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Recent advances in the identification of patent thickets

Abstract: Recent empirical research has provided compelling evidence that the proliferation of intellectual property rights (IP) and the fragmentation of patent rights among different patent holders have created barriers to innovation and impediments to the commercialization of scientific discoveries. Legal and economic scholars have suggested that due to the rising number of patent applications, the limited resources in patent offices around the world and the lack of sufficient time to prior art search, examiners have failed to conduct thorough patent examination processes. Moreover, researchers have linked the growing number of overlapping intellectual property rights to the tragedy of the anticommons and to the concept of patent thickets. Multiple studies have been performed in order to develop measures that could verify the existence of patent thickets and to better understand the social and economic impact of fragmentary patent owners. When it comes to the energy sector, the problem of patent thickets is now even more important. As the technological innovation in this sector increases and the energy-related patenting continues to grow, it has been argued that the issue of patent thickets may have a direct impact on investment decisions and the long-run development of this sector. This paper presents an overview of literature on the definition of a patent thicket and summarizes some of the possible factors causing thickets to arise. Additionally, it discusses the recent developments in patent thicket measures and patent thicket identification methods.

Keywords: patent thickets, patent system, patent examination

Najnowsze osiągnięcia w dziedzinie identyfikacji chaszczy patentowych

Streszczenie: Wyniki prowadzonych w ostatnim czasie badań empirycznych wskazują, że rozprzestrzenianie praw włas- ności intelektualnej (*Intellectual Property* – IP) oraz fragmentacja praw patentowych wśród różnych posiadaczy patentów stwarzają bariery dla innowacji oraz powodują utrudnienia w komercjalizacji odkryć naukowych. Prawnicy i ekonomiści zasugerowali, że ze względu na rosnącą liczbę zgłoszeń patentowych, ograniczone zasoby w urzędach patentowych na całym świecie oraz brak wystarczającego czasu na uzupełnienie aktualnego stanu wiedzy w danej dziedzinie, osoby odpowiedzialne za ich weryfikację nie były w stanie przeprowadzić szczegółowych badań patentowych. Ponadto wyniki przeprowadzonych badań wskazują na powiązanie rosnącej

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liczby nakładających się praw własności intelektualnej do tzw. tragedii prywatnego zawłaszczenia i koncepcji chaszczy patentowych. Przeprowadzono wiele badań w celu opracowania narzędzi i miar, które mogłyby zweryfikować występowanie chaszczy patentowych oraz lepiej zrozumieć społeczny i ekonomiczny wpływ właścicieli fragmentarycznych praw patentowych. Problem chaszczy patentowych jest istotny dla sektora energetycznego, ponieważ staje się on coraz bardziej innowacyjny. W konsekwencji kwestia chaszczy patentowych może w znacznym stopniu wpłynąć na jego długoterminowy rozwój. Niniejszy artykuł przedstawia przegląd literatury dotyczącej pojęcia chaszczy patentowych oraz omawia wybrane czynniki powodujące wzrost udziału chaszczy patentowych. Ponadto w artykule omówiono najnowsze osiągnięcia w odniesieniu do mierników chaszczy patentowych oraz metod ich identyfikacji.

Słowa kluczowe: chaszcze patentowe, system patentowy, badania patentowe

Introduction

Recent empirical research has provided compelling evidence that the proliferation of intellectual property rights (IP) and the fragmentation of patent rights among different patent holders have created barriers to innovation and impediments to the commercialization of scientific discoveries (Galasso and Schankerman 2010; Heller and Eisenberg 1998). Statistical data from the World Intellectual Property Organization (WIPO) has shown that from 2004 to 2014, patent filing applications have increased at an average annual rate of 5.5 percent (see Table 1) (WIPO 2015). Furthermore, according to the latest report from the WIPO (2016), the State Intellectual Property Office of the People's Republic of China (SIPO) received 'more applications than Japan and the US combined' in 2015 with a total of 1,101,864. In 2015, SIPO became the first patent office to receive over one million applications in a single year, showing that China has become the main driver of worldwide patent growth[1]. Figure 1 shows the equivalent patent activity by origin in 2014.

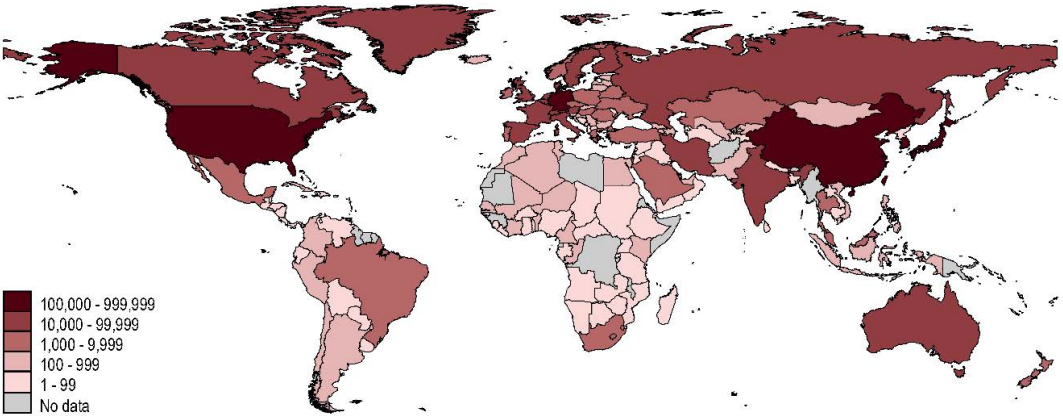
TABLE 1. Patent applications by region, 2004–2014

TABELA 1. Zgłoszenia patentowe, dystrybucja geograficzna, 2004–2014

	Number of applications		Share of world total [%]		Average growth [%] 2004–2014
	2004	2014	2004	2014	
Africa	10,100	14,900	0.6	0.6	4.0
Asia	772,100	1,607,500	49.0	60.0	7.6
Europe	322,600	346,200	20.5	12.9	0.7
Latin America & the Caribbean	45,000	64,100	2.9	2.4	3.6
North America	395,100	614,300	25.1	22.9	4.5
Oceania	29,400	33,900	1.9	1.3	1.4
World Total	1,574,300	2,680,900	100.0	100.0	5.5

Source: WIPO 2015.

[1] For more information on IP filling activities, please see the Economics & Statistics series report from the WIPO.



Source: Standard map A16.

Fig. 1. Equivalent patent applications by origin, 2014
Source: WIPO 2015

Rys. 1. Liczba zgłoszeń patentowych według źródła pochodzenia, 2014

Legal and economic scholars have suggested that as a result of the rising number of patent applications, the limited resources in patent offices around the world and the lack of sufficient time to prior art search, examiners have failed to conduct thorough patent examination processes. Lemley and Shapiro (2005) found that the large number of patent filings and the limited resources at the United States Patent and Trademark Office (USPTO) have forced examiners to spend, in a three year period, approximately 18 working hours on each patent application. Similarly to these findings (Harhoff and Wagner 2009), show that between 1978 and 1998, the number of pending patent cases per examiner increased from 24 to 120 at the European Patent Office (EPO). Furthermore (Harhoff and Wagner 2009), point out that for the period 1990–2000, patent applications tripled at the EPO, creating a backlog of over 400,000 pending applications.

In the energy sector, the rising number of patent applications is evident. Solar and wind technologies are two of the most innovative and fastest growing technology areas in the energy field. Their patenting growth rates have gone from 13% in 2004 to a 19% in 2009 (Bettencourt et al. 2013). In addition, earth drilling, and in particular deep drilling technologies have also become an important driver of patent growth. In 2015, 1465 patents were granted to deep drilling technologies, making this technological field a new dominant area within the oil and gas technologies (Bansal et al. 2017). Around the world, there are countless technologies that are being developed and that have the potential of becoming disruptive innovations. These innovations could change the way the energy sector is perceived and the way energy is generated, transmitted and consumed. As a result, energy related companies tend to ensure that their concepts and technology components are legally protected from rival companies. Thus, a number of studies have provided evidence that patent thickets may influence firm patenting behaviors and the innovative activity of numerous technology fields (Hall et al. 2013). In the energy sector, as the technological advancements become

more intertwined, patent thickets have accelerated the exposure of energy related companies to infringement battles and, consequently, have had an impact on the long-run development of this sector.

This paper presents a literature review on the definition of a patent thicket. What is more, it revisits the empirical literature on patent tickets and presents a summary on the advancement of qualitative and quantitative measures that have been employed in the study and identification of thickets.

1. The emergence of patent thickets

Various studies have linked the fragmentation of intellectual property rights to the concept of "anticommons" and have used the privatization process in post-socialist economies as a concrete example of how governments have created or have allowed the creation of an excessive number of overlapping property rights (Heller and Eisenberg 1998; Clarkson 2005). With this in mind (Heller and Eisenberg 1998; Shapiro 2001), argue that Patent and Trademark Offices (PTOs) around the world seem to have granted patents to ideas that may not meet the standards of novelty and non-obviousness and have allowed for the creation of overlapping property rights.

The significant increase in patent filings around the globe has introduced additional uncertainty into the patent system. To some extent, the backlog of pending patent applications has been correlated to the fragmentation of patent rights or commonly known as 'patent thickets'. Shapiro (2001) used the term 'patent thickets' to describe the fragmentation of property rights as a 'dense web of overlapping intellectual property rights that a company must hack its way through in order to actually commercialize new technology'. Moreover, consistent with Shapiro's term of patent thickets (Fischer and Ringler 2015), defined a patent thicket as 'overlapping exclusion rights held by different parties that allow multiple parties to block each other'.

What is more, scholars have claimed that an increase in the number of patent filings may not be the only determinant condition for the observed growth in patent thickets, and have attributed the increased pendency and growth of patent thickets to patents with vague (broad), overlapping and even conflicting patent claims (Hall et al. 2013; Barnett 2014). From a study of over 164 papers that have been published in an attempt to define a 'patent thicket', Egan and Teece (2015) identified seven economic issues that have been associated with the concept of patent thickets:

- Imperfect competition,
- Coordination problem,
- Wasteful duplication,
- Moral hazard,
- Transaction costs,
- Probabilistic patents.

For instance (Régibeau and Rockett 2010), examine the relationship of "patent importance" and the length of patent review in the USPTO before 2001. Through a model of approval delay, Régibeau and Rockett concluded that important innovations tend to be approved more quickly and found strong evidence that approval delay decrease in the later

stages of innovation cycles. Likewise (Harhoff and Wagner 2009), find that the increase in pendency time in the EPO is also caused by the complexity of the patent applications, which can lead to an increase in workload and extend the pendency times. Various attempts have been done to develop specialized tools that could measure and verify the existence of patent thickets. In the next section, we present an overview of recent advancements in patent thicket detection.

2. Qualitative and quantitative measures

Several methods based on social network analysis have been proposed for the detection of patent thickets. Social network analysis (SNA) is predominantly developed and used by sociologists, anthropologists, and organizational theorists; however, with the increasing number of network analysis qualitative and quantitative tools, its application has expanded to other academic disciplines. It is characterized by studying human interaction and the relationship between 'arcs' ('ties' or 'edges') and 'nodes ('vertices') (Sternitzke et al. 2008). In the study of patent networks, inventors or patent applicants are represented as nodes, and the cooperation between these individuals are represented as edges. Furthermore, network analysis is widely used in the study of research collaboration, publications, citation frequency and citation index, among other subjects.

Network analysis has been applied to uncover the network interaction of patenting companies. For instance (Clarkson 2005, 2004), proposes a patent thicket identification method based on the calculation of standard network density of patent pools and citation data. A representation of patent citations is shown in Fig. 2 and a patent network is shown in Fig. 3 (Clarkson 2005). Barnett (2014) uses a network visualization software to show the complex interaction of entities that are participants of patent pools in global information and communication technologies. In this case, network visualizations expedite the process

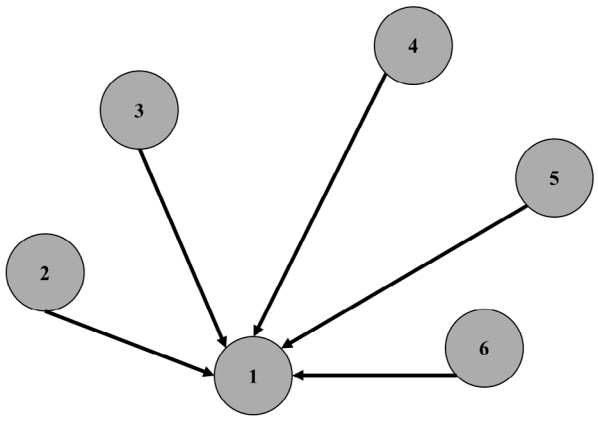


Fig. 2. Patent citations
Source: adapted from (Clarkson 2005)

Rys. 2. Cytowania patentów

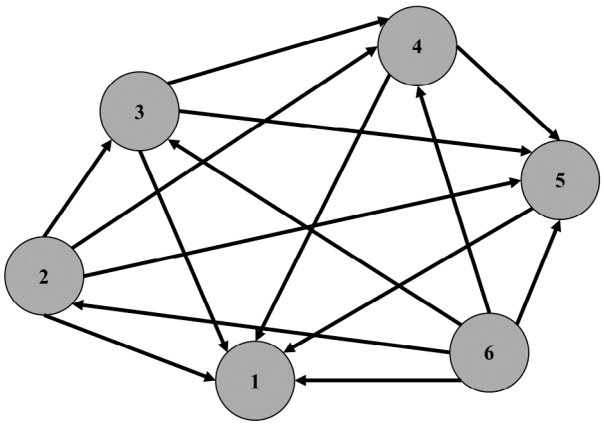


Fig. 3. Patent Network B
Source: adapted from (Clarkson 2005)

Rys. 3. Sieć patentowa B

of identifying dominant administrators and dominant licensors-members. Pool administrators are represented by nodes, with its node size showing the degree centrality, and edges indicating the connections in between licensors-members. Likewise (Sternitzke et al. 2008), exemplify the use of network analysis and visualization techniques to determine the level of cooperation between inventors and applicants in technology fields related to light emitting diodes (LEDs) and laser diodes (LDs).

As the applications of network analysis tools expanded, the identification and visualization of patent thickets have become increasingly important. Currently, at the Mineral and Energy Economy Research Institute, Polish Academy of Sciences in Krakow, a study on the application of a network analysis software tool for the visualization of patent thickets is being carried out. Initial results of the study, which is supported by the National Science Center (NCN), grant No. DEC-2013/11/B/HS4/00682 "A new method for identification of patent thickets", demonstrate the advantages of using a social network analysis tool in the visualization and the identification of patent networks. In the study, with the participation of subject-matter experts, 307 patent thickets have been identified within 58 USPTO technology groups. Furthermore, the possible application of natural language processing techniques for the identification of patent thickets is being evaluated. Preliminary results from the identification and visualizations of patent thickets in complex and discrete technologies are presented in Fig. 4 and Fig 5. In both figures, patents are represented as 'nodes' and citations as 'edges'.

In recent years, researchers in the fields of economics and intellectual property rights have widely adopted a patent thicket measure built on the premise that the fragmentation of patent ownership is usually correlated to the existence of patent thickets. Ziedonis (2004) provides a citation-based fragmentation index (a Herfindahl-Hirschman Index – HHI) which establishes the theoretical framework for the analysis of strategic patenting behavior and patent thicket growth.

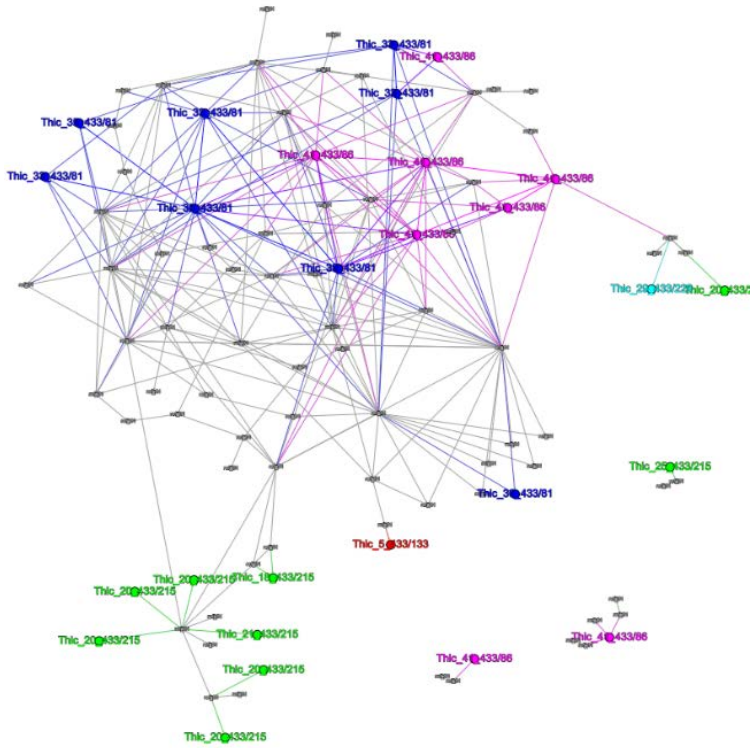


Fig. 4. An example of patent thickets in complex technology groups (Patent group 433/86 – Dentistry
Source: own work

Rys. 4. Przykład chaszczy patentowych w grupach patentowych złożonych technologii (grupa 433/86 – Stomatologia)

The HHI is calculated as the sum of the squares of shares:

$$HHI = \sum_{i=1}^{n} (CR_i)^2$$

where:

CR_i – concentration ratio,
n – number of entities,
i – entity number.

The HHI can be normalized (0 to 1) or non-normalized (0 to 10000). Two factors influence the value of the HHI: (i) the number of individual entities, (ii) inequalities in their shares. Assuming an identical number of entities, the higher the dispersion of the shares, the higher the value of the HHI (Kamiński 2012).

Although Ziedonis (2004) does not propose a patent thicket identification method, a wide number of studies have used the citation-based fragmentation index to understand the rela-

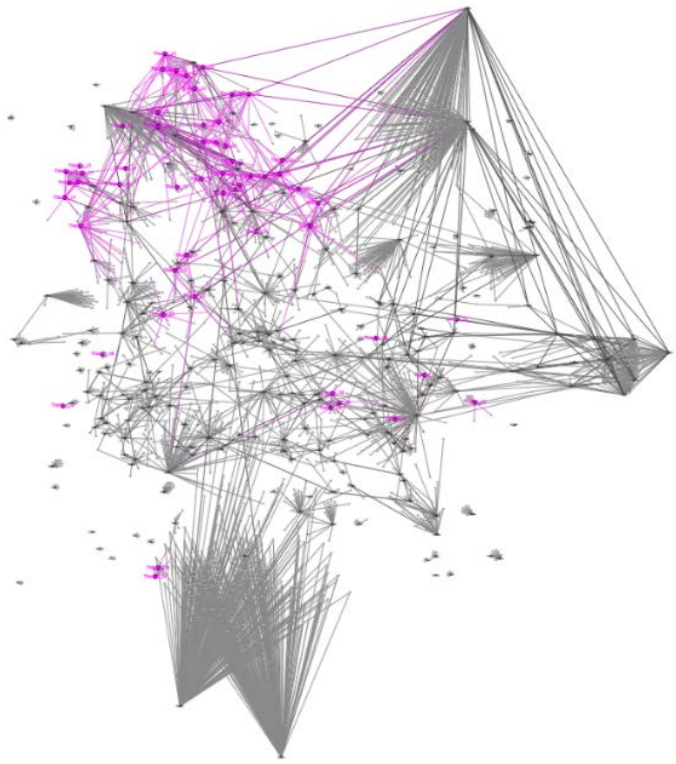


Fig. 5. An example of patent thickets in discrete technology groups (Patent group 23/313R – Chemistry)
Source: own work

Rys. 5. Przykład chaszczy patentowych w grupach patentowych dyskretnych technologii (grupa 23/313R – Chemia)

tionship between the level of patent ownership fragmentation and the presence of thickets in particular markets. It is often claimed that in some technology areas, companies have strong incentives to file a large number of applications with the aim of creating an entanglement of patents and use their portfolios against litigation and injunctions (Harhoff et al. 2015). Different models which include a citation-based fragmentation index and designed to estimate the impact of strategic patenting and R&D (research and development) spillovers can be found the literature (see Noel and Schankerman 2013; Ziedonis 2004). Von Graevenitz et al. (2013) suggest the application of a fragmentation index as a measure of 'direct competition' between companies in the area of technology.

Furthermore, building on the idea that a patent thicket is a network of companies and that it is possible to demonstrate the existence of a patent thicket by determining the density of a network (Harhoff et al. 2015; Von Graevenitz et al. 2011), proposed a method for the identification of thickets employing the concept of firm triples and blocking patents. Blocking patents are 'patents which have claims that overlap each other in a manner that the invention claimed in one patent cannot be practiced without infringing the claims of other patents and vice versa' (Carlson 1999; Clark et al. 2001). Fig. 6 shows the general (a) and identified structure (b) of triples and blocking patents.

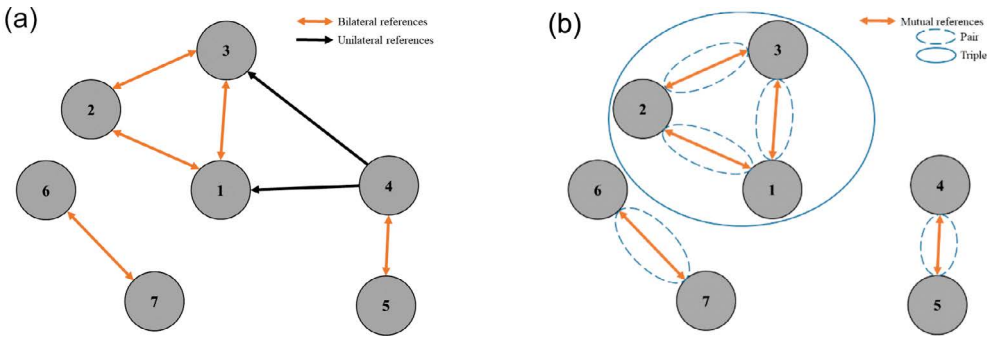


Fig. 6. General (a) and Identified Structure (b) of triples and blocking patents
Source: adapted from (Von Graevenitz et al. 2013)

Rys. 6. Ogólna (a) i zidentyfikowana struktura (b) potrójnych i blokujących patentów

Conclusions

In recent years, there has been a significant progress in the study of patent thickets and in the area of intellectual property rights. Various identification strategies and thicket measures have been proposed in the literature. Social network analysis is a methodology that has received much scholarly attention due to its advantages over other identification methods. This method, which is predominantly developed and used in social sciences has helped researchers uncover the network interaction of patenting companies. At present, the Mineral and Energy Economy Research Institute, Polish Academy of Sciences in Krakow, a study on the application of a network analysis software tool for the identification and visualization of patent thickets is being carried out. In the study, with the participation of subject-matter experts, 307 patent thickets have been identified within 58 USPTO technology groups. Furthermore, the possible use of a natural language processing technique for the identification of patent thickets is being investigated. This paper provides a literature review on key terms related to patent thickets. What is more, it revisits the empirical literature on patent tickets and presents a summary of qualitative and quantitative measures that have been employed in research.

As previously indicated, the energy sector has been particularly exposed to the problem of patent thickets. As the technological innovation in this sector increases and the energy-related patenting continues to grow, patent disputes between energy related technology companies has accelerated. A number of studies have pointed out that technology companies tend to employ all tools that are legally entitled, even strategically obtaining patents, solely with the aim of blocking their competitors technological developments, affect their market share and reduce their profits. This especially applies to the innovations that could become disruptive. Consequently, the study and understanding of patent thickets is of key importance for the long-run development of the energy sector.

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