How to measure patent thickets – A novel approach

Georg von Graevenitz, Stefan Wagner and Dietmar Harhoff

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Munich School of Management
University of Munich

Fakultät für Betriebswirtschaft
Ludwig-Maximilians-Universität München

How to measure patent thickets – a novel approach

Georg von Graevenitz[1], Stefan Wagner[2], Dietmar Harhoff[3]

Abstract

The existing literature identifies patent thickets indirectly. In this paper we propose a novel measure based on patent citations which allows us to measure the density of patent thickets directly. We discuss the algorithm which generates the measure and present descriptive results validating it. Moreover, we identify technology areas which are particularly impacted by patent thickets.

JEL: L13, L20, O34.

Keywords: patenting, patent thickets, patent portfolio races, complexity.

[1] Georg von Graevenitz, Ludwig Maximilians University, INNO-tec, Kaulbachstrasse 45, 80539 Munich, Germany graevenitz@lmu.de.

[2] Stefan Wagner, Ludwig Maximilians University, INNO-tec, Kaulbachstrasse 45, 80539 Munich, Germany, swagner@bwl.lmu.de, Phone +49 89 2180 2877, Fax +49 89 2180 6284.

[3] Dietmar Harhoff, Ludwig Maximilians University, INNO-tec, Kaulbachstrasse 45, 80539 Munich, Germany, harhoff@lmu.de.

1. Introduction

In the United States the establishment of the CAFC in 1982 led to a strengthening of patent rights (Jaffe, 2000). Subsequently, there was an explosion of patent applications at the USPTO (Hall, 2005; Hall and Ziedonis, 2001; Kortum and Lerner, 1999), and a similar increase has been observable at the European Patent Office (EPO) since 1995 (von Graevenitz et al., 2007). These patent explosions have had particularly strong impact on technologies characterized by modular design and high complexity of products such as electronics and semiconductors. The combination of complex technology and high volume patenting creates patent thickets which can be defined as dense webs of overlapping patent rights (Shapiro, 2001).

Cohen et al. (2000) identify complex technologies by bisecting the standard industry classification. Kortum and Lerner (1999), Hall (2005) and von Graevenitz et al. (2007) find that patenting increased particularly in complex technologies. Hall and Ziedonis (2001) and Ziedonis (2004) conduct interviews which establish that semiconductor firms are affected by patent thickets. All these papers provide evidence that patent thickets matter but do not provide a direct measure of their existence and extent.

We propose a novel measure of the density of patent thickets and describe an algorithm to generate this measure from patent data. The measure derives directly from information on blocking of one patent by another. Blocking patents can hold up whole technologies. Prominent examples include early disputes between Texas Instruments and a number of Japanese semiconductor firms over the “Kilby” patent or the dispute between Intel and Intergraph over the Clipper patents (Shapiro, 2003).

The growth of patent thickets has given rise to several enquiries[4] and legislative initiatives in the United States and Europe. In the United States there have been repeated, yet hitherto unsuccessful attempts to change patent law, witness the Patent Reform Acts of 2005 (H.R. 2795), 2007(H.R. 1908, S.1145) and 2009 (S. 515/S. 610/H.R. 1260). Both the US Patent and Trademark Office and the European Patent Office recently overhauled their fee structures and rules in order to discourage excessive patent filings. A measure that makes the evolution of patent thickets transparent provides an important contribution to the policy debate.

This paper is structured as follows: in Section 2 we motivate the measure and set out the algorithm which generates it. Section 3 presents descriptive results validating the measure. A short summary and outlook on future uses of our measure concludes the paper in Section 4.

[4] National Research Council (2004), F.T.C. (2003) and Bessen and Meurer (2008) focus on the US patent system. Von Graevenitz et al. (2007) analyze primarily the patent system governed by the European Patent Office (EPO).

2. The Algorithm

Our measure of patent thicket density exploits the classification of references in the search reports issued by the EPO. Search reports describe the state of prior art regarded as relevant for the patentability of an invention application and contain a list of references to prior patents and/or non-patent sources. Often, existing prior art limits the patentability of an invention and the references pointing to such critical documents are then classified as X or Y references (Harhoff et al., 2006).[5]

We propose a measure that identifies constellations in which three firms each own patents that block patent applications of the other two firms. If three firms block each other in this way we call this a *triple*. Figure 1 illustrates blocking, mutual blocking and blocking in a triple. The likelihood of resolving a mutual blocking relationship between any two firms in a triple depends on the actions of the third party. Therefore, the bargaining problem cannot be resolved through independent bilateral bargaining by each firm pair in the triple, and the resolution of blocking relationships is more difficult than in a bilateral relationship. This raises bargaining costs substantially. By identifying and counting the number of triples within a given technology we can measure the density of patent thickets.

Our algorithm involves the following steps:

1. We partition the set of all patents into subsets corresponding to technology areas using the OST-INPI/FhG-ISI technology nomenclature (OECD 1994).

   For each technology area, we

2. then identify all firms whose patents are referenced as X or Y references by a given firm;
3. compile a directed list of all firm pairs in which the first firm blocks one or more patents owned by the second;
4. identify all pairs in which each party can block at least one patent belonging to the other;
5. identify all groups of three firms which consist of mutually blocking firm pairs from the subset of firms that block each other mutually.

Our measure is a count of the number of triples arising in a technology area in a given time period.

[5] Type X references refer to prior art documents which taken by themselves call novelty or inventive step of a claim into question. Type Y references do so in conjunction with other documents.

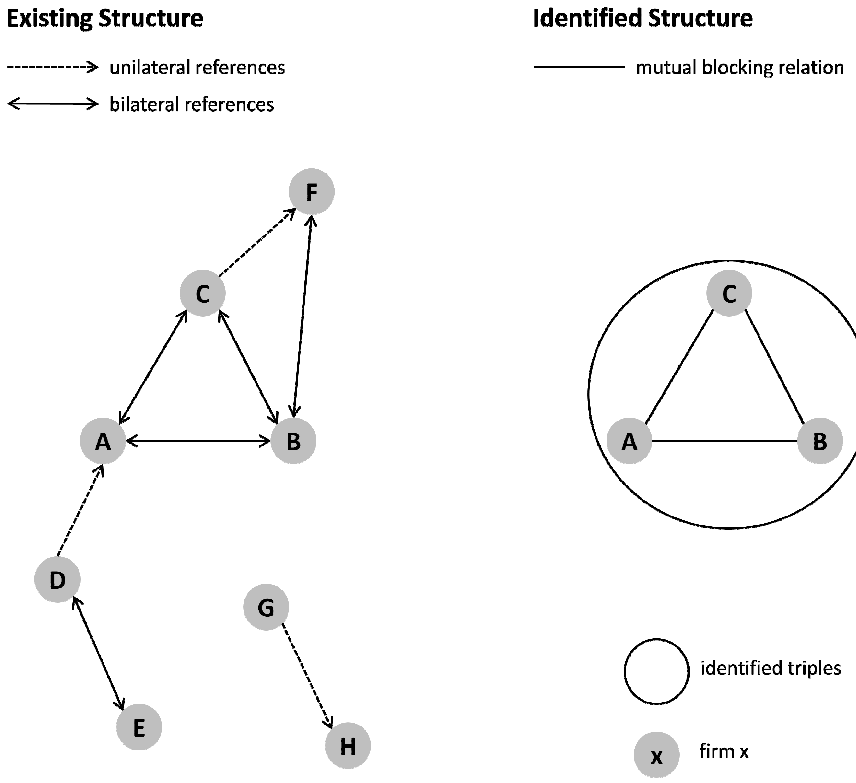

Figure 1: Schematic presentation of the structure of unilateral and bilateral blocking relationships between patent holders.

In practice we have limited the number of blocking firms considered for each blocked firm at step 2 of the algorithm to the ten most important firms blocking that firm's patents. This reduces the computational burden and helps us to focus on the most important blocking relations.

3. Descriptive Validation

To demonstrate that the triples measure of patent thicket density is capable of identifying patent thickets we provide three descriptive results. These have been obtained by applying our algorithm to patent filings at the EPO between 1980 and 2003. Data were taken from the PATSTAT database (”EPO Worldwide Patent Statistical Database”) as of September 2006.

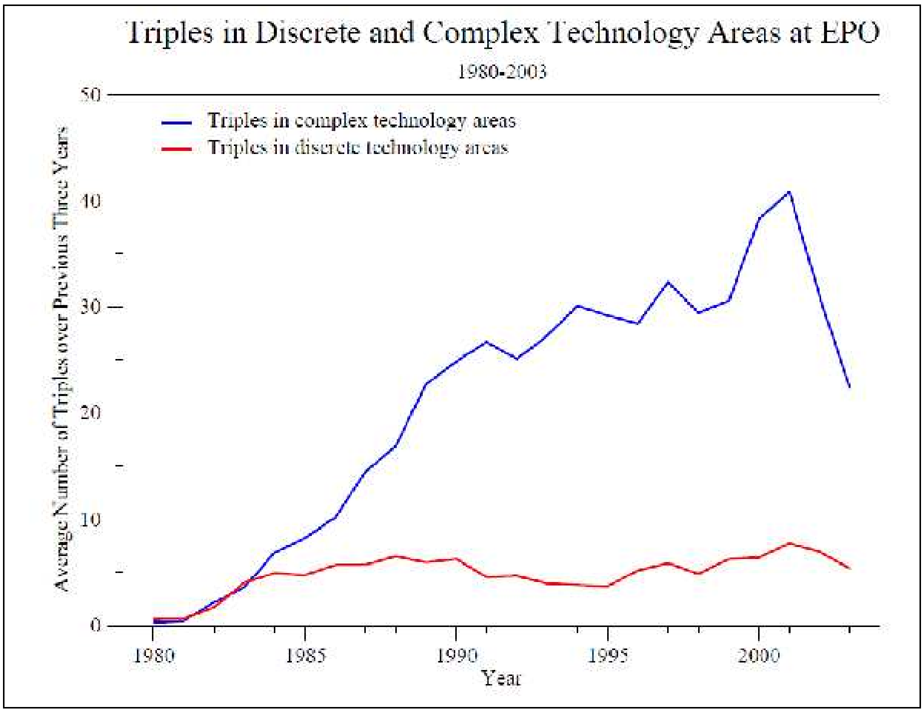

Figure 2: Average number of triples identified in complex and discrete areas.

First, we bisect the technology areas in our data according to the definition of complex and discrete technologies suggested by Cohen et al. (2000) and compute the aggregate number of triples for complex and discrete technology areas by year. Figure 2 shows that the density of patent thickets in complex technology areas has been rising steadily since the early 1980's whereas the density of patent thickets has been constant in discrete technology. The decrease in the number of triples in 2004 is the consequence of grant lags at the EPO (Harhoff et al., 2006).

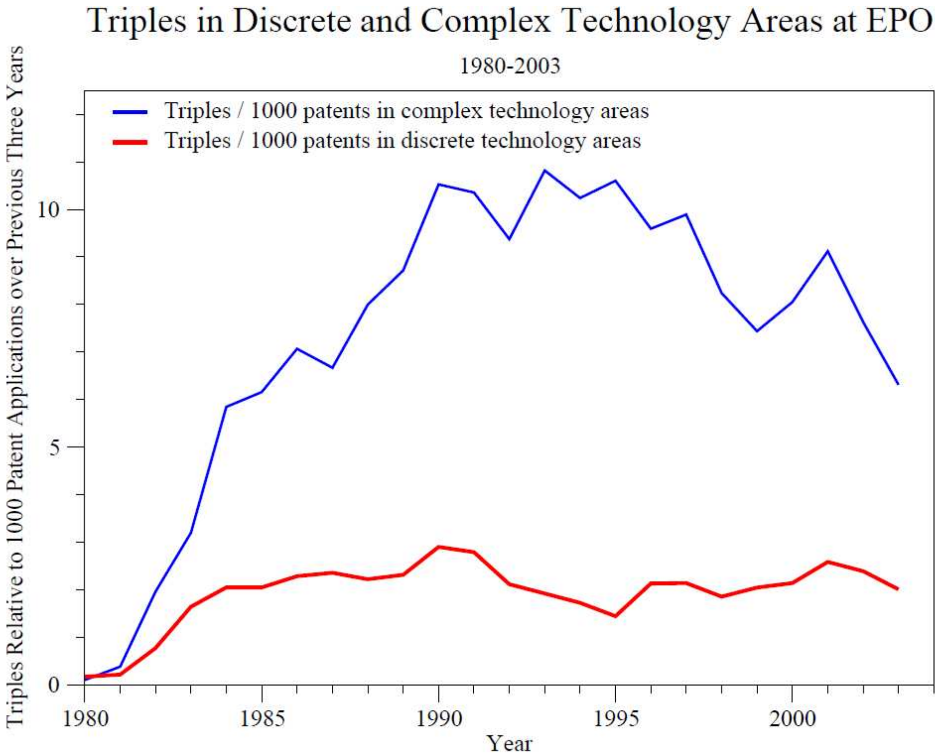

Figure 3: Average number of triples identified relative to 1000 patent applications in complex and discrete areas.

Second, Figure 3 provides information on the number of triples relative to patent applications in complex and discrete technologies and shows that the difference between discrete and complex areas is not a function of the number of patent applications.

Finally, Table 1 sets out the number of triples by technology area. This table shows that very dense patent thickets exist in all technology areas related to information technology. This finding accords well with the results of Hall (2005).

Technology area	Patent Applications	Triples Mean	Median	Min.	Max.	Classification
Electrical machinery, Electrical energy	3790	18.79	19	0	42	Complex
Audiovisual technology	2377	93.68	116	0	148	Complex
Telecommunications	4979	78.01	88	0	166	Complex
Information technology	3047	47.53	55	0	73	Complex
Semiconductors	1740	52.72	57	1	91	Complex
Optics	2684	46.57	47	0	77	Complex
Analysis, Measurement, Control	3662	5.45	3	0	21	Complex
Medical technology	1666	3.15	3	0	8	Complex
Nuclear engineering	281	0.8	1	0	4	Complex

Organic fine chemistry	4816	5.51	3	0	19	Discrete
Macromolecular chemistry, Polymers	3167	16.92	15	1	38	Discrete
Pharmaceuticals, Cosmetics	2979	2.78	3	0	8	Discrete
Biotechnology	1902	0	0	0	0	Discrete
Agriculture, Food chemistry	451	0.06	0	0	1	Discrete
Chemical and Petrol industry	2245	10.89	10	0	22	Discrete
Chemical engineering	1317	1.06	1	0	3	Discrete
Surface technology, Coating	1529	2.67	2	0	9	Discrete
Materials, Metallurgy	1869	1.95	1	0	6	Discrete
Materials processing, Textiles, Paper	2150	3.28	3	0	9	Discrete
Handling, Printing	2088	15.9	9	0	50	Discrete
Agricultural and Food processing,	303	0.33	0	0	2	Discrete
Environmental technology	477	3	0	0	15	Complex
Machine tools	942	1.55	1	0	5	Complex
Engines, Pumps and Turbines	1559	18.53	13	0	69	Complex
Thermal processes and apparatus	587	0.29	0	0	2	Complex
Mechanical elements	1583	1.77	1	0	7	Complex
Transport	2114	12.89	12	0	50	Complex
Space technology, Weapons	199	0	0	0	0	Complex
Consumer goods	1171	0.58	0	0	4	Complex
Civil engineering, Building, Mining	688	0	0	0	0	Complex

Table 1: Patent applications and the distribution of triples between 1980 and 2003.

Table 1 identifies additional technology areas - previously not identified as being affected by patent thickets – characterized by patent thickets of lower intensity. These include Optics; Handling and Printing or Machines, Pumps and Turbines.

4. Summary

We provide a measure of the density of patent thickets based on triples of firms that can mutually block some of each others' patents. The number of triples measures the density of patent thickets in a technology area.

The number of triples is high for technology areas classified in previous studies as complex whereas it is much lower in areas classified as discrete. We also find that patent thickets are particularly dense in technology areas previously identified in qualitative assessments as harboring patent thickets.

The advantage of the triples measure proposed here is that it provides a simple way of computing the density of patent thickets across technologies and at any given point in time. In this way the measure enables researchers to analyze the effect of the threat of hold up in different technology areas on firms' patenting strategies. In a related study, von Graevenitz et al. (2008) use the triples measure to demonstrate that growing density of patent thickets is associated with increasing number of patent applications.

Bibliography

BESSEN, J. AND M. MEURER (2008): Patent Failure, Princeton University Press.

COHEN, W., R. NELSON, AND J. WALSH (2000): ``Protecting their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not)," Working Paper 7552, NBER.

F.T.C. (2003): ``To Promote Innovation - The Proper Balance of Competition and Patent Law and Policy," Report, GPO.

HALL, B. (2005): ``Exploring the Patent Explosion," Journal of Technology Transfer, 30, 35-48.

HALL, B. AND R. ZIEDONIS (2001): ``The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-1995," Rand Journal of Economics, 32, 101-128.

HARHOFF, D., K. HOISL, AND C. WEBB (2006): ``European Patent Citations - How to Count and How to Interpret Them"

JAFFE, A. (2000): ``The U.S. Patent System in Transition: Policy Innovation and the Innovation Process," Research Policy, 29, 531-557.

KORTUM, S. AND J. LERNER (1999): ``What is behind the Recent Surge in Patenting?" Research Policy, 28, 1-22.

NATIONAL RESEARCH COUNCIL (2004): Patent System for the 21st Century, Report of the Board on Science, Technology, and Economic Policy, Washington, D.C.: National Academies Press.

OECD (1994): Using Patent Data as Science and Technological Indicators, Patent Manual.

SHAPIRO, C. (2001): ``Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard-Setting," in Innovation Policy and the Economy, ed. by A. Jaffe, J. Lerner, and S. Stern, Cambridge, Mass.: MIT Press, vol. 1.

-- -- -- (2003): ``Technology Cross-Licensing Practices: F.T.C. vs. Intel (1999)," in The Antitrust Revolution, ed. by J. Kwoka and L. White, Oxford: Oxford University Press, 350-369.

VON GRAEVENITZ, G., S. WAGNER, K. HOISL, B. HALL, D. HARHOFF, P. GIURI, AND A. GAMBARDELLA (2007): The Strategic Use of Patents and its Implications for Enterprise and Competition Policies, Report for the European Commission.

VON GRAEVENITZ, G., S. WAGNER, AND D. HARHOFF (2008): Incidence and Growth of Patent Thickets - The Impact of Technological Opportunities and Complexity. CEPR Discussion Paper 6900, London.

ZIEDONIS, R. (2004): ``Don't Fence Me In: Fragmented Markets for Technology and the Patent Acquisition Strategies of Firms," Management Science, 50, 804-820.