NPEs registered as UK dormant companies, it makes an interesting case study for two reasons: first, it illustrates how small inventors can exploit frictions in corporate and patent transparency to litigate patents; and, second, it shows how the boundaries of UK dormant companies are fluid and constantly evolving, making them much less vulnerable to countersuits and making it more complex to hold anyone accountable.

5.1 Company presentation

According to the original incorporation document, DGDB was created on 8 November 2007 and incorporated in Panama. Each individual on the board is involved in, at least, five hundred other companies, either as a director, president or representative (see Table B1 in the Appendix). It is not clear whether they are the "real" stakeholders in DGDB's strategy, or whether they merely execute the administrative and legal tasks, or even whether they are just figureheads. Indeed, it is explicitly stated in the company's incorporation document that the board of directors can use proxies to represent themselves, with the "real" individuals being able to act via the figureheads. The latter, as is also stated in the incorporation document, have no legal responsibility and the actual board of the company could not be identified in any public data source.[25]

To identify the (active and inactive) companies linked to DGDB, we rely on Orbis[26] and OpenCorporates, which provide data directly from the national registers.[27] The methodology is presented in the Appendix. We identify thirteen UK-registered[28] companies in which DGDB appeared either as director or shareholder or both (these companies are listed in Table

[24] The most litigious company identified in our analysis is Manchester Telecommunications Development which was incorporated in the UK on the 30/11/2007, three weeks after the incorporation of DGDB in Panama. The company, now dissolved, was the owner of two patents and has been involved in 10 litigation cases.

[25] Moreover, the incorporation document explicitly specifies that the company holds 100 shares for a total capital of 10,000 USD and that individuals A.M.C.P. (Signatory/Representative) and L.V. (Director and President) hold one (1) share each. This means that ninety-eight shares are unaccounted for, making it impossible to know who owns the company. The document also states that all decisions made by the company must be validated by a simple majority vote (in some cases unanimity is required). Therefore, neither A.M.C.P. nor L.V. have control over the company. In addition, Article 8 of the incorporation document states that in meetings of the board of directors, the directors may be represented by one or more proxies who do not have to be directors of the company but who must be appointed by public or private document, with or without powers of substitution.

[26] Orbis is a financial database, it contains data from financial reports of companies as well as shareholder and management information (directors, ultimate corporate owners, etc.) (https://www.bvdinfo.com/en-gb).

[27] We identified ten companies in which DGDB acts as a director. However, since both Orbis and OpenCorporates only allow searches to be made in fields related to the role of company directors – and not as shareholders – we suspect that the number of companies in the DGDB network is likely to be more than ten.

[28] The companies linked to DGDB all have a specific industry code: 99.99/9 (UK SIC Classification 2007).

6). All of these companies were dormant companies with either £1 or £100 in capital and most of them were created within the first two months of the incorporation of DGDG (see Table 6). The combination of the use of proxy directors and corporate directors and the thin capitalization can result in a marked lack of transparency and accountability with respect to the individuals actually exercising control (Cable, 2013).

In addition, almost all thirteen UK dormant companies identified have the exact same legal address. More specifically, twelve are located at *The 606 Centre, 5A Cuthbert Street W2 1XT, London* and one at *Carpenter Court 1, Maple Road SK7 2DH, Stockport*. Interestingly, the same addresses are also reported by a large number of other firms: according to OpenCorporates, the London address appears as the legal address of almost 200 other companies (of which 42 were active in 2020) and the Stockport address of more than 13,000 companies (2,746 of which were active in 2020).[29] Finally, none of the UK dormant companies in the DGDB group has a website, email contact or phone number, making it difficult to identify who is behind them.

Table 6. DGDB and its network of dormant companies

Company Name	Position held by DGDB	Incorporation date	Status as of January 2021
ALPHA PHYSICAL AND LASER LIMITED	Director/Shareholder	14/11/2007	Active, controlled now by EUROINVEST LIMITED
ALPHA LONDON MECHANICAL LTD.	Director/Shareholder	15/11/2007	Dissolved
LONDON EXPERT ELECTRONIC LTD.	Director	15/11/2007	Dissolved
MANCHESTER BIOGENE TIGER LTD.	Director	15/11/2007	Active, controlled now by EUROINVEST LIMITED
MANCHESTER BIOLOGICAL LTD.	Director	15/11/2007	Dissolved
DOUBLE EAGLE MEDICAL LTD.	Director	29/11/2007	Dissolved
LONDON FUTURE OPTICAL LTD.	Director	29/11/2007	Dissolved
MANCHESTER TELECOMMUNICATIONS DEVELOPMENT LTD.	Director	30/11/2007	Dissolved
DRAGON CHEMICAL ENGINEERING LTD.	Director/Shareholder	03/12/2007	Active, controlled now by EUROINVEST LIMITED
CAPRICORN BIOCHEMICALS LTD.	Director	01/01/2008	Dissolved
LONDON PACKET RADIO LTD.	Shareholder	25/11/2011	Dissolved
LONDON SMART BELLOWS LTD.	Shareholder	25/05/2012	Dissolved
LONDON SMART CASES	Shareholder	25/05/2012	Active, controlled now by EUROINVEST LIMITED

Source: Based on data from Orbis IP, OpenCorporates and Companies House. The methodology used to identify the companies is described in Section 3.1.

[29] It is, of course, possible for multiple companies to have the same address, given that companies selling incorporation services provide a registration address in their packages. The services sold by these companies are tailored towards providing anonymity for individuals that wish to create a company. For this particular purpose, a service provider, such as SFM (https://www.sfm.com/), offers nominee directors and nominee shareholders: "The nominee director service may be used where a client doesn't wish to be personally appointed or has to meet local requirements. The name of the director will appear in the corporate documents, in any business contract and sometimes in the jurisdiction's business registers. Upon appointment of a nominee direction, nominee service agreement will be signed between the client and the nominee. It will guarantee the client that the nominee can only act or sign documents upon the client's request and with the client's prior approval. Professional directors introduced by SFM work with the highest level of integrity and confidentiality."

5.2 Business model

Patent Acquisition

The wish to remain invisible to the market is confirmed by the fact that DGDB appears as neither the current nor as the past owner of any patent, acquiring patents only through its UK dormant companies.[30] Eight of the thirteen dormant companies are the owner of at least one patent, from a total of fifteen patents (see Table B2 in Appendix).[31] All the patents were granted at the German Patent Office (DPMA) and filed by inventors residing in Germany, suggesting that the operational business unit has its home in Germany, even if the headquarters of DGDB are in Panama and all the dormant companies in the group are located in the UK.

Interestingly, the patent portfolio consists of different technologies and each dormant company acquired patents in just one technological field (see Table B2 in the Appendix). This strategy is typical of a particular type of NPE, the *Litigation NPE*, as described in Section 2.1 (FTC, 2016), which creates a new affiliate entity for each separate patent portfolio that it acquires.

In only one specific case is the patent seller a company (CREATION BELLOWS HOLDING LIMITED, an independent dormant company); in all other cases, DGDB acquired the patents directly from the patent inventors through its dormant companies. Some of these inventors are prolific inventors with several patents[32] and sometimes they appear as directors and/or shareholders of their own company,[33] although their patents are not assigned to these companies.

Moreover, in line with the business model of *Litigation NPEs,* DGDB holds German patents that are relatively low cited. DGDB patents receive on average 1.07 citations compared to 2.16 citations received by other patents filed at the German patent office that have been transacted in similar years (2008-2012).[34] In particular, eight patents of the DGDB portfolio have not received any citations[35] and no patent has received more than five citations.

Patent Litigation[36]

[30] We conducted our search in Questel Orbit, Google Patent, Espacenet, Orbis IP.

[31] The fact that five dormant companies do not appear as patent owners does not mean they do not hold any patent assets. NPEs may in fact take advantage of the fact that the registration of transfers of patent ownership is often not mandatory (Gorbatyuk and Kovács, 2019; Sterzi, 2020). For example, the German Patent Office does not impose a strict time period for recording a change of patent ownership, so that the patent holder may potentially signal the change of ownership at any time (for example, immediately prior to initiating a lawsuit).

[32] One inventor in particular has filed 81 patents.

[33] This may be the case, for example, of W.R., who appears as the director of two UK companies with names that are similar to one of DGDB's shell companies and which specialize in providing legal services to help individuals set up Limited Companies and monetize patent assets.

[34] Citations are computed by Orbis IP at July 2021, 12th.

[35] These patents are DE10220060B4, DE20204265U1, DE10148799C2, DE10050370B4, DE19834095B4, DE50210968D1, DE202006018745U1, DE10220061B4.

[36] The patent litigation analysis is based on data provided by Darts-ip.

DGDB began its litigation activity in December 2008, about a year after its incorporation in Panama, when Manchester Telecommunications (one of the group's dormant companies) filed a patent infringement suit against AVM Computersysteme Vertriebs GmbH (AVM), a company founded in Berlin in 1986 and operating in the consumer electronics industry.

Since that date, DGDB has been involved in fourteen litigation cases, exclusively in Germany, where eight of the fifteen patents identified in its portfolio were litigated (either in infringement or invalidity cases or both) in the period 2008–2011 (litigated patents are listed in Table 7). In all cases, the name of DGDB does not appear officially among the plaintiffs (or the defendants), since the plaintiffs (or defendants) are officially the dormant companies of the group (see Table 7). AVM is the most frequently targeted entity, appearing as a defendant or plaintiff – in the case of invalidity actions – in eight litigation suits.[37]

The decision to litigate patents in Germany follows the general strategy of NPEs of targeting the largest technological market in the EU, as well as the jurisdiction that is predisposed to grant preliminary injunctions even when a patent is later found to be invalid (Cremers et al., 2017) and which has the highest infringement win rate for NPE plaintiffs in Europe (Darts-ip, 2018). Moreover, the thin level of capitalization required in Germany can also serve to shield the UK dormant companies in the DGDB group should they lose a court action. Indeed, according to section 144 of the German Patent Act, parties that are unable to pay court and attorney fees because of their financial situation can request that legal costs be reduced. This is exactly what occurred in a patent invalidation case brought by Manchester Telecommunications Development, one of DGDB's dormant company, when it lost a patent lawsuit against AVM (Bundesgerichtshof Appeal, 03-09-2013) and sought to avoid having to pay the legal costs incurred by AVM.[38]

Table 7. Litigated patents

Patent Number	First worldwide family litigation filed: date	First worldwide family litigation filed: type	Date of transfer to DGDB dormant company	DGDB dormant company involved in the litigation
DE19719863	25/06/2008	Invalidity Action	20/10/2011	LONDON SMART BELLOWS
DE19630515	03/12/2008	Infringement	30/10/2008	MANCHESTER TELECOMMUNICATIONS DEVELOPMENT
DE202006018745	31/07/2009	Infringement	30/10/2008	ALPHA LONDON MECHANICAL LTD
DE10211642	22/04/2010	Infringement	30/10/2008	MANCHESTER TELECOMMUNICATIONS DEVELOPMENT
DE10148799	23/04/2010	Infringement	30/10/2008	MANCHESTER TELECOMMUNICATIONS DEVELOPMENT
DE20204265	02/12/2010	Invalidity Action	04/12/2008	MANCHESTER TELECOMMUNICATIONS DEVELOPMENT
DE10220060	04/03/2011	Invalidity Action	07/01/2010	DOUBLE EAGLE MEDICAL
DE10350078	04/03/2011	Invalidity Action	07/01/2010	DOUBLE EAGLE MEDICAL

Source: Based on data from Darts-ip and Google Patents.

[37] In some cases, the names of the defendants and plaintiffs were not reported or only their initials were reported.
[38] Manchester Telecommunications Development requested a reduction in accordance with Section 144 (Patent Act), which allows the Court to reduce the costs when the defendant's assets are insufficient to cover the legal costs. The Court rejected the request, however.

Dissolution

The dormant companies that appear as plaintiffs or defendants in patent lawsuits were all dissolved on termination of the litigation, while the others were either dissolved or transferred to EUROINVEST LIMITED (see Table 6), a dormant company registered in the UK that is the owner of twelve patents through its network of UK dormant companies. The link between EUROINVEST and DGDB, however, is not limited to the transfer of four companies (and their patents), given that various secretaries and directors of DGDB's dormant companies also hold positions in the EUROINVEST group (see Figure B2 in Appendix). Based on this evidence, it would appear that the main beneficiaries of EUROINVEST may well also be the main beneficiaries of DGDB.

6. Conclusions

Traditionally, the use of shell companies by NPEs has been documented as a prerogative of large patent aggregators for acquiring valuable patents and keeping them secret from their competitors. In this paper, we have focused our attention on small NPEs that exploit dormant companies in the UK and we have investigated whether these companies have, on the contrary, been created for the purpose of launching litigation campaigns. In our analysis, we identified 224 independent NPEs registered in the UK in 2019 as dormant companies, holding more than 14,000 patent documents worldwide. We investigated whether these companies were created for the purpose of holding high-quality IP assets so as to make competitors unaware of the true extent of their portfolios or, rather, with the aim of keeping patents hidden while they launched litigation campaigns. An econometric analysis based on patents filed at the UK IPO, EPO, and USPTO supports the second hypothesis: namely, the patent portfolios of the NPEs registered as dormant companies contain patents that are at a higher risk of being infringed and litigated than the average, but of similar technological quality.

We have concluded the paper by providing a case study of Dragon Green Development Balboa SA (DGDB), the company incorporating the most litigious dormant companies identified in our analysis. While DGDB may not be representative of all NPEs registered as dormant companies in the UK, the case study provides insights into the way in which some NPEs exploit information frictions in both corporate and patent markets to litigate and monetize IP assets in Europe. The business structure of DGDB is designed to ensure that what is visible of the company provides no details about the individuals who control and reap the rewards from the patents acquired on the patent market. Moreover, the combination of thin capitalization and the use of proxy directors and corporate directors results in a marked lack of transparency and accountability with respect to DGDB's beneficial owners.

The present study highlights the fact that any general definition of NPEs encompasses a wide range of heterogeneous firms and business models. Accordingly, policy makers need to look beyond the NPE vs. PE distinction and target the market frictions that make opportunistic behaviour in IP litigation profitable. All in all, this paper identifies compelling reasons for advocating greater transparency in both the corporate and patent markets. Patent offices need to be endowed with substantive rulemaking authority and should be required to make patent ownership information more readily available to help track formal changes of ownership.

Moreover, legislative initiatives should be implemented to facilitate patent clearance and to limit ex-post licensing and litigation. In parallel, legislation is required to promote greater corporate transparency and accountability to circumvent holdout problems and to make frivolous litigation less attractive.

Our study has a number of limitations, which, however, can be exploited for future research. Specifically, our conclusions are based on patents held by UK dormant companies that were active in 2019. This has two notable drawbacks: first, our results cannot be generalized to all UK dormant companies that were active in the past and liquidated before 2019; second, the fact that these entities are believed to acquire patents primarily for litigation purposes is inferred from observable patent characteristics and, for this reason, it would be interesting to monitor their behaviour in the near future to confirm our findings.

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APPENDIX A. ADDITIONAL TABLES AND FIGURES

Table A1. Quality and Scope of patents held by NPEs registered as dormant companies in the United Kingdom (USPTO patents): exclusion of non-dormant company patents that have not been transferred – PROBIT Estimates

	(5)	(6)	(7)	(8)
	Y=NPE	Y=NPE	Y=NPE	Y=NPE
Patent Quality	-0.0027**	-0.00219*	-0.00153*	-0.000387
	(0.0013)	(0.00119)	(0.00089)	(0.00056)
Patent Scope	0.0693***	0.0718***	0.0707***	0.0673***
	(0.00822)	(0.00830)	(0.00856)	(0.0101)
Constant	-3.503***	-3.232***	-3.233***	-3.470***
	(0.0281)	(0.0785)	(0.105)	(0.138)
Observations	702,780	700,944	684,878	680,970
Fil. Year FE	NO	YES	YES	YES
Technology FE	NO	NO	YES	YES
Other controls	NO	NO	NO	YES

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Patents held by non-dormant companies and that are not transferred are excluded. Patent quality is proxied by the number of forward citations over a period of five years after the publication date. Patent scope is proxied by the number of distinct assigned four-digit International Patent Classification (IPC) classes. Among the control variables, we include 35 technological classes (2011 WIPO) and filing year dummies, as well as the following patent characteristics: Patent originality, Backward citations, Radicalness and Number of claims (Squicciarini et al., 2013). Filing years: 1990-2015. Sources: OECD Patent Quality Indicators database, January 2020 (Squicciarini et al., 2013). For the sake of synthesis, we omit estimated coefficients for year and technology dummies.

Table A2. Correlation Matrix (EPO)

	(1)	(2)	(3)	(4)	(5)	(6)
Patent Quality (1)	1.00					
Patent Scope (2)	0.10*	1.00				
Originality (3)	0.03*	0.30*	1.00			
Backward citations (4)	0.09*	0.05*	0.15*	1.00		
Radicalness (5)	-0.02*	-0.11*	0.47*	0.07*	1.00	
Number of claims (6)	0.04*	0.11*	0.08*	0.02*	0.03*	1.00

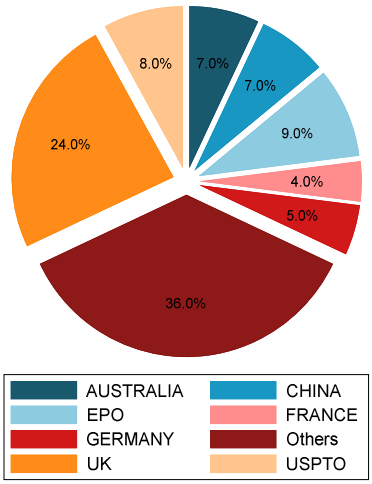
Based on observations used in Column 4, Table 3. Total number of observations: 2,495,891. Significance level: *p<0.05.

Table A3. Correlation Matrix (USPTO)

	(1)	(2)	(3)	(4)	(5)	(6)
Patent Quality (1)	1.00					
Patent Scope (2)	0.08*	1.00				
Originality (3)	0.06*	0.28*	1.00			
Backward citations (4)	0.26*	0.08*	0.21*	1.00		
Radicalness (5)	-0.04*	-0.07*	0.49*	0.09*	1.00	
Number of claims (6)	0.11*	0.02*	0.08*	0.18*	0.04*	1.00

Based on observations used in Column 4, Table 4. Total number of observations: 3,500,904. Significance level: *p<0.05.

Figure A1. Patent documents by patent office



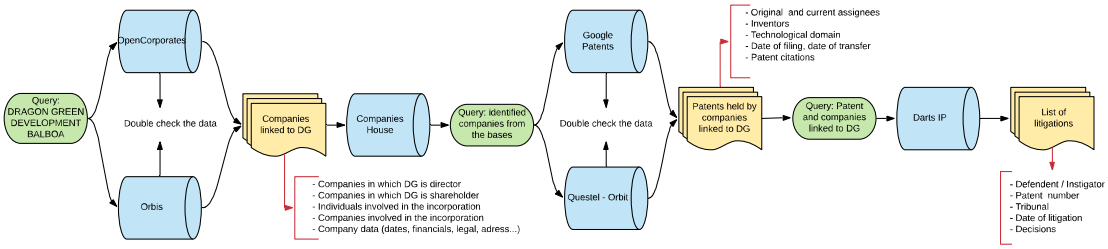
The figure shows the percentage of patent documents held by the identified NPEs registered as UK dormant companies by patent office. Source: ORBIS IP

APPENDIX B. DRAGON GREEN DEVELOPMENT BALBOA SA

1. Methodology to identify UK dormant companies linked in the network of Dragon Green Development Balboa (DGDB) SA and their patents

We made use of three types of data. First, we relied on the *OpenCorporates* and ORBIS financial databases to identify the firms linked to DGDB. The use of two databases allowed us to confirm that the information retrieved was correct. We further verified all information by reading the official documents available at Companies House. Second, in order to identify the patents held by the companies in the DGDB group we used *ORBIT* (*QUESTEL*)[39] and *GOOGLE Patents.*[40] Both databases were used to double check all information. Finally, in order to identify patent litigations involving DGDB dormant companies, we used the Darts-IP Database. The sequence of these three steps is shown in Figure A2.

Figure B1. Methodology to identify UK dormant companies linked in the network of Dragon Green Development Balboa (DGDB) SA and their patents.



The graph shows the queries made and the data resulting from these queries.

2. Other Tables and Figures

Table B1. Details of individuals listed as being involved in the incorporation of Dragon Green Development Balboa SA

Name	Function	Number of companies in which individuals appear as director treasurer, president or representative
D. I. C.	Director and Treasurer	843
J. E. A.	Director and Secretary	583
L. V.	Director and President	927
M. E. Q. DE C.	Signatory/Representative	864
A. M. C. P.	Signatory/Representative	1813

[39] Orbit contains 115 million patents and offers worldwide coverage.
[40] Google Patents is a free online database containing around 17 million patents filed at the larger patent offices.

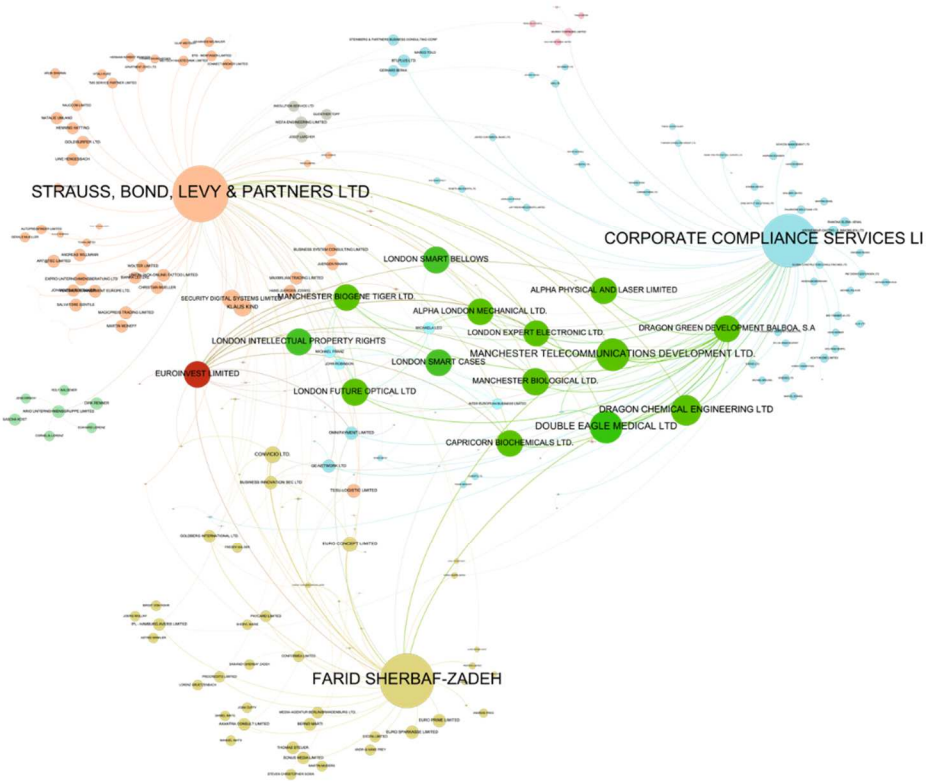
The table shows the initials (full names withheld to protect anonymity) of individuals involved in the creation of DGDB, their function and the number of other companies in which they appear (as directors, treasurers, presidents or representatives) as of February 2020. Source: Orbis and OpenCorporates.

Table B2. Details of the patents held by the DGDB Group

Date of transfer	DGDB dormant company	Patent Number	Previous Owner - Type	Previous Owner - Name	Country of residence of the inventor	Technology
30/10/2008	MANCHESTER TELECOMMUNICATIONS DEVELOPMENT	DE10211642(A1)	Inventor	M.G.	DE	Telecommunications
30/10/2008	ALPHA LONDON MECHANICAL LTD	DE202006018745(U1)	Inventor	A.E.G.F.	DE	Machine Tools
30/10/2008	DRAGON CHEMICAL ENGINEERING	DE19834095	Inventor	H.Z.	DE	Environmental technology
30/10/2008	MANCHESTER TELECOMMUNICATIONS DEVELOPMENT	DE50210968	Inventor	M.G.	DE	Telecommunications
30/10/2008	MANCHESTER TELECOMMUNICATIONS DEVELOPMENT	DE10148799	Inventor	M.G.	DE	Telecommunications
30/10/2008	MANCHESTER TELECOMMUNICATIONS DEVELOPMENT	DE19630515(A1)	Inventor	M.G.	DE	Telecommunications
04/12/2008	MANCHESTER TELECOMMUNICATIONS DEVELOPMENT	DE20204265(U1)	Inventor	M.G.	DE	Telecommunications
30/04/2009	LONDON FUTURE OPTICAL	DE10050370B4	Inventor	T.B.	DE	Consumer Goods
07/01/2010	DOUBLE EAGLE MEDICAL	DE10220060(B4)	Inventor	G.F.	DE	Computer Technology
07/01/2010	DOUBLE EAGLE MEDICAL	DE10350078(B3)	Inventor	G.F.	DE	Computer Technology
15/09/2011	ALPHA PHYSICAL AND LASER LIMITED	DE10109989B4	Inventor	G.F.	DE	Transport
20/10/2011	LONDON SMART BELLOWS	DE19719863(C1)	Company	CREATION BELLOWS HODING LIMITED	DE	Mechanicals
19/01/2012	MANCHESTER BIOGENE TIGER LTD	DE19926640C2	Inventor	R.F.	DE	Computer technology
20/09/2012	LONDON SMART BELLOWS	DE19719863C1	Inventor	R.W.	DE	Mechanicals
10/10/2013	LONDON INTELLECTUAL PROPERTY RIGHTS	DE10220061	Inventor	G.F.	DE	Computer technology

Source: Based on data from Questel Orbit and Google Patents. The methodology used to identify the companies is described in Section 3.1.

Figure B2. The network of directors and secretaries formed around DGDB



The figure shows the network linking all directors, secretaries and shareholders of the DGDB group. Each node in this network is a company or an individual that acts as a director, secretary or shareholder.