The Current Intellectual Property Debate: A Citation-Based Analysis

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This paper addresses the research landscape of Intellectual Property Rights. It describes and probes the key players and the most influential journal publications. While most literature reviews are qualitative, in many cases highly subjective and necessarily selective, this paper takes another course. By using Social Network Analysis and the Co-Author Citation Approach it constructs a quantitative approach. The outcome is threefold. First, the works with the most influence are identified, as are 9 sub-networks into which the Intellectual Property research splits. Second, the research institutions and their networks are analyzed. This research illustrates that the Intellectual Property research landscape is shaped by a handful of universities, the rest follow suit. Third, it is demonstrated that North America dominates the academic Intellectual Property debate by far. Regions such as South America and Africa do not even appear in the body of knowledge. This paper gives an overview of Intellectual Property research. Based on the quantitative output further research questions can be formulated.

Key words: intellectual property rights, social network analysis technique, co-author citation

Introduction

Intellectual Property (IP) refers to patents, copyrights, trademarks and other forms of ownership of ideas. Forero-Pineda observed a global trend towards stronger Intellectual Property Rights (IPR) in the last two decades (2006). According to him and many other notable researchers the main development in the field of IPR goes from invention to discovery and from mechanical devices to living organisms (Byström, Einarsson and Nycander 1999); from industrial products and technological processes to services and financial and administrative methods (Lerner 2000), and from so called 'brick' to 'click' trademarks (Bubert and Büning 2001). The trend is clear. We can observe an extension of the objects which are covert under the IRP. This goes hand in hand with a reinterpretation of certain conceptual borders. Such is the case of the borders between invention and discovery, and between natural and artificial phenomena

(Forero-Pineda 2006). In this context, the concept of IPR has never been clear, unambiguous or beyond dispute. There are at any time different positions, views or comprehensions. In almost the same manner concepts differ geographically, which means that there are differences between the western world and eastern positions as well between the interests of the North and South.

This paper addresses these different positions from the point of academic debate. The question is in which direction academics discuss IRP. The goal is threefold. First, on the ground of a literature review of major academic journals the most influencing articles are identified by a quantitative citation analysis. The result is a network which reflects the IRP research landscape as well as the authors and works with the most influence. Further, the areas of study are analyzed by the age of the most published and cited papers. The outcome is an overview of the trends in research. Second, this paper examines the academic institutions, which have the highest impact on the IPR debate. Here it becomes obvious that only a handful of institutions shape the research landscape. Third, because different geographical regions are facing different challenges about IP, this paper focuses on the contributions of these regions to IPR research and their chance to shape the academic debate. A brief introduction is given to the approach, along with a description of methodology used and of data collection. The principal investigation was a univariate statistical analysis, which was performed to determine the latent structure underlying the IPR literature. The view of IPR literature, which this analysis presents, is discussed and a simple nonparametric technique is used to test the geographic dichotomy.

Methodology

There are a number of techniques that can be used to examine a body of literature. Most frequent is the simple literature review where a highly subjective approach is used to structure the earlier work (Drejer 1996; 1997). There are also some objective and quantitative techniques available, for example the analysis of author citations, co-citations (or a combination of the two) and systematic review (Pilkington and Teichert 2006). The various types of citation analysis are based on the premise that authors cite papers they consider to be important to the development of their research. As a result, heavily-cited articles are likely to exert a greater influence on the subject than those that are less-frequently cited (Sharplin and Mabry 1985; Culnan 1986). To identify research activities in the field of IPR the Author Citation Analysis (ACA) is used, which is a modifi-

cation of the Co-Word Analysis (CWA) (Small 1974; Small and Griffith 1974). The ACA was developed by White and Griffith (1981a; 1981b; 1982) and described in technical detail by White (1986) in terms of co-cited author retrieval and by McCain (1990) in terms of co-citation mapping. The ACA is a bibliometric technique to structure a research field. It is 'based on counting highly co-cited pairs of oeuvres – i. e., a body of writings by the same author, or first author in collaboration' (White and Griffith 1982, 257) and provides a map of the structure of a research field through pairs of documents jointly cited or co-cited, which appear frequently in the bibliographic reference lists of citing documents. Further, Social Network Analysis Technique (SNAT) is applied to describe the relationship between two authors, institutions or countries. In such a network each is acquainted with some subset of the other. These networks can be represented as a set of points (or vertices) denoting people, joined in pairs by lines (or edges) denoting acquaintance (Newman 2001). The nodes in the network represent the authors, institutions or countries, while the links show relationships or flows between the nodes.

The ACA requires an association measure and an algorithm for searching through a citation's space. The analysis is designed to explain how the main areas are interrelated. Metrics for ACA and CWA have been studied extensively (Grivel and François 1995). Two cited authors, i and j, co-occur if they are used together in a single document. Take a corpus consisting of N documents. Each document is indexed by a set of unique terms that can occur in multiple documents. Let C_k be the number of occurrences of citations k; i. e., the number of times k is used for indexing documents in the corpus. Let C_{ij} be the number of co-occurrences of citation i and j (the number of documents indexed by both citations). Different measures of association have been proposed. The basic metric used for this study is the Association Indices E_{ij} (Delecroix and Eppstein 2004). The strength of association between terms i and j is given by the expression:

$$E_{ij} = \frac{C_{ij}^2}{C_i C_j} \quad \text{with} \quad 0 \leq E_{ij} \leq 1. \tag{1}$$

This metric provides an intuitive measure of the strength of association between terms, and only indicates that there is some semantic relationship. This metric is easier to understand and utilize in the production and interpretation of the term 'association maps' than the so-called inclusion metric. It allows associations of both major and minor terms and is symmetrical in their relationships (Callon,

Courtial and Turner 1991). *E* can be used as the basis for devising several complementary measures of term interactions and term networks in a unified manner.

In recent years, ACA studies have appeared frequently (e.g. Perry and Rice 1998; White 2003; Delecroix and Eppstein 2004; Pikington and Teichert 2006). Scholars have invested in this technique; yet, given the debate concerning how data should be retrieved and manipulated, there has been little or no disagreement about how resulting maps or 'intellectual structures' should be interpreted.

Research Approach

DATA COLLECTION

Data for this study are collected from the ISI Web of published by Thomson Reuter in February 2010. The articles used are from the databases Sci-Expanded (Science Citation Index) and SSCI (Social Science Citation Index). This is a common approach. Most cocitation research studies are based on these databases (Sean 2008). The search topic 'Intellectual Property' was applied to the years from 1990 to 2010. Because the research question focuses on the influence of certain works in the field of IPR, the search was concentrated only on research journal articles. Other publication materials such as proceedings, books and so on are neglected. Another limitation is that only English journals were considered. The reason for this is that it can be assumed that English as a scientific language is understood by the majority of researchers. Because the focus lies on journals with a high reputation in the research field of IPR, it can be further assumed that authors of research articles in non-English speaking journals know and cite the works in the chosen body of journals. As a further limitation, only the subcategories law and engineering were excluded. It can therefore be assumed that law or engineering scholars are most likely to cite works within their discipline. The same can be expected for social science-oriented research. Because there are most likely no strong ties between these disciplines, the outcome would be three networks; law dominated, engineering dominated and social science-dominated. In this work only the research studies within social science-oriented works are analyzed. Within this discipline 39 categories ranging from business, management and economics to ethics, sociology and philosophy, communication to international relations were identified and included in this study. As a result 270 journals are found, together with 1,889 contributions covering the period between 1990 (January) to 2010 (February).

Most articles concerning IPR were published in *Research Policy* (5.4 per cent) and *Journal Of Business Ethics* (2.8 per cent). The first 15 journals with the most contributions represent 20.8 per cent of the overall publications. The *h*-index as published by Thomas Reuter was 45. This index is based on the set of an author's most cited papers and the number of citations that he or she has received in the papers published by other researchers. The *h*-index can be applied to the productivity and impact of an individual scientist or a group of scientists in an institution (Hirsch 2005). The number 45 means that there are 45 published papers, which have 45 or more citations. In this study 116 papers were included. This means that only authors with more than 15 citations were included. Assuming 45 of 116 as a relative fraction, it may be seen that 0.387 lies over and 0.613 under the *h*-index (or nearly one-third to two-thirds). The sum of all citations in the body of works observed here over the time period was 13,160 or 6.97 citations on average

SOFTWARE USED

The program used was UCINET 6.0, a social network analysis software package (Borgatti, Everett and Freeman 2002). UCINET 6.0 is a comprehensive program for the analysis of social networks and other proximity data. It is probably the best known and most frequently used software package for the analysis of social network data and contains a large number of network analytic routines. By applying the UCINET 6.0 program to the given 116 papers identified as a core data set, three Social network analysis graphs emerged.

Findings

AUTHOR CITATION NETWORK

The author citation network of IPR researches is divided into 9 sub-networks, which are connected with each other. These sub-networks include between 4 and 32 authors. They are numbered from A to I. *Sub-network I* is the largest sub-network and consists of 32 authors while sub-network E and F are the smallest with just 4 authors. The fact that IPR research splits into different sub-networks is not surprising because of the heteronomy of access to the subject. Authors with only one tie are not treated as networks in this paper.

Further, the sub-networks have been analyzed. Figure 1 shows each sub-network with its first and last publication year. The cross marks the weighted average year in which the sample was published. Figure 1 also gives information about the actuality of a re-

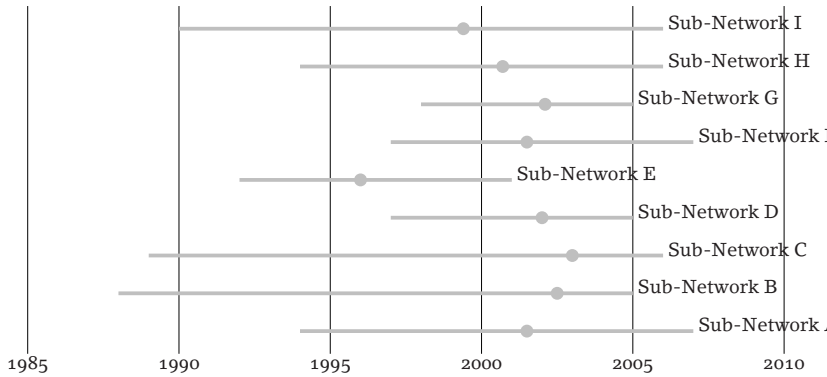

FIGURE 1 Time span of sub-networks in IP research (the dot denotes the mean value)

search field. Sub-networks with low max and avg could be seen as ended, while low min stands for a research with an early starting point. In the following, each network is described.

Sub-network I represents the main research activities in the field of IRP. Helpman (1993) focused on the debate on the enforcement of IPR within a general equilibrium framework in which the North invents new products, and the South imitates them. He provides a welfare evaluation of a policy of tighter IPR by decomposing the welfare into different items. Similar to this, the work of Ginartes and Park (1997) presented an index of patent rights for 110 countries for the period 1960–1990. They used this index to examine the factors or characteristics of economies that determine how strongly patent rights will be protected. The evidence does indicate that more developed economies tend to provide stronger protection. Oxley (1999) focused on the choice between equity and contractual alliance forms under differing regimes of IP protection and other national institutional features. He empirically identified transaction-level characteristics as primary drivers of governance choice in alliances, but IP protection was also a significant factor. He concluded that firms adopt more hierarchical governance modes when protection is weak. Lee and Mansfield (1996) also analyzed IPR in an international context. In their work the relationship between a developing country's system of IP protection and the volume and composition of US foreign direct investment in that country are the centre of attraction. Similarly, Maskus and Penubarti (1995) studied the influence of different international levels of patent protection on the trade flows. Their results indicate that increasing patent protection has a posi-

tive impact on bilateral manufacturing imports into both small and large developing economies. However, although papers in this sub-network differ in their outcome, their research focuses on the same aspect of IPR. Network I is clearly driven by the question of how IPR affects at the international level the protection of new invention. The focus in this paper is to analyze how weak or strong IPR influences the innovativeness of countries. The perspective is from the North as the inventor of new products to the South, which is seen as the reproducer.

The oldest article in the sub-network H belongs to Arora and Gambardella (1994). They focused on the quality of labour in innovative firms. Each innovation has both a source of knowledge from trial-and-error and one from a systematic, structured and organized process of applying theoretical knowledge. They noticed that developments in many scientific disciplines, along with progress in computational capabilities and instrumentation, were encouraging a new approach to industrial research. Innovations resulting from empiricist procedures such as trial-and-error would lose their importance in favour of specialization and focus on producing new knowledge, and this focus on innovation could affect both users and producers. Arora and Gambardella (1994) stated that the use of general and abstract knowledge in innovation opens up the possibility for a division of labour in inventive activity and in the division of innovative labour. They predicted implications of this development on public policy, especially on IPR. This paper served as basic research in the sub-network H. It is the oldest one and lays the basis for further elaboration of this idea. Anton and Yao (1994) analyzed the problem faced by financially weak independent inventors when selling a valuable, but easily imitated, invention for which no property rights exist. The only way to protect the innovation is by negotiating a contingent contract (with a buyer) prior to revealing the invention or, alternatively, the inventor can reveal the invention and then negotiate with the newly informed buyer. What is interesting here is the way inventors can protect IP if laws are missing. This article like the others before it is generally theoretical. Negotiation also plays a role in Anand and Khanna's (2000) work. They used a dataset on licensing contracts to present some simple 'facts' concerning licensing behaviour. Their analysis revealed robust differences between industries in several contractual features, such as exclusivity, cross-licensing, ex-ante versus ex-post technology transfers, and licensing to related versus unrelated parties. Commercialization strategy is also studied by Gans, Hsu and Stern (2002). They found that re-

turns for start-up firms on innovation are earned through cooperation with established firms through licensing, alliances, or acquisition. IPR are important for the growth of start-up firms because they increase the relative returns to cooperation. This is essential because these types of companies are highly innovative. IPR therefore has a pro-competitive impact. Using a different method but with the same outcome, Grindley and Teece (1997) established that innovation and the management of intellectual capital play an increasingly important role vis-'a-vis competition in high-technology industries. In markets where innovation is cumulative, firms frequently need to engage in extensive licensing and cross-licensing. In their paper, the authors described how patent protection is amplified by a more active licensing stance of IP owners. This network focuses on IP commercialisation through licensing.

Sub-network G. Lanjouw, Pakes and Putnam (1998) and Grupp and Schmoch (1999) mentioned that especially in the age of globalisation Patent counts are imperfect for measuring the output of innovativeness. Both papers elaborate a concept of measuring the output of innovativeness which not only counts patents but also the sustainability of the innovation. Lanjouw, Pakes and Putnam (1998) described models of patent application and renewal processes. Further, they illustrated their use with estimates of how the value of patent protection would vary under alternative legal rules and renewal fees and with estimates of the international flows of returns from the patent system. Grupp and Schmoch (1999) applied the approach in 'good economic tradition' with consideration of recent micro-level patent behaviour; then they moved to a macro-statistic level. By referring to national statistics they proposed consistent, workable adjustments to patent statistics that overcome the above-mentioned biases, which they denote as the 'triad patent model.' Gallini (2002) analyzed the US Patent Reform. He explored whether enhanced patent protection achieves the economic objectives of IPR. Gallini (2002) evaluated the theory and evidence to determine which stronger patents stimulate innovation, encourage firms to disclose their inventions, and facilitate efficient technology transfer. For this approach he referred to the earlier works in his network on measuring the output of innovativeness by patents. All scholars in network G focus on how valuable the patents are or how the innovativeness of a company can be measured.

Sub-network F. Cox et al. (1997) presented a secure algorithm for watermarking images, and a methodology for digital watermarking that may be generalized to audio, video, and multimedia data. It is

advocated that a watermark should be constructed as an independent and identically distributed Gaussian random vector that is imperceptibly inserted in a spread-spectrum-like fashion into the perceptually most significant spectral components of the data. With the help of this watermark detector the owner can be identified unambiguously. Cox et al. (1997) presented a method to protect IP audio, video, and multimedia data. Huang and Wu (2004) focused on visible watermarking schemes as IPR protection mechanisms for digital images and videos that have to be released for certain purposes but their reproductions are prohibited. Thus visible watermarking techniques protect digital contents in a more active manner, which is quite different from invisible watermarking techniques. Chang, Lin and Huang (2007) offered ansvd-based watermarking scheme that embeds watermarks into images, which can resist various attacks. In their paper, the authors extended their idea so that the hidden watermarks could be removed to provide authorized users with better image quality for later use after the ownership of purchased images has been verified. Ohbuchia, Masudab and Aono (1998) presented several algorithms for embedding data in triangular meshes, arguably the most important component in both VRML and MPEG-4 in defining arbitrary shapes. Their work broached the issue of watermarks embedding in 3D graphics contents to be used as a tool in managing IP and other issues associated with these contents.

This network is clearly engaged in securing ownership rights of audio, video, and multimedia data. All papers provided a method to equip data with a watermark as copy protection. This seems to be an important research aspect in the landscape of IP but has no links to other branches of research. With regard to contents, this research aspect differs substantially from the sub-networks before, because it provides a tangible means to measure the output of innovativeness.

Sub-network E. Brush (1992) analyzed farmers' rights and genetic conservation in traditional farming systems. He noticed that crop genetic resources are concentrated in some of the world's poorest farming systems. These resources are interesting to co-operations, which use them without compensating farmers. Concerns for equity and conservation have led to proposals to protect crop genetic resources as IP. In his paper Brush argued that conventional IP regulations should not be used to protect crop genetic resources. In the 1993 paper, Brush stated that commoditization of knowledge by means of IPRS has been practiced for 500 years, but it continues to raise numerous ethical issues. With respect to indigenous knowledge, there are two major ethical issues. The first is 'Can/Should in-

digenous knowledge be privatized and commoditized by outside interests?' The second is 'Can/Should life forms be privatized through patents?' Brown's (1998) research is based on the same issue. With the digital revolution, the ability of individuals and corporations to appropriate and profit from the cultural knowledge of indigenous people has increased dramatically. This indigenous knowledge is largely unprotected by existing IP law. In response, legal scholars, anthropologists, and native activists now propose new legal regimes designed to defend indigenous cultures by radically expanding the notion of copyright. Brown argued that unfortunately these proposals are often informed by romantic assumptions that ignore the broader crisis of intellectual property and the already imperilled status of the public domain. He took a sceptical position when it came to legal schemes, which should control cultural appropriation. He further underlined the urgent need for an intellectual property debate that would reflect on the political viability of special-rights regimes in pluralist democracies. Through his work he questioned the cultural aspects of IP. Shavell and Ypersele (2001) compared reward systems to IPR. Under a reward system, innovators are paid for their works directly by the government and these innovations pass immediately into the public domain. The authors concluded in their model that IPR does not possess a fundamental social advantage over reward systems and that an optional reward system is superior to IPR.

In conclusion, all papers in sub-network E take a critical position when contrasting IPR with the group, which could be excluded from the use of the protected property. These works ask for the limitations on IPR regimes and see them where it comes to indigenous knowledge and cultural disagreements.

Sub-network D. Moschini and Lapan (1997) reviewed IPR in agriculture and outlined a modelling framework that accounts for relevant institutional features of agricultural R&D. Their analysis emphasized vertical market linkages whereby agricultural innovations adopted by farmers are produced upstream by suppliers. The authors further argued that the conventional assumption of competitive pricing cannot hold when new technologies are produced by private firms, because such innovations are typically protected by IPR that confer monopoly rights to discoverers. This paper is in so far rudimentary because it focuses on innovative technologies. Its output can be used to analyze IP especially in the field of biotechnology. Pray, Huang and Qiao (2001) analyzed how farmers use cotton engineered to produce the Bacillus thuringiensis (Bt) toxin which substantially reduces the use of pesticide. This resulted in substan-

tial economic benefits for small farmers. Farmers obtained the major share of benefits, but because of weak IPR very little went back to government research institutes or to foreign firms that developed these varieties. Falck-Zepeda, Traxler and Nelson (2000) examined the distribution of welfare from the introduction of Bt cotton in the United States. The welfare framework explicitly recognizes that research protected by IPR generates monopoly profits, and makes it possible to partition these rents among consumers, farmers, and the innovating input firms. Qaim and Traxler (2005) analyzed the biotechnology impacts under diverse agro-ecological and institutional conditions. Their paper analyzes the effects of Roundup Ready soybeans in Argentina. Based on recent survey data, it is shown that the technology has somewhat more pronounced benefits for smaller farms than for larger farms. Due to comparatively high IP protection only small technology mark-ups in seed prices and widespread adoption cash in, Argentine soybean growers receiving 90 per cent of the benefits. Qaim and Traxler (2005) concluded that the results demonstrate that farmers in developing countries can gain considerably when they obtain access to suitable foreign innovations through technology spillovers. The major interest in sub-network D is the agriculture R&D and how farmers and consumers benefit under different IPR regimes.

Sub-network C. Liebeskind (1996) argued that firms have particular institutional capabilities that allow them to protect knowledge from expropriation and imitation more effectively than market contracting. He showed that it is these generalized institutional capabilities that allow firms to generate and protect the unique resources and capabilities that are central to their strategic theories. Von Hippel and von Krogh (2003) claimed that only two models of innovation are prevalent in organizational science. The so-called 'private investment' model assumes that returns to the innovator come from private goods and efficient regimes of IP protection. The 'collective action' model assumes that under conditions of market failure, innovators collaborate to produce a public good. The phenomenon of open source software development shows that users program to solve their own as well as shared technical problems, and freely reveal their innovations without appropriating private returns from selling the software. Von Hippel and von Krogh (2003) proposed that open source software development is an exemplar of a compound 'private-collective' model of innovation that contains elements of both the private investment and the collective action models and can offer society the 'best of both worlds' under many conditions. Finally,

the authors see potential research questions for scholars in organizational science. The result of the Di Gregorio and Shane (2003) study provided insights into why some universities urge more new companies to exploit their IP than do others. Results show that intellectual eminence and the policies of making equity investments in TLO start-ups and maintaining a low inventor's share of royalties increases new firm formation. Hettinger's (1989) paper, the oldest in this network, conducts an experiment to justify IP at all. Other scholars refer to Hettinger's work when discussing the fundamentals of IP in their paper.

Sub-network C represents the theoretical discussion on IP from the perspective of organizational science. The papers listed here probe how to organize the enterprise in order to protect important assets to finally maximise the income from the innovation. However, the authors come to different conclusions. In the end, it seems that management theory has to adjust to new developments in IP.

Sub-network B. Merton coined the term 'Matthew Effect' which refers to the sociological phenomenon that the rich get richer and the poor get poorer. This phenomenon can be applied to other disciplines. For instance, in economics it demonstrates that those who possess power and economic or social capital can leverage these resources to gain more power or more economic or social capital. In the cited paper, Merton (1988) transferred the 'Matthew Effect' to science. With this he laid the foundation which other authors apply in reference to IP. Powell and Owen-Smith (1998) came up with a more applied approach, which refers to the Merton (1988) theory. They ask for the realms of science and technology in the life sciences age, which leads to increased commercialization of university research. Major changes in the mandate of research universities were facilitated by both federal legislation that has promoted technology transfer and by the increased reliance of business firms on university R&D. Powell and Owen-Smith (1998) discussed the primary factors that are blurring the division of labour between industry and academia in the life sciences, and analyzed the consequences on universities for treating knowledge as IP. Universities' efforts to enhance the commercial value of life sciences research is causing increased politicization of government research funding, a growing winner-take-all contest between the 'have' and 'have-not' universities, and subtle but potentially profound changes in the culture of academic research. Thursby and Kemp (2002) undertook research in the licensing activity of US universities, which has increased substantially with licensing process as their topic of interest. They found

that licensing has increased for reasons other than increase in university resources. Given input levels, universities are today more commercially productive than they were in the past. Owen-Smith and Powell (2003) also analyzed university capabilities and their impact on research commercialization. Their focus was on biotechnology industry networks. They pointed out that reaping the benefits of such connections, however, requires experience in balancing academic and corporate priorities to avoid the danger of being captured by industrial interests.

In sub-network B the focus lies on university R&D and commercialization of new inventions. Each work in this network develops on this issue while taking into account the potential 'Matthew Effect' caused by governmental policy.

Sub-network A. Gopal and Sanders (1998) found that the pervasiveness of software piracy throughout the world is having a profound effect on the software publishing industry and the development of digital intellectual properties and technologies, especially in developing countries where piracy rates are extremely high. Takeyama (1994) found that unauthorized reproduction of IP in the presence of demand network externalities can not only induce greater firm profits relative to the case where there is no copying, but can also lead to a Pareto improvement in social welfare. Ceteris paribus, when network externalities are present, firms have a greater incentive to expand output because marginal revenue is higher and/or they may wish to create pre-emptive installed bases. Peace, Galletta and Thong (2003) stated that thefts of software and other IP have become a major problem in computing today. Further they indicate that individual attitudes, subjective norms, and perceived behavioural control are significant precursors to the illegal copying of software. In addition, punishment severity, punishment certainty, and software cost have direct effects on an individual's attitude toward software piracy, whereas punishment certainty has a significant effect on perceived behavioural control. Takeyama (1994) also broached the issue of harm to firms from unauthorized reproduction of their products. This may be significantly greater than that predicted by most static models; copying by some consumers reduces the appropriable surplus from all consumers, including those consumers who lack propensity to the copy.

Sub-network A is a more recent field of research which is concerned with the question of software piracy. The effects of illegally copying software on the property rights holding company are analyzed, as well as the way enterprises deal with this challenge.

TABLE 1 Author citation network

No.	Country/Region	Citing others		
		$\sum$	$\overline{x}$	σ
1	North America	134	42.500	37.500
2	Europe	26	10.000	9.000
3	Asia	16	8.000	7.000

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After analyzing the most influencing works in the IP research landscape and identifying the sub field within the topic, this paper investigates the research institutions which dominate the research.

INSTITUTION CITATION NETWORK

Beside the author who conducts the research, such factors as scientific infrastructure, access to the study object, financial funding and partnership between academic and private collaborators play a crucial role in the research. Further, research follows an underlying concept, a research strategy, or even a political intention. Therefore the answer to the question 'Who shapes the research landscape?' has to include the institutions as the platform on which research is located, financed and supported.

This paper uses as a statistical measure the ego network, which consists of a focal node, the so called 'ego' and the nodes to which the ego is directly connected (these are called 'alters') plus the ties, if any, among the alters. A standing hypothesis or guiding principle is that people, or in this case institutions, with heterogeneous networks have substantial influence. The greater the diversity of their network is, the more chance that an institution in the network has an impact on the others. Typical measures are homophily, size, average strength of ties, heterogeneity, density or composition (Scott 2009; Everett and Borgatti 1999). This paper embraces only the network sizes. The (first) authors can be aggregated to the institution, where they were employed to the time when their papers were published.

After subsuming the authors to their institutions, 77 institutions were left, of which 69 were universities and 9 were other institutions such as banks (World Bank, Federal Reserve Bank), enterprises (Aurigin Sys, LogicVision, Charles River Associates, IBM), and international organisations (WHO, OECD). The network differs significantly from the author's citation network. This means that some institutions are involved in more than one sub-network. Columbia University leads with a mean of 0.132 citations and is followed by Stanford University and University of California at Berkley (both mean

TABLE 1 *Continued from the previous page*

Get cited by other			N. America	Europe	Asia
$\sum$	$\overline{x}$	σ			
155	49.500	43.500	0.903	0,060	0,037
15	6.000	5.000	0.731	0,231	0,038
6	3.000	3.000	0.938	0,063	0,063

0.105). At position 15 the influence in terms of the mean of citations decreases by half. In terms of *Ego Size,* University of Pennsylvania (18), Georgia State University (14), American University, Washington (11), University of California at Berkley (10) and University of Michigan (10) possess the biggest ego networks. Here the size of EGO network is more significant for the impact on the research landscape. Because self-citations are included, a high mean and a low Ego Size value shows that institutions get cited by their own scholars instead of by researchers from other institutions.

What becomes clear is that the IP research is shaped by a handful of institutions. Even if it is a heterogenic research subject, the publication in standard academic literature is dominated by the line of thinking of these universities. Other institutions in this network, even if they have a high output of journal articles, do not start or dominate a special field of research, nor are even the driving force for the development of IP research. This is surprising because research in general and social research in particular needs an underlying paradigm (Kuhn, 2008). IP in terms of what can be seen as property at all depends strongly on such paradigm. Similarly to that it has to be asked where the boundaries of IP are or for what purpose things should be secured. If the research landscape is shaped by so few institutions it has to be asked what happens to the different opinions and assumptions. As it seems, if they are not represented by the leading institutions, then it will be hard for them to find an audience in the research landscape. Because research is more than practising a special way of interpretation of the world, it finds its way into legislation, political decisions and international agreements, and has an effect on real life. Here it has to be asked how different regions are represented in the IP research.

REGION CITATION NETWORK

To analyze the regional impact on IP research the publications have to be aggregated by the country in which the first author was employed when the work was published. Because there are many coun-

tries which appear only once, the countries were organised under the regions of North America, Europe and Asia. No country from South America or Africa has delivered a work in the chosen body of knowledge. Table 1 displays the regions, the authors that they cite and by whom they get cited.

About 73.1 per cent of all citations in European publications come from North America. Asia cites 93.8 per cent and North America cites its own works by 90.3 per cent. Clearly it can be said that North America dominates in terms of how the academic world sees the publications and does research about IP. Europe cites its own works by 23.1 per cent and Asia by 6.3 per cent. The research output of European scholars plays a miniscule role for North America (6 per cent). Asia is overlooked by both Europe (3.8 per cent) and North America (3.7 per cent) in the academic debate. Asia takes only 6.3 per cent of its own publications into account.

It is evident that having only a single point of view can be detrimental, as the way the IPR regime is designed touches people not only in the industrialized countries but world wide. It has to be asked how the perspectives of developing countries are represented. If developing countries are the subject of IP research, then they are analyzed and observed mainly by North American scholars. Their own scientific findings play no role. As we have seen before, IP can be principally justified on naturalistic or consequential grounds. The heterogeneity or plurality of paradigms, opinions, perspectives or convictions gets lost when it comes to academic debate. Academics have to answer the question of how they can incorporate the needs of those who have no access to the academic world. Of course, there are scholars in probably every country who do research on IP. Because IPR needs to be fixed in legislation, scientific influence on the subject plays an important role. However, the articles that are published in leading journals have a further effect. Through books and university classes, their ideas reach the research readers or students. Therefore it has to be asked if a more plural approach in IP research – as it is published in leading journals – would even help the academic debate.

Conclusion

In contrast to the commonly produced subjective or qualitative literature review, this paper tries to shed light on IP research by using a quantitative approach. The outcome is three-fold.

First, the leading works as well as the current research networks are identified. By taking the published journals into account, the IP

research landscape is split into 9 different sub fields: (A) software piracy, (B) University R&D, (C) Effects on organizational science, (D) Agriculture innovations, (E) IP and the excluded group of users, (F) Watermarking for digital data, (G) IPR and innovativeness, (H) IP and licensing and the North–South perspective. Even if the query for the data base was management oriented, the focus of only one sub-network (C) is clearly management oriented; other research interests centre on technology-dominated aspects of IP. Management theory is only marginally touched. Further scholars have often taken a macro perspective when analyzing IP. It has to be asked how these findings can help enterprises which face challenges in IP in their daily business life. How operation guidelines can be deduced or how findings can be made useable is not discussed in academic literature. So far it can not be said if the handling instructions for IP issues are a black spot in IP research; what can be said is only that practical aspects for companies did not find their way into this chosen body of knowledge. Moreover, a primary article which constructs the theoretical fundamental was not found. The research landscape exists more as detached splinters, which give attention to a single problem than as a comprehensive theory to which scholars apply. For starting a new research field (see e. g. Merton 1988) an idea from a totally different discipline is used to build the initial point. That means that scholars transfer ideas which are found elsewhere to IP and thereby add another perspective to the subject. Not every sub-net has its peak at the same time. There are networks which have ended such as E and G. Here the last widely recognized papers were published in 2005. It has to be observed as to what degree these fields will play a role in the future. If we take a look at the average time period in which each sub-network expands, then we find that a sub research field in IP spans over 12.11 years (σ 3.89) on average. After this time there are no publications that are expected to be recognized in highly ranked journals.

The institution citation network shows that the IP landscape is shaped by a handful of universities. Other institutions have little influence on the academic debate. Moreover, the universities with the highest impact are all US universities. In the institution network, no sub-networks are identified; this means that the leading research institutions play a crucial role in more than one IP research field. Dominating the landscape of IP is beyond the concrete research question of this study.

It is not surprising that the picture for the region citation network looks nearly the same. North America produces in terms of cita-

tions the highest research output by far. South America or Africa, both regions, which are often mentioned as the ones that have been negatively influenced by the IPR regime of the industrialized countries, are not represented in the academic debate. Both did not publish even one paper which is recognized by North America, Europe or Asia. However, even Europe and Asia prefer the works of North America over their own publications.

In reference to this quantitative approach some research questions arise. First of all, it has to be asked to what degree are other perspectives represented. It also has to be understood as to what are the reasons that one idea or perspective becomes stronger or grabs greater attention. The easiest answer would be that it is a superior research work. Because only leading US universities seem to generate such works, basic conditions such as access to journals, networks, financial funding and so on play a crucial role. Here many points of views justified by developing countries are lost. A further question could be the impact of such research networks on legislation and political decisions, or in general on the shaping and development of a global regime of IPR. The provoking question could be: do we really ground our international agreements concerning IP protection on the best knowledge, or do we rely only on academic conclusions which are charged with opinions, convictions and other interests?

References

Anand, B. N., and T. Khanna. 2000. 'The Structure of Licensing Contracts.' *Journal of Industrial Economics* 48 (1): 103–135.

Anton, J. J., and D. A. Yao. 1994. 'Expropriation and Inventions: Appropriable Rents in the Absence of Property Rights.' *American Economic Review* 84 (1): 190–209.

Arora, A., and A. Gambardella. 1994. 'The Changing Technology of Technological Change: General and Abstract Knowledge and the Division of Innovative Labour.' *Research Policy* 23 (5): 523–532.

Borgatti, S. P, M. G. Everett, and L. C. Freeman. 2002. *Ucinet for Windows: Software for Social Network Analysis*. Harvard, MA: Analytic Technologies.

Brown, M. 1998. 'Can Culture be Copyrighted?' *Current Anthropology* 39 (2): 193–222.

Brush, S. B. 1992. 'Farmers' Rights and Genetic Conservation in Traditional Farming Systems.' *World Development* 20 (11): 1617–1630.

———. 1993. 'Indigenous Knowledge of Biological Resources and Intellectual Property Rights: The Role of Anthropology.' *American Anthropologist* 95 (3): 653–671.

Bubert, I., and M. Büning. 2001. 'Trademark Law: Domain Name Issues.'

In *E-Commerce Law and Practice in Europe I,* edited by Walden and J. Hörnle, 1–76. London: Woodhead.

Byström, M., P. Einarsson, and G. Nycander. 1999. *Fair and Equitable: Sharing the Benefits from Use of Genetic Resources and Traditional Knowledge.* Stockholm: Swedish Scientific Council on Biological Diversity.

Callon, M., J. Courtial, and W. Turner. 1991. 'La méthode Leximappe, un outil pour l'analyse stratégique du développement scientifique et technique.' In *Gestion de la recherche: Nouveaux problèmes nouveaux outils,* edited by V. Dominique, 207–277. Bruxelles: de Boeck Publishers.

Chang, C., C. Lin, and Y. Huang. 2007. 'An SVD Oriented Watermark Embedding Scheme with High Qualities for the Restored Images.' *International Journal of Innovative Computing, Information and Control* 3 (3): 609–620.

Cox, I. J., J. Kilian, F. T. Leighton, and T. Shamoon, T. 1997. 'Secure Spread Spectrum Watermarking for Multimedia.' IEEE *Transaction on Image Processing* 6 (12): 1673–1687.

Culnan, M. 1986. 'The Intellectual Development of Management Information Systems.' *Management Science* 32 (2): 156–172.

Delecroix, B., and R. Eppstein. 2004. 'Co-Word Analysis for the Non-Scientific Information Example of Reuter Business Briefing.' *Data Science Journal* 3:80–87.

Di Gregorio, D., and S. Shane. 2003. 'Why do Some Universities Generate More Start-ups Than Others?' *Research Policy* 32 (2): 209–227.

Drejer, A. 1996. 'Frameworks for the Management of Technology: Towards a Contingent Approach.' *Technology Analysis and Strategic Management* 8 (1): 9–20.

———. 1997. 'The Discipline of Management of Technology, Based on Considerations Related to Technology.' *Technovation* 17 (5): 253–265.

Everett, M., and S. Borgatti. 1999. 'The Centrality of Groups and Classes.' *Journal of Mathematical Sociology* 23 (3): 181–201.

Falck-Zepeda, J., G. Traxler, and R. Nelson. 2000. 'Surplus Distribution from the Introduction of a Biotechnology Innovation.' *American Journal of Agricultural Economics* 82 (2): 360–369.

Forero-Pineda, C. 2006. 'The Impact of Stronger Intellectual Property Rights on Science and Technology in Developing Countries.' *Research Policy* 35 (6): 808–824.

Gallini, N. T. 2002. 'The Economics of Patents: Lessons from Recent US Patent Reform.' *Journal of Economic Perspectives* 16 (2): 131–154.

Gans, J. S., D. H. Hsu, and S. Stern. 2002. 'When Does Start-up Innovation Spur the Gale of Creative Destruction?' RAND *Journal of Economics* 33 (4): 571–586.

Ginarte, J. C., and W. G. Park. 1997. 'Determinants of Patent Rights: A Cross-National Study.' *Research Policy* 26 (3): 283–301.

Gopal, R., and G. Sanders. 1998. 'International Software Piracy: Analysis of Key Issues and Impacts.' *Information Systems Research* 9 (4): 380–397.

Grindley, P. C., and D. J. Teece. 1997. 'Managing Intellectual Capital: Licensing and Cross-Licensing in Semiconductors and Electronics.' *California Management Review* 39 (2): 8–43.

Grivel, L., and C. François. 1995. *Une station de travail pour classer, cartographier et analyser l'information bibliographique dans une perspective de veille scientifique et technique.* Rennes: Presses Universitaires de Rennes.

Grupp, H., and U. Schmoch. 1999. 'Patent Statistics in the Age of Globalisation: New Legal Procedures, New Analytical Methods, New Economic Interpretation.' *Research Policy* 28 (4): 377–396.

Helpman, E. 1993. 'Innovation, Imitation, and Intellectual Property Rights.' *Econometrica* 61 (6): 1247–1280.

Hettinger, E. C. 1989. 'Justifying Intellectual Property.' *Philosophy and Public Affairs* 18 (1): 31–52.

Hippel, E. von, and G. von Krogh. 2003. 'Open Source Software and the "Private-Collective" Innovation Model: Issues for Organization Science.' *Organization Science* 14 (2): 209–223.

Hirsch, J. E. 2005. 'An Index to Quantify an Individual's Scientific Research Output.' *Proceedings of the National Academy of Sciences of the United States of America* 102 (46): 16569–16572.

Huang, C.-H., J.-L. Wu. 2004. 'Attacking Visible Watermarking Schemes.' IEEE *Transaction on Multimedia* 6 (1): 16–30.

Kuhn, T. S. 2008. *The Structure of Scientific Revolutions.* 3rd ed. Chicago, IL: University of Chicago Press.

Lanjouw, J. O., A. Pakes, and J. Putnam. 1998. 'How to Count Patents and Value Intellectual Property: The Uses of Patent Renewal and Application Data.' *Journal of Industrial Economics* 46 (4): 405–432.

Lee, J. Y., and E. Mansfield. 1996. 'Intellectual Property Protection and US Foreign Direct Investment.' *Review of Economics and Statistics* 78 (2): 181–186.

Lerner, J. 2000. 'Where Does State Street Lead? A First Look at Finance Patents, 1971–2000.' NBER Working Paper Series 7918, National Bureau of Economic Research, Cambridge, MA.

Liebeskind, J. P. 1996. 'Knowledge, Strategy, and the Theory of the Firm.' *Strategic Management Journal* 17:93–107.

Maskus, K. E., and M. Penubarti. 1995. 'How Trade-Related are Intellectual Property Rights?' *Journal of International Economics* 39 (3–4): 227–248.

McCain, K. 1990. 'Mapping Authors in Intellectual Space: A Technical Overview.' *Journal of the American Society for Information Science* 41 (6): 433–443.

Merton, R. K. 1988. 'The Matthew Effect in Science: Cumulative Advantage and the Symbolism of Intelectual Property.' ISIS 79 (299): 606–623.

Moschini, G., and H. Lapan. 1997. 'Intellectual Property Rights and the Welfare Effects of Agricultural R&D.' *American Journal of Agricultural Economics* 97 (4): 1229–1242.

Newman, M. 2001. 'The Structure of Scientific Collaboration Networks.' *Proceedings of the National Academy of Sciences* 98 (2): 404–409.

Ohbuchia, R., H. Masudab, and M. Aono. 1998. 'Data Embedding Algorithms for Geometrical and Non-Geometrical Targets in Three-Dimensional Polygonal Models.' *Computer Communications* 21 (15): 1344–1354.

Owen-Smith, J., and W. Powell. 2003. 'The Expanding Role of University Patenting in the Life Sciences: Assessing the Importance of Experience and Connectivity.' *Research Policy* 32 (9): 1695–1711.

Oxley, J. E. 1999. 'Institutional Environment and the Mechanisms of Governance: The Impact of Intellectual Property Protection on the Structure of Inter-Firm Alliances.' *Journal of Economic Behaviour and Organization* 38 (3): 283–309.

Peace, A., D. Galletta, and J. Thong. 2003. 'Software Piracy in the Workplace: A Model and Empirical Test.' *Journal of Management Information Systems* 20 (1): 153–177.

Perry, G., and R. Rice. 1998. 'Scholarly Communication in Developmental Dyslexia: Influence of Network Structure on Change in a Hybrid Problem Area.' *Journal of the American Society for Information Science* 49 (2): 151–168.

Pilkington, A., and T. Teichert. 2006. 'Management of Technology: Themes, Concepts and Relationships.' *Technovation* 26 (3): 288–299.

Powell, W., and J. Owen-Smith. 1998. 'Universities and the Marker for Intellectual Property in the Life Sciences.' *Journal of Policy Analysis and Management* 17 (2): 253–277.

Pray, C., D. Ma, J. Huang, and F. Qiao. 2001. 'Impact of Bt Cotton in China.' *World Development* 29 (5): 813–825.

Qaim, M., and G. Traxler. 2005. 'Roundup Ready Soybeans in Argentina: Farm Level and Aggregate Welfare Effects.' *Agricultural Economics* 32 (1): 73–86.

Scott, J. 2009. *Social Network Analysis: A Handbook*. 2nd ed. London: Sage.

Sean, E. 2008. 'All Author Cocitation Analysis and First Author Cocitation Analysis: A Comparative Empirical Investigation.' *Journal of Informetrics* 2 (1): 53–64.

Sharplin, A., and R. Mabry. 1985. 'The Relative Importance of Journals Used in Management Research: An Alternative Ranking.' *Human Relations* 38 (2): 139–149.

Shavell, S., and T. van Ypersele. 2001. 'Rewards Versus Intellectual Property Rights.' *Journal of Law and Economics* 44 (2): 525–547.

Small, H. 1974. 'Co-Citation in Science Literature: New Measure of Relationship Between 2 Documents.' *Journal of the American Society for Information Science* 24 (4): 265–269.

Small, H., and B. Griffith. 1974. 'Structure of Scientific Literatures: Identifying and Graphing Specialties.' *Science Studies* 7 (1): 17–40.

Takeyama, L. 1994. 'The Welfare Implications of Unauthorized Reproduction of Intellectual Property in the Presence of Demand Network Externalities.' *Journal of Industrial Economics* 42 (2): 155–166.

———. 1997. 'The Intertemporal, Consequences of Unauthorized Reproduction of Intellectual Property.' *Journal of Law and Economics* 40 (2): 511–522.

Thursby, J., and S. Kemp. 2002. 'Growth and Productive Efficiency of University Intellectual Property Licensing.' *Research Policy* 31 (1): 109–124.

White, H. 1986. 'Co-Cited Author Retrieval.' *Information Technology and Libraries* 5 (2): 93–99.

White, H. 2003. 'Author Co-Citation Analysis and Pearson's *r*.' *Journal of the American Society for Information Science and Technology* 54 (13): 1250–1259.

White, H., and B. Griffith. 1981a. 'Author Co-Citation: A Literature Measure of Intellectual Structure.' *Journal of the American Society for Information Science* 32 (3): 163–172.

———. 1981b. 'A Co-Citation Map of Authors in Judgement and Decision Research.' In *Concepts in Judgement and Decision Research: Definitions, Sources, Interrelationships, Comments,* edited by B. Anderson, 261–271. New York: Praeger.

———. 1982. 'Authors as Markers of Intellectual Space: Co-Citation in Studies of Science Technology and Society.' *Journal of Documentation* 38 (4): 255–272.

Zorian, Y., E. J. Marinissen, and S. Dey. 1999. 'Testing Embedded-Core-Based System Chips.' *Computer* 32 (6): 52–60.