Department: Impresa e Management
Chair: Intellectual Property Rights

Could technology help itself?

Cutting-edge technologies for the IPR's intermediation

SUPERVISOR

Prof. Massimiliano Granieri

CANDIDATE

Marco Pellarin

680761

CO-SUPERVISOR

Prof. Giuseppe Colangelo

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To every single person who has been part of my journey. Professors, colleagues and friends.

Most importantly, to my beloved parents, Leo and Barbara, my grandma Sonia and grandpa Danilo, who sadly left us at the beginning of this educational path. I am forever grateful for your support.

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ABSTRACT

Blockchain and artificial intelligence (AI) are two of the most discussed topics these days. They are discussed among professionals, technicians and enthusiasts as well. By now, blockchain is probably the one at the earliest phase between the two; it had a big technological success thanks to the cryptocurrencies – which have been its killer app – yet other applications, such as smart contracts, are still something "on the way". On the other hand, artificial intelligence has already a wide set of proofs of success and it is deployed in a variety of fields; from aeronautics to financial trading platforms.

区域链和人工智能是近日来最受关注的两大主题，在众多专业教授、科研人才以及科技发烧友中引发了热烈的讨论。截至目前，区域链仍处于比较初期的发展阶段；由于数字货币的出现，引发了区域链的巨大成功。但是一些其他的应用，诸如智能合同等仍在开发过程之中。另一方面，人工智能已经成功应用到不同领域之中，从航天技术到金融交易平台无处不在。

However, the Intellectual and Property Rights field is still a greenfield for both technologies. Engineers, computer scientists, managers and lawyers, are all active on "how blockchain and artificial intelligence may help the intermediation of IPRs", publishing academic papers, organising forums and kicking off start-up companies. In other words: this is a thriving moment for cutting-edge technologies in IPRs' field.

然而，知识产权领域对于这两种技术而言仍是一片广阔的绿地。大量的工程师、计算机科学家、经理人和律师们都在竭尽所能思考如何将区域链与人工智能技术应用于知识产权的管理、发表学术文章、组织学术论坛以及开启创业公司。换言之，这些尖端科技正处于知识产权领域一个相当繁荣的时刻。

From an academic perspective, this is both a challenging and stimulating topic. It is challenging as it requires the management student to learn about the functioning of blockchain and AI, which are

vertical technologies, and it is stimulating as well as it is a greenfield, meaning that many things have not been done or even said yet, giving the opportunity of writing something new.

从学术的角度而言，这是一个既极具挑战性又高度刺激性的话题。形容其极具挑战性是因为这个话题要求管理专业学生去深入学习区域链和人工智能相关的功能知识，而这两种科技本身非常垂直化。形容其高度刺激性是因为在此领域还有很多事情可以开发，很多言论可以畅谈，为新兴事物的出现提供了很好的机会。

This thesis is based on academic literature and professional journals in the fields of patents, blockchain and artificial intelligence, and it is structured in four chapters.

本文基于现有专利、区域链以及人工智能领域内的学术文献以及专业期刊，进一步结构化为四部分。

Chapter one introduces the topic, presenting the state of the art of the research and explaining the base-line concepts of blockchain and artificial intelligence. Chapter two explores which are the problems currently affecting the patent system and the intermediation of IPRs. In the third chapter, the use of AI as a mean for corporate strategy in IPR-related topics will be discussed with the use of business cases. Finally, in the fourth chapter, blockchain solutions will be discussed presenting two business cases, one of which contains personal ideas and suggestions from the author.

第一章引入了主题，展现了区域链与人工智能领域当前的现状并介绍了相关的基础概念。第二章探索了可能会影响专利系统与知识产权的问题。在第三章中，我们将以企业案例的方式探讨人工智能作为企业战略的重要组成部分应用于知识产权相关的主题。最后，在第四章，区域链解决方案将通过两个商业案例进行呈现，其中之一涵盖了作者个人的想法与意见。

1. RESEARCH OUTLINE, BLOCKCHAIN TECHNOLOGY AND ARTIFICIAL INTELLIGENCE

1.1. Research question

Nowadays, each one of us is surrounded by a multitude of technologies which are the means for sharing information among people and entities; we are living in the so called "knowledge society". The knowledge society generates, shares and makes available to all individuals knowledge that can be used to improve the human condition.

But what does that mean? It means that our lives are affected by information dissemination, circulation and availability in any dimension of it, from politics to economics. Innovation in information and communication technologies (ICT) have been the enabler of this society. It is undeniable that, over the years, decision-making has been getting easier and easier thanks to ICT, yet there are some exceptions. As an example, businesses and individual innovators face several issues when it comes to intellectual property rights (IPRs) management and strategic decision-making due to inefficiencies in the dissemination, circulation and availability of information in the market. Indeed, depending on the size and the skills of the individual – or entity – it is possible to make deeper analysis and take better decisions. Large corporations with a strong expertise in the field of patents will have an advantage over small inventors with hard innovation skills and no management abilities.

The market for patents is both highly inefficient and illiquid, featuring a large number of intermediaries involved between idea creators and consumers, which capture significant shares of the value created. Intermediaries in the patent market not only capture some of the value, they also limit or destroy its creation because of the thick net separating the parties.

Hence, the research question seeking an answer is the following: *Could cutting-edge technologies, such as artificial intelligence and blockchain, reduce inefficiencies in the IPRs' intermediation?*

The purpose of this thesis is to determine whether artificial intelligence and blockchain technologies may have a positive impact on the intermediation of IPRs, as the patent market seems to be a suitable environment for being disrupted by the introduction of innovative technologies that are aimed at reducing the need for intermediaries and bringing the various parties closer.

1.2. Research field's literature

This thesis rests on both an extensive search for previous works and on the understanding of artificial intelligence and blockchain technologies. Because of this, it is possible to say that this work is mainly – but not only – inspired by the following publications:

- "Application of blockchain technology and crowdfunding to solve structural inefficiencies in digital rights and patents – a comparative analysis" by Andreas Gabl & Stephan Ulrich Krehl[1], which gives a broad overview about inefficiencies in the patent and digital rights markets and studies how to solve them deploying blockchain-based and crowdfunding-based solutions;
- "Overcoming Information Asymmetry in Patent Pledge Records" by Nicole Shanahan[2], which makes clear how structured intervention on one very specific topic – the patent pledge – can have a broad impact. Small adjustments, big efficiency gains for the innovation system;
- "Decentralized blockchain technology and the rise of Lex Cryptographia" by Aaron Wright & Primavera De Filippi[3], that highlights the multiple effects of technological

[1] Gabl, Andreas & Krehl, Stephan Ulrich. 2017. Application of blockchain technology and crowdfunding to solve structural inefficiencies in digital rights and patents – a comparative analysis. [Master Thesis] MIT Sloan School of Management. Available at: https://dspace.mit.edu/handle/1721.1/111452

[2] Nicole Shanahan. 2016. Overcoming Information Asymmetry in Patent Pledge Records. Code X, Stanford Center of Legal Informatics, Stanford University. Available at SSRN: https://ssrn.com/abstract=2880919

[3] Wright, Aaron & De Filippi, Primavera. 2015. Decentralized blockchain technology and the rise of Lex Cryptographia. Available at SSRN: https://ssrn.com/abstract=2580664

advancement, discussing about how blockchain calls for a new subset of laws due to the shift of power away from central authorities;

- "FRAND market failure: IPXI's standards-essential patent licence exchange" by Jorge L. Contreras[4], which explains how and why an earlier attempt of creating a liquid IP intermediation market, making it more efficient thanks to a "commoditization" of IPRs, failed;
- "ARTIFICIAL INTELLIGENCE – WHAT EVERYONE NEEDS TO KNOW" by Jerry Kaplan[5], which provides a complete overview about AI and all the AI-related topics that are worth knowing and discussing even among non-experts in the field.

The sum of these five publications represents the solid starting point for the development of further work providing an overview of inefficiency problems, knowledge about the topics to be discussed, applied cases, examples and the state of art of the research.

1.3. State-of-the-art of the research

Before starting any discussion or investigation about how artificial intelligence and blockchain could, or could not, help the intermediation market of IPRs, it is of the essence to resume the main considerations published by now about the topic. This sum up aims at understanding which are the ideas among the industry and what is the stage we are at now, so to be able to keep in mind what has been said and to make a real contribution to the state-of-the-art literature thanks to a piece of work that will differentiate from the previous ones.

As already stated, the five above-mentioned publications are the starting point of this thesis which, together with an additional number of sources introduced throughout the work and collected in

[4] Contreras, Jorge L.. 2016. FRAND Market Failure: IPXI's Standards-Essential Patent License Exchange. 15 Chicago-Kent J. Intel. Prop. 419. Available at SSRN: https://ssrn.com/abstract=2670344

[5] Jerry Kaplan. 2016. ARTIFICIAL INTELLIGENCE – WHAT EVERYONE NEEDS TO KNOW. Oxford University Press. ISBN: 9780190602390

the bibliography, constitute the core scientific papers from which is possible to draw out an abstract about the state of the art.

Summing up the state of the art of the research, as introducing the functioning of artificial intelligence and blockchain, is not an easy job both because of the difficulty in searching for previous literature and the challenge in understanding technical topics with a management university background.

To introduce the reader to the state-of-the-art of the research, it is worth start by mentioning Andreas Gabl & Stephan Ulrich Krehl, 2017:

> *"[...] blockchain technology is a powerful tool which – based on the findings of our analysis - however, can only fulfil its potential if certain conditions are met. We identified these conditions as the following:*
>
> *a) Assets and its use cases should be identifiable and traceable. A song is unambiguously identifiable: It can be hashed and the internet can be crawled for this hash to identify usage. In contrast, usage of patents is more difficult to identify. In Chapter 5.2.4. we have shown that patent applications usually only disclose the minimum information necessary to obtain a patent and use broad and unspecific language on purpose (Hagiu & Yoffie 2013, p.47). As a result, it cannot be easily identified whether a patent has been infringed. Instead, the month-long process of detection requires the know-how of patent and industry experts (Hagiu et al. 2011, pp.9-10). Therefore, it is not possible to crawl the internet for patent infringements as opposed to copyright infringements for music.*
>
> *b) It should be possible to standardize licensing agreements to a certain degree. Blockchain technology could allow for a broader range of licensing opportunities for content owners. They could give away some of their music for free while charging for other creations or allow use on certain websites while restricting it on others (Rogers 2016). While such licensing agreements are theoretically possible for patents as well,*

patent licensing negotiations are usually far more complex. Patents are subject to strong complementarities and portfolio effects (Hagiu & Yoffie 2013, pp.46-47). Furthermore, intellectual property rights for one technology are often distributed between many different right holders (Hall et al. 2012, pp.2-6; Shapiro 2000, p.120). As a result, licensing deals can take several years and need customization for every company. Usually a licensing agreement with one licensee cannot be easily applied to another licensee (European Patent Office 2008; Hagiu et al. 2011, p.9).

c) Data on asset usage should be available online. Blockchain can help to track where and how music is consumed online and can distribute royalties based on this information (Howard 2015i; Rogers 2015). However, blockchain technology cannot be applied to identify whether a street musician plays a content owner's song as long as there is no digital copy of the performance. With the same logic applied, blockchain cannot help to find out whether a company in China infringes a patent when it builds a non-digital product. As long as there is no detailed and standardized information digitally available where it is evident that a certain technology is used, there is only limited use for blockchain technology as a tool to trace usage."

In other words, the two authors are suggesting that blockchain-based technologies are not disruptive per se and cannot be extensively applied to the IP intermediation market, instead, blockchain is disruptive depending on the usage that is made out of it. Moreover, the outcome – which is eventually the improvement in the efficiency of the intermediation markets – depends also on other environmental variables, a system of elements which needs to be addressed towards the same direction to make the change happen.

As an example, smart contacts – which are based on blockchain technology – if put in place of patent pools together with a decentralized database may have very limited scopes as common patent pools practices, such as cross-licencing and pool-to-one bargaining, would not be possible

due to the strict technological rules embedded in the contract. In this specific case the digitalisation brings accurate processes and repeatability by reducing flexibility to zero.

However, an additional statement by Andreas Gabl & Stephan Ulrich Krehl is that *"even the blockchain will require governance systems to ensure data integrity"*. This may seem a contradiction yet hostility by market players may call for the intervention of a governance system, granting the proper functioning of the operations and the integrity of data inserted in the chains.

If what has just been said is about the impact of technology on granting intellectual property rights to their owners, what follows is about the impact of technology on providing quality information to IP holders and inventors.

Many companies are currently committed to open innovation models and patent pledges are growing their popularity among patent holders thanks to their flexibility. Patent holders are increasingly making voluntary, public commitments to limit the enforcement and other exploitation of their patents. The best-known form of patent pledge is the so-called FRAND commitment, in which a patent holder commits to license patents to manufacturers of standardized products on terms that are "fair, reasonable and non-discriminatory". Patent pledges have been appearing in fields well beyond technical standard-setting, including open source software, green technology and the biosciences.[6]

However, even if the goal of patent pledges is noble, simple and clear, according to Nicole Shanahan, 2016:

> *"[…] Patent pledges often take the form of press or website announcements by patent holders that they will not enforce their patents under certain conditions. But in order to be most useful, and to achieve the greatest degree of legal enforceability and recognition, the intended market audiences for patent pledges must be informed about the details of these pledges. Thus, in addition to bibliographic information concerning*

[6] Jorge L. Contreras, Meredith Jacob. 2017. Patent Pledges: Global Perspectives on Patent Law's Private Ordering Frontier. Edward Elgar Publishing. ISBN: 9781785362484

pledged patents (such as patent numbers, titles, application numbers, assignees, etc.), it is useful to understand the content of the patents for each respective pledge. This means understanding the practical use and application of patents based on claim language, a task that has been historically challenging due to the limitations of existing patent search technology. […] This means that, even though a pledge is made, the larger community must put forth the expenditure on expert hours to understand the relevance of the pledged patents. It generally requires a sophisticated party to conduct a thorough analysis of the contents of the pledged portfolios and make the determination whether the patents are useful for a particular application."

Nicole Shanahan, in the same piece of work, also argues that the solution to this information asymmetry problem stands in four activities: managing relevant metadata, creating a consistent patent ontology, incentivizing engagement and monetizing the exchange of information, integrating pledge databases into existing search tools.

According to the author, the main contribution of cutting-edge technologies could be in two fields. The first contribution is the management of relevant metadata:

"[…] The following data is largely machine maintained and produced. The machines generate algorithmic analysis of data using approaches such as natural language processing with latent semantic analysis and latent dirichlet allocation which are methods for extracting the meaning and representation of words using statistical computations, or logical rule-based processing which uses declarative semantics and structured data to solve questions. These methods are used by artificial intelligence developers to solve higher order intellectual tasks.

- *Semantic search of the patent database to provide a patent landscape analysis*
- *Patent validity ratings (i.e. algorithms that utilize several metrics to determine if a patent is "strong" or "weak").*
- *Mapping of patent claims to relevant products and services*

- *Claims analysis*

Public availability of even a small subset of the above data would be a large improvement over the current pledge environment, which rarely includes even a patent application number."

The second contribution is the integration of pledge databases into existing search tools:

"Bringing down the cost and barriers involved in communicating what is in a patent pledge, for example identifying the patents that have been pledged, will be key to the efficacy of pledges. One way to accomplish these goals is by conducting a semantic relevancy patent search limited to the claims of patents that have been pledged. For example, Innography provides a front end to a database that users can input a large block of descriptive text."

It is clear how a smart application of the available technologies would be even more helpful than just applying the most innovative solution. As an example, making a modification such as the integration of pledge databases into existing search tools would be a significative contribution to the management of IP portfolios. Running queries with integrated tools, on a regular basis, would allow inventors and corporations to save time, labour and money to be invested in more fruitful activities.

Even though the words from Nichole Shanahan only discuss how to overcome the information asymmetry in the patent pledge records, its concepts can be broadened to the IP intermediation matter as a whole. Indeed, reading again the quotations keeping in mind how the author's ideas may be extended to other fields should help understanding how to improve IP intermediation processes with a scarce availability of quality information.

According to the state of the art of the research done in this field, in the short term, a complete migration to blockchain-based and AI-based solutions seems not realistic. Such a process might take years or even decades because of the infancy of the current blockchain solutions and the

enormous amount of work needed to collect and clean the data for running AI-managed databases. However, *"Improvements to the economics of acquiring patent rights can dramatically shift how individuals and companies interact with intellectual property. This is where designing a private ordering software system will become most useful: technology is the ultimate transaction cost economizer."*[7]

1.4. Blockchain

1.4.1. Introduction

Blockchain was born in 2008, when an anonymous author – using the false name of "Satoshi Nakamoto" – published the paper "Bitcoin: A Peer-to-Peer Electronic Cash System"[8] disclosing blockchain in the form of a cryptocurrency, thinking that an electronic payment system based on cryptographic proof instead of trust was needed.

The blockchain is a distributed ledger based on a network of nodes, which records transactions securing them with cryptographic hashes. The network of nodes manages and verifies transactions without the need of a trusted – or centralised – intermediary and this is probably the most status-changing feature of the technology. Hence, blockchain is a disintermediating technology which can validate a transaction, safeguard its process and store the records without involving any central authority, as it would otherwise happen. In other words, blockchain has the potential for changing the common intermediation structure, challenging the *status-quo*, according to which a central entity must overlook transactions acting as the trusted party.

[7] Nicole Shanahan. 2016. Overcoming Information Asymmetry in Patent Pledge Records. Code X, Stanford Center of Legal Informatics, Stanford University. Available at SSRN: https://ssrn.com/abstract=2880919

[8] Satoshi Nakamoto. 2008. Bitcoin: A Peer-to-Peer Electronic Cash System. Available at: https://bitcoin.org/bitcoin.pdf

1.4.2. Technology

The blockchain is a de-centralised ledger recording transactions in a series of blocks which are cryptographically chained together. Each block contains the hash of the previous block (see "Prev Hash" in Figure 1) and the data regarding transactions that happened at roughly the same time. The hash represents the cryptographic link holding the chain together.

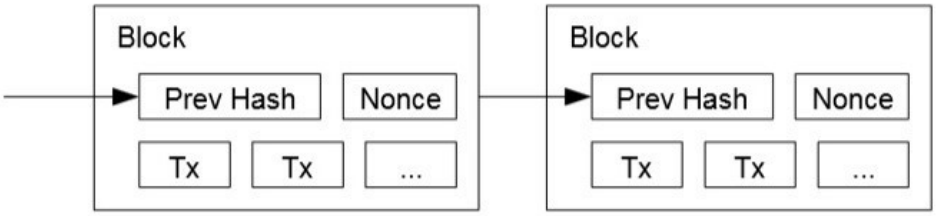


Figure 1 - Representation of two "blocks".

The fact that blockchain is designed as a peer-to-peer (P2P) network of nodes with no single point of control means that there is no single party who can shut the system down. Indeed, even if one or several nodes in the blockchain network fail, transactions can be completed anyway.

The P2P network is the infrastructure for the continuous updating of the blockchain with new data and information. The updating process of the chain relies on a well-defined set of rules which are most probably too technical to be fully investigated in this thesis. However, the white paper published by Satoshi Nakamoto, in 2008, can elucidate which are the steps to run the network:

> *"1) New transactions are broadcast to all nodes*
>
> *2) Each node collects new transactions into a block*
>
> *3) Each node works on finding a difficult proof-of-work for its block*
>
> *4) When a node finds a proof-of-work, it broadcasts the block to all nodes*
>
> *5) Nodes accept the block only if all transactions in it are valid and not already spent*

6) Nodes express their acceptance of the block by working on creating the next block in the chain, using the hash of the accepted block as the previous hash.

Nodes always consider the longest chain to be the correct one and will keep working on extending it. If two nodes broadcast different versions of the next block simultaneously, some nodes may receive one or the other first. In that case, they work on the first one they received, but save the other branch in case it becomes longer. The tie will be broken when the next proof of-work is found and one branch becomes longer; the nodes that were working on the other branch will then switch to the longer one.

[...] If a node does not receive a block, it will request it when it receives the next block and realizes it missed one."

The sequence of actions and the precautions introduced by Satoshi Nakamoto can be further explained making the example of a transaction between two parties, A and B. Supposing that A is the owner of an asset and B is the individual who wants to buy it, the steps of the process are as follows:

1) Individual A transfers the ownership of the asset to individual B. As soon as the transaction is completed it is broadcasted to all nodes;
2) Nodes collect the transaction into a new block, with the aim of updating the portfolio of the users relying on the blockchain to complete their transaction;
3) When the transaction has been collected, each node has to find a Proof-of-Work (PoW) for its block. Given that each node can suggest new blocks to be added to the overall blockchain, the distributed consensus mechanism is put in place for guaranteeing that the entire network agrees on which is the block that should be added. Indeed, in order to be able to add a block to the blockchain a node has to solve a computational problem which returns a timestamp for all transactions;
4) Each node undergoes the PoW procedure before broadcasting its block to the network;

5) Since the block added to the chain is the block validated by the majority of nodes *"[..] miners are in effect 'voting' on the correct record of Bitcoin transactions, and in that way verifying the transactions"* (Böhme, 2015);
6) A block is then accepted as soon as nodes start collecting the next group of transactions to be inserted in the new block, including the cryptographic hash of the previous one.

The integrity of the system and the validity of the chain is granted by the just mentioned distributed consensus mechanism, which requires a non-honest node to own more than 50% of the total network's computational power if willing to add a block containing manipulated data for changing a past transaction.

The second measure against non-honest nodes is related to the immutability of the blockchain. As the cryptographic hash is the only link between two blocks, even the smallest modification of the data contained in a block changes its hash causing the breakage of the chain. A broken chain is shorter, hence it has no value given that nodes in the network only accept the longest one.

A non-honest node should break the chain, manipulate the data and build a new block together with all the following ones, starting from the hacked block up to the latest. Only after having built an entire corrupt chain and having invested the same amount of computational power invested by the whole network up to now, the alternative chain could possibly be accepted.

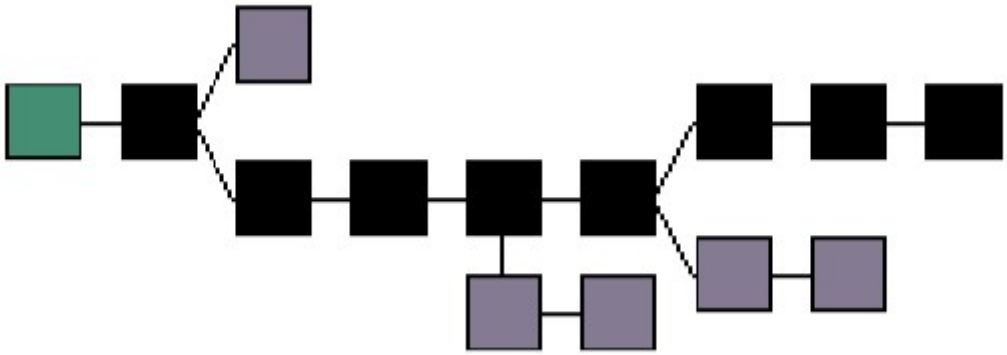


Figure 2 - Representation of a blockchain.

Last but not least, given that blockchain is a database synchronised throughout its network of nodes, transaction data are consistent between different members and they are accessible by different parties.

1.4.3. Architecture

Even though the two previous paragraphs may be enough for the complete understanding of the following chapters, a few additional details about how blockchain can be engineered could give a complete overview to the reader.

Indeed, it is very useful to recall what has been stated by Andreas Gabl & Stephan Ulrich Krehl, 2017:

> *"Besides the applied consensus mechanisms, the architectures of blockchains are usually defined in three categories. First, it is differentiated whether authorisation is required for validators in the network:*
>
> - *Permissionless: Anyone can participate in the verification process and no prior authorisation is required. In order to verify transactions, nodes just need to*

provide required assets, for example computational power or stake in the system.

- *Permissioned: Only members with permission can verify transactions. The specific members are selected by a central authority or consortium (Mainelli & Smith 2015, pp.13-14; Peters & Panayi 2016, p.5).*

Second, it is defined how access to blockchain data is restricted:

- *Public: Anyone can read and submit transactions on the blockchain. Users do not have to be authenticated and as a result cannot be identified.*
- *Private: Permission to read and submit transactions is restricted to specific users, for example within an organisation or a group of organisations (Peters & Panayi 2016, p.5).*

Third, one can distinguish between the purposes for which a blockchain is built:

- *General purpose: Blockchains can be designed so that they are applicable for different functions, for example storing algorithmic code or running customized logical processes (Mattila 2016, pp.8-9).*
- *Special purpose: In contrast, blockchain architectures can be built in a way that they are optimized for a specific task such as tracking assets or transferring value (Mattila 2016, pp.8-9)."*

Considering that many experts in the field of blockchain have been arguing that this is a "general purpose technology"[9&10], the three above mentioned features – permission, publicity,

[9] Andreas Gabl & Stephan Ulrich Krehl, 2017: *''Given its profound economic impact, several authors describe blockchain as a 'general purpose technology' putting it in the same level as for example electricity, transistors, computers, the internet, or mobile phones (Davidson et al. 2016a, p.2; Umalkar et al. 2016).''*

[10] Andreas Gabl & Stephan Ulrich Krehl, 2017: *''As a 'general purpose technology' blockchain would have a creative-destructive effect and eventually lead to multifactor productivity growth and subsequent innovation across different industries creating a new technical paradigm and economic growth for multiple years (Catalini & Gans 2016, p.7; Davidson et al. 2016b, p.7).''*

purpose – give a taste of how elastic and various its applications could be. A different engineering of the architecture, changing the structural rules behind the technology, allows for the creation of a multitude of "versions" of blockchain which could then provide solutions that better untie specific problems.

1.5. Artificial Intelligence (AI)

1.5.1. Overview

"The term artificial intelligence is applied when a machine mimics cognitive functions that humans associate with other human minds, such as learning and problem solving" (Russell & Norvig, 2009[11]). Reading this definition, it is easy to notice how artificial intelligence is a much broader topic than blockchain, as it puts together a family of outcomes – the cognitive functions – instead of a specific technology, process or solution. Artificial intelligence focuses on several topics and the general problem of simulating intelligence has been broken down into sub-problems. These consist of particular traits or capabilities that researchers expect an intelligent system to display. The traits described below are the ones which have received the most attention:

- artificial general intelligence;
- computer vision;
- knowledge reasoning;
- machine learning;
- natural language processing;
- planning;

[11] Russell, Stuart J.; Norvig, Peter (2009), Artificial Intelligence: A Modern Approach (3rd ed.), Upper Saddle River, New Jersey: Prentice Hall, ISBN 0-13-604259-7

- robotics.

However, just some of these sub-problems need to be investigated for the understanding of this thesis. Where to start from then?

The words of Jerry Kaplan, published in his book "Artificial intelligence: what everyone needs to know" in 2016, may be of some help:

> *"[…] imagine a different approach: a computer program with no preconceived notion of what the rules are, that observes humans playing the game and learns not only what it means to win but what strategies are most successful. For instance, it might learn that after one player gets two in a row, the other player should always make a blocking move, or that occupying three corners with blanks between them frequently results in a win. Most people would credit the program with AI, particularly since it was able to acquire the needed expertise without any guidance or instruction.*
>
> *[…] Nonetheless, there is an unintuitive yet real practical equivalence between selecting an answer from an enormously large proliferation of possibilities and intuiting an answer through insight and creativity […] every possible musical performance of a given length can be represented as one of a finite collection of MP3 files. Is the ability to select that particular music file from the list an equivalent creative act to recording that selection? Surely it's not the same, but perhaps these skills are equally deserving of our applause."*

This quotation describes how the behaviour of computers is defined intelligent when related to reasoning and learning. Playing, and winning, a game is not enough to demonstrate intelligence, a more complex behaviour is required to equal the intelligent behaviour of a human being.

It is undeniable how machines are able to perform better than humans in specific fields and it is also easy to make an example. Think about the cheapest calculator you could buy and answer this question: could it beat you in quick mathematics? Of course yes. There is no possibility a human being could perform better and faster calculations than a machine could. However, this is not enough to say that the machine is intelligent or even more intelligent than a human being; would you argue this? Knowing the arithmetic rules and never failing to apply them does not mean the calculator is the intelligent one between the two.

Going on with the discussion, aiming at understanding when a machine can be defined intelligent, a second quote from Jerry Kaplan, 2016, should be enlightening:

> *"But there's another problem with using human capabilities as a yardstick for AI. Machines are able to perform lots of tasks that people can't do at all, and many such performances certainly feel like displays of intelligence. A tsunami warning system may sound an alarm based on barely perceptible changes in ocean heights that mirror complex undersea geography; […] The behaviour exhibited by systems like these, which will become ever more common in the near future, doesn't lend itself to comparison with human capabilities. Nonetheless, we are likely to regard such systems as artificially intelligent. […] Which leads me to my personal view of the meaning of AI. The essence of AI — indeed, the essence of intelligence — is the ability to make appropriate generalizations in a timely fashion based on limited data. […] Whether it does so the same way people do, and whether it appears to be self- aware as people are, would seem to be irrelevant."*

In other words, the first definition of artificial intelligence that has been given in this chapter, the one by Russell & Norvig, may be too flawed. It is better to avoid the comparison between human and machine intelligence or using human capabilities as a yardstick for AI because the outcome might be the wrong framing of the behaviour. Contrary to the widely held belief that

intelligent behaviours are the result of natural human-designed mind paths, we are approaching an era when intelligence will not be our exclusive.

1.5.2. The capabilities of AI

1.5.2.1. Planning

Planning is a branch – sub-problem – of AI which is concerned with developing techniques to address problems that require formulating a series of steps to accomplish some desired goal. This technology can be applied to solve various problems such as managing the air traffic, packing odd-sized boxes into a truck and analysing legal contracts and regulations. As explained by Jerry Kaplan, 2016, the functioning goes as follows:

> *"The common element of these challenges is that there is usually a known initial state, one or more desired final states, a specific set of operations or "moves" available to proceed from initial to final state(s), and some measure of the value of a solution, such as minimizing the number of steps required. In other words, planning systems figure out what to do."*

While solving planning problems, systems engage in symbolic inference enhanced with heuristic reasoning. The heuristic reasoning helps solving these problems as its approach takes into consideration that the number of possible combinations or sequences of steps can be large, too large, so examining all the available option is not the way to find the solution. Indeed, it has also been written that:

> *"Heuristics attempt to reduce the so-called search space to manageable dimensions using a variety of approaches, some of which are guaranteed to reach a proper solution (if it exists), while others run the risk of failing to find a solution, or at least not the best solution ("admissible" versus*

"inadmissible" heuristics, respectively). For example, if you were trying to climb to the top of a mountain, a pretty good heuristic is to make sure each step you take is uphill— but of course this works only if the hill is a smooth slope upward, never taking a dip. More technically, this incremental approach is called a greedy heuristic (always select the step that gives you the most immediate gain), and works reliably only when domains meet certain criteria for consistency (specifically, if they are monotonic with respect to progress toward the goal)."[12]

Planning systems can run a variety of strategies, some of which may start from the known condition and some others may start with the goal and reason backwards.

For instance, while reasoning backwords in the attempt of finding the initial condition which gets you to the desired status, a planning system that has to make sure to get you home in time for dinner subtracts how long each stop is going to take you, figuring out when it is time to leave.

1.5.2.2. Machine learning & neural networks

By now, machine learning is probably the most discussed field of artificial intelligence and there is a lot of hype around the topic. It attracts people of any kind: academics and professionals, experts and amateurs, IT specialists and non-specialists; this is because learning is an important aspect of human intelligence and it is astonishing how computers can perform something similar.

Learning comes from experience, practice and training. To say that something is learned implies that it must be represented in some way that it can be put to use and it is not just

[12] Jerry Kaplan. 2016. ARTIFICIAL INTELLIGENCE – WHAT EVERYONE NEEDS TO KNOW. Oxford University Press. Available at: https://global.oup.com/academic/product/artificial-intelligence-9780190602390?cc=it&lang=en&

captured and stored. For instance, computer programs digest data that may take a seemingly infinite variety of forms: surface temperatures, social platforms' shares and likes, speech recordings, credit card transactions, stock trades; anything that can be captured, quantified, or represented in digital form.

What is the novelty here? The novelty stands in the vast scale – millions of files for learning a task – and the computational techniques that seem to mimic certain aspects of the human brain, giving machines the ability to learn as humans do.

Firstly, this new data-centric approach has been applied to all sciences and it goes by several names, most commonly machine learning and big-data. Secondly, the computational techniques that seem to mimic certain aspects of the human brain are called neural networks and they are a specific approach to machine learning.

Indeed, *"an artificial neural network is a computer program inspired by certain presumed organizational principles of a real neural network (such as your brain)."*[13]

However, we do not know much about how the brain works and just little is known about the intermediate structure, about how the neurons link to perform their tasks.

Because of this, AI researches simulate the behaviour of neurons as individual elements in their programs and try to solve the trivia developing techniques for connecting them up and studying the results.

A straight forward explanation about neural networks – NN – can be taken, once more, from Jerry Kaplan's work:

> *"You might think that you train an artificial neural network to recognize a cat by showing it pictures with and without cats, indicating which contain cats. You can do it this way, and indeed this is called "supervised learning." But one of the remarkable things about artificial neural networks is that it's*

[13] Jerry Kaplan. 2016. ARTIFICIAL INTELLIGENCE – WHAT EVERYONE NEEDS TO KNOW. Oxford University Press. Available at: https://global.oup.com/academic/product/artificial-intelligence-9780190602390?cc=it&lang=en&

actually possible to skip both of these steps. You can present the network only with pictures that contain cats, and you don't have to tell it anything; this is called "unsupervised learning." How can it possibly learn what a cat is, knowing nothing whatsoever about the world, much less about cats? Cat pictures, by themselves, contain patterns — what you recognize as cat faces, whiskers, paws, and so on, in a seemingly endless variety of poses, colours, and angles. But what an artificial neural network actually detects is incredibly sophisticated and complex correlations between the images— regardless of whether they are rotated, stretched, partially obscured, or the like."

1.5.2.3. Natural language processing (NLP)

Nouns, verb phrases and subordinate clauses. It is universally accepted that language obeys syntactic rules, and these are three of the basic word categories and sentence structures people learned at primary school.

These rules have been codified by IT specialists in order to process natural (human) language on computers but, unfortunately, the structure behind our languages is too flexible for a computer because of its thousands of exceptions and this has been the baseline issue hindering the implementation of a well-functioning system only based on grammar rules. In addition, a word or a phrase may hold different meanings, which can be understood only by having knowledge of the context that is far beyond the immediate text, hence impeding a computer to formulate a correct outcome. As a matter of fact, the NLP did not improve its capabilities until the machine learning approach arrived.

The machine learning approach mainly requires access to large computer-readable bodies of text, which are now easily available. This approach avoids the creation of hand-crafted solutions as it is able to automatically find correlations between the source and the target

examples thanks to the million files analysed during the instruction process, when the machine learns to correlate different texts to the same meaning.

2. IPRs' INTERMEDIATION FAILURES – MAIN ISSUES IN THE PATENT SYSTEM

2.1. Growing number of patents and other general trends[14]

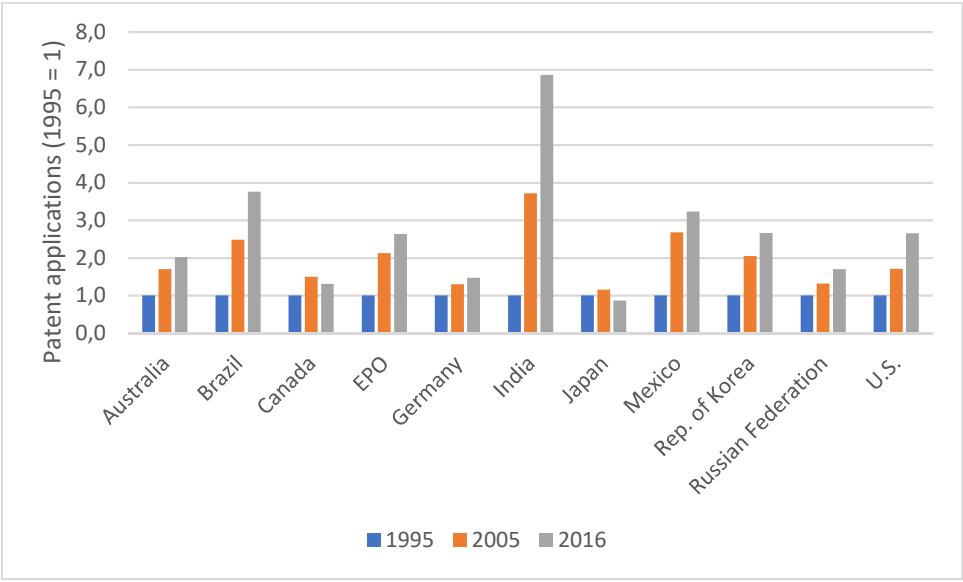
Global intellectual property filings have reached new heights thanks to the recent firm economic growth. Last year, global patent filings grew by 8.3%, making for seven years of straight increases. China remains the main driver of global growth in filings and affirms its leadership among the most important patent offices around the globe. Patent applications in China increased by an additional 21.5%, keeping a fast pace and showing no intention to slow down. The U.S. saw an increase in filing activity for patents as well, yet Uncle Sam's 2.7% growth pales if compared to the 21.5% rate of The Red Dragon.

However, even though it is no lie that there are differences in IP filing procedures, which limit direct comparability of operational statistics across offices, data can usefully inform decision-makers and academics, especially when monitoring trends over time. Therefore, how large has the increase been?

The number of applications filed worldwide reached the 1 M mark in 1995 and has trended upward since then. It took sixteen years to exceed 2 M applications – 2011 – but it only took five years to reach the 3 M mark. Indeed, more than 3.1 M applications were filed in 2016, showing an astonishing acceleration of the trend.

The consistent growth rate can be ascribed to China, which increased filings from 18,700 in 1995 to 1.3 M in 2016, together with Brazil, India and the Islamic Republic of Iran which have also seen above-average increases over the past two decades, and the European Patent Office (EPO), the Republic of Korea and the U.S. each of whom saw average annual growth of around 5% over the same period. The following figure shows the evolution of the number of patent applications by office, starting from 1995 up to 2016.

[14] WIPO. 2017. World Intellectual Property Indicators 2017.
Available at: www.wipo.int/publications/en/details.jsp?id=4234



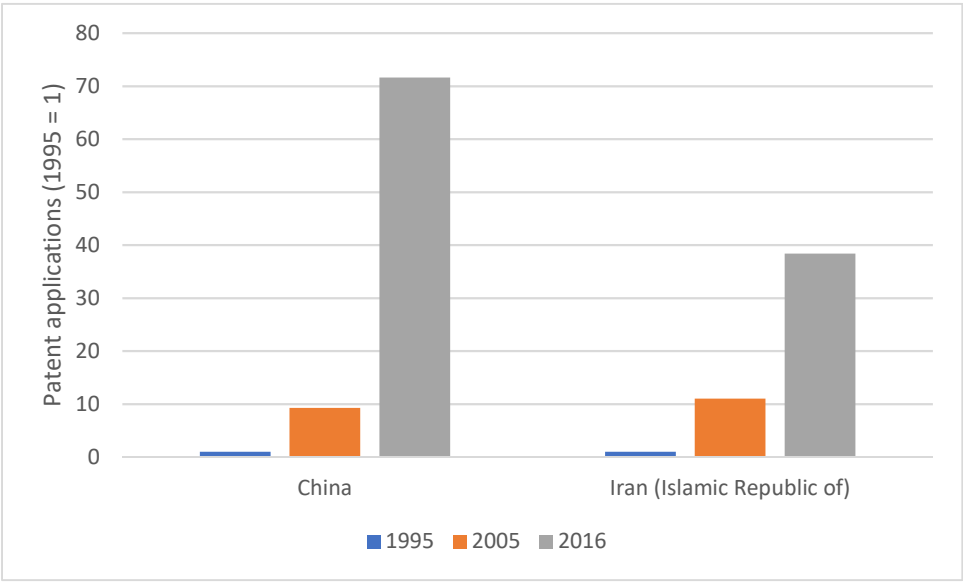


Figure 3 - Patent applications by year. 1995, 2015, 2016.

As already mentioned, a record number of 3.1 M patent applications were filed in 2016, worldwide, and it was the first time ever that more than three million patent applications were filed in a single year. An 8.3% increase from 2015 (Figure 4).

An exceptional number of filings in China, about 236,600 applications, is what drove the strong growth but when China is excluded, applications filed in the rest of the world grew by only 0.2% in 2016 as The Red Dragon received more applications than the combined total for the EPO, Japan, the Republic of Korea and the United States.

Indeed, the next two figures show the growing trend in patent applications and patent grants worldwide, which led to 3,127,900 applications and 1,351,600 grants in 2016.

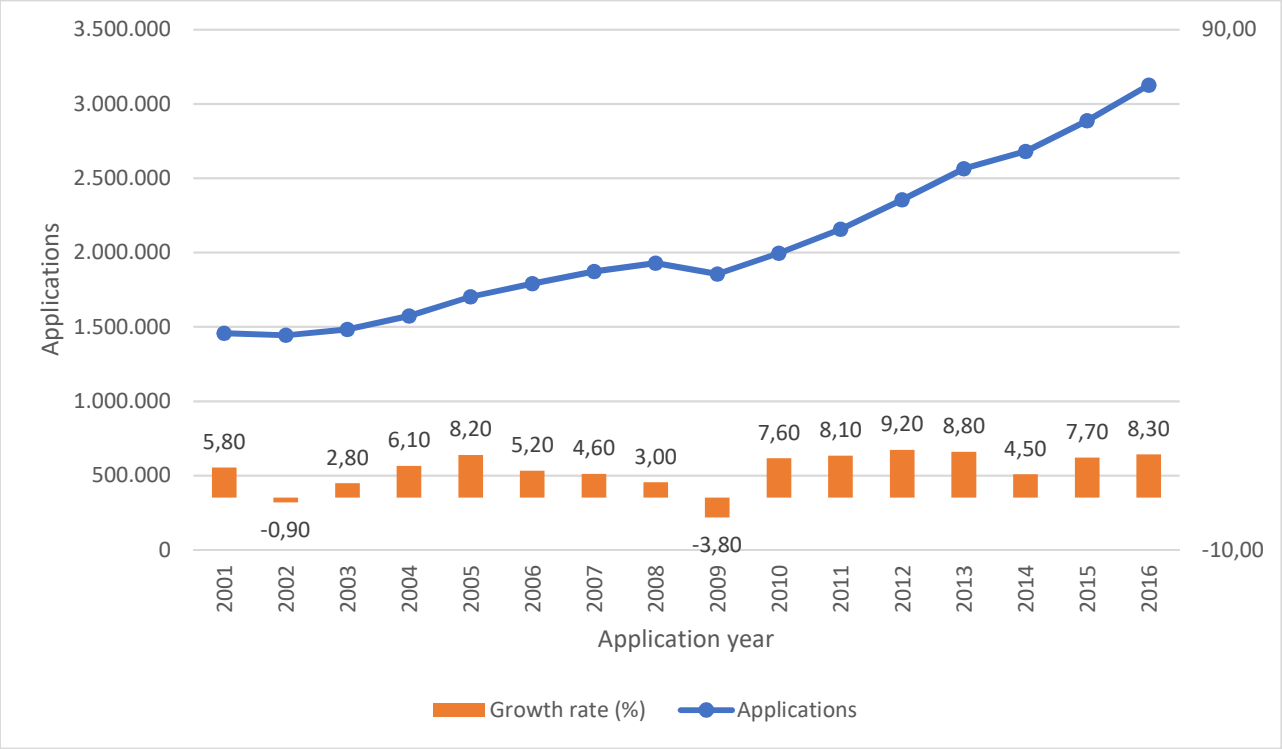


Figure 4 - Trend in patent applications worldwide.

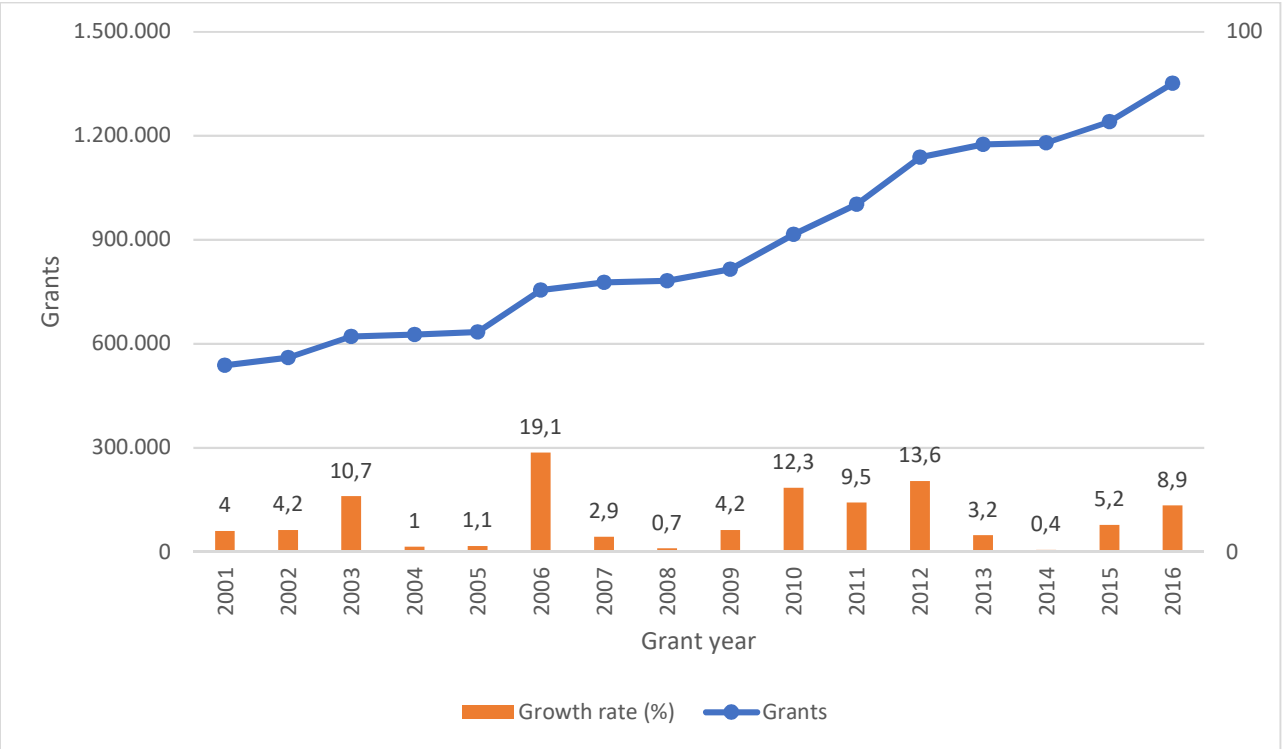


Figure 5 - Trend in patent grants worldwide.

Asia became the first region to receive two million applications in a single year as its offices received just over two million applications in 2016, representing a 13% increase on 2015. Easy to say, Asia became the leading region both in terms of patent applications and grants, increasing its worldwide shares respectively from 49.7% in 2006 to 64.6% in 2016 and from 48.8% in 2006 to 57.0% in 2016. The positive correlation with the Chinese trend means that excluding China, the share of the rest of Asia in the world total actually decreases from around 37.9% to 21.8%.

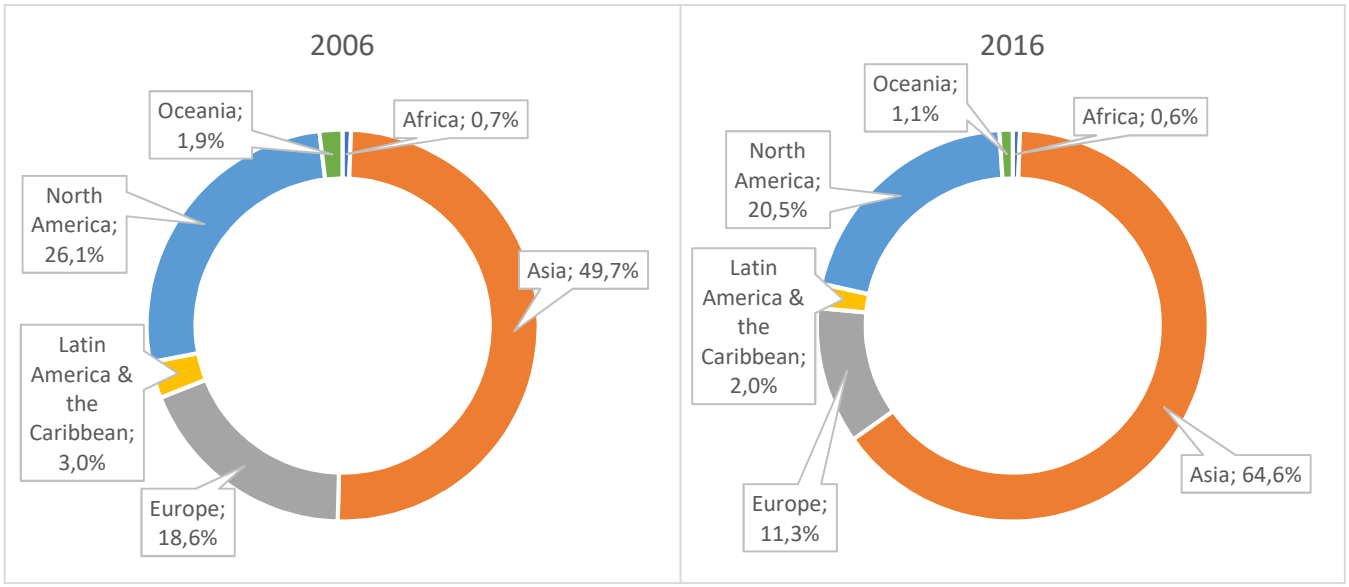


Figure 6 - Patent application by region.

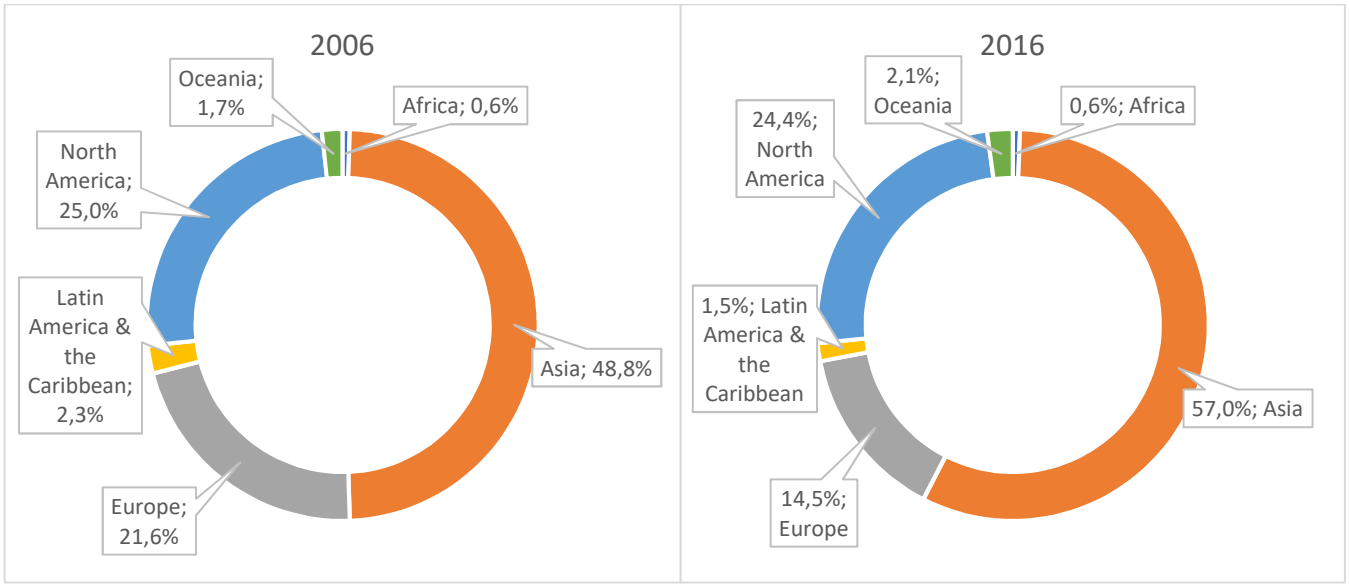


Figure 7 - Patent grants by region.

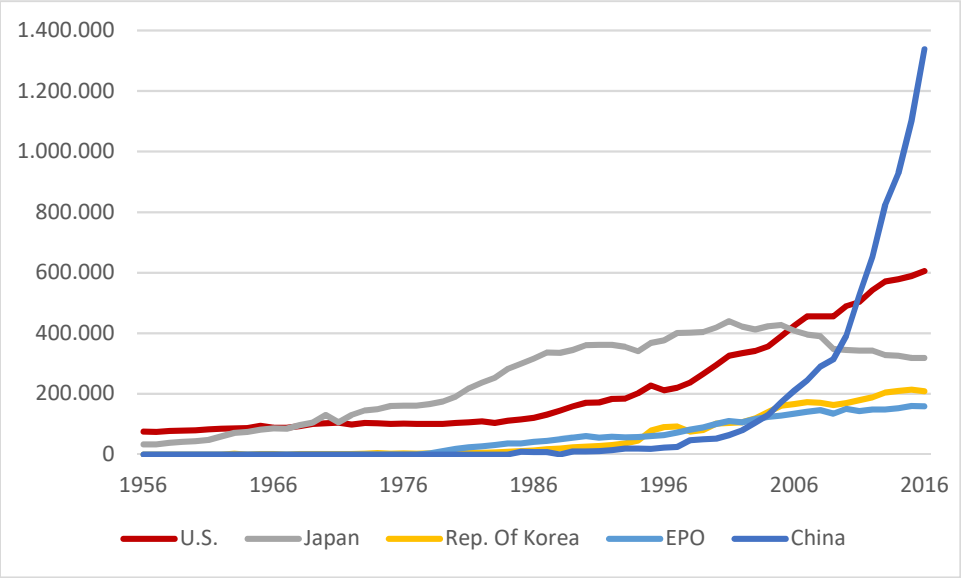


Figure 8 - Trend in patent applications for the top five offices.

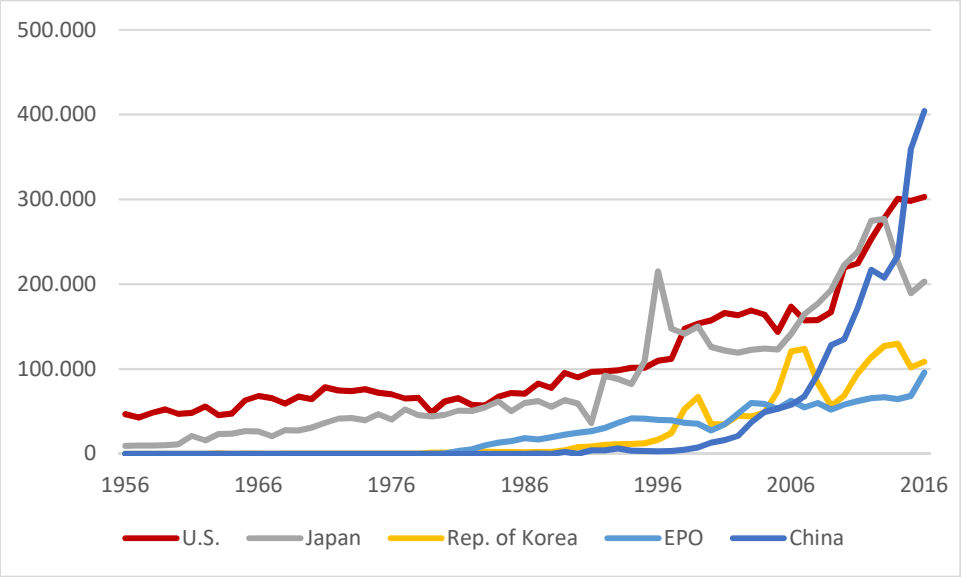


Figure 9 - Trend in patent grants for the top five offices.

From 1883 to 1968, the patent office of the U.S. was the leading office for world filings (Figure 8) when it was taken over by the patent office of Japan. After Japan surpassed the U.S. in 1968, it maintained the top position until 2005 when U.S. took it back until the rise of China in 2010. Since the early 2000s, however, the number of applications filed in Japan has trended downward and this is also the reason why Asia would only contribute for the 21,8% of global patent applications without the contribution of The Red Dragon.

From the above figures, it is also clear how both the EPO and the Republic of Korea have seen increases since the early 1980s. However, China surpassed the European Patent Office and the Republic of Korea in 2005, being the patent office receiving the largest number of applications worldwide. But why is China leading the world in filing patents?

Firstly, it is a matter of population. Consider that in 2016, population estimates put China at 1.40 B[15] and The United States at 325,79 M[16] people.

Secondly, it is a matter of timing. China is a communist country which approaches private property with a different attitude. Hence, Patent law in modern mainland China began with the promulgation of the Patent Law of the People's Republic of China, in 1984. Then, in 1985, China acceded to the Paris Convention for the Protection of Industrial Property, followed by the Patent Cooperation Treaty in 1994. China also joined the World Trade Organization (WTO) in 2001, becoming a member of the TRIPS[17] agreement. Since then, China has amended its Patent Law three times: first in 1992, then again in 2000, and most recently in 2009, aiming at complying with its international obligations and facilitating its development into an innovative country. Indeed, the current leader Xi Jinping stated several times his willingness of driving a structural change of the national industry towards new technological standards – and recognizing intellectual property to citizens is a mandatory step for this pursuit.

However, China mainly relies on resident patent applications and it is a follower when compared to other big players and their non-resident patent applications.

[15] World Population Prospects: The 2017 Revision. 2017. United Nations Department of Economic and Social Affairs, Population Division. Available at: https://esa.un.org/unpd/wpp/DataQuery/

[16] Population estimates. 2017 . US Census Bureau.
Available at: https://www.census.gov/datasets/2017/demo/popest/nation=total.html

[17] The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) is an international legal agreement between all the member nations of the World Trade Organization (WTO). It sets down minimum standards for the regulation by national governments of many forms of intellectual property (IP) as applied to nationals of other WTO member nations. TRIPS was negotiated at the end of the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) in 1994 and is administered by the WTO. The TRIPS agreement introduced intellectual property law into the international trading system for the first time and remains the most comprehensive international agreement on intellectual property to date.

The international agreements, signed throughout the last decades, led to a condition where trans-border applications are the *sine qua non* of the patent system.

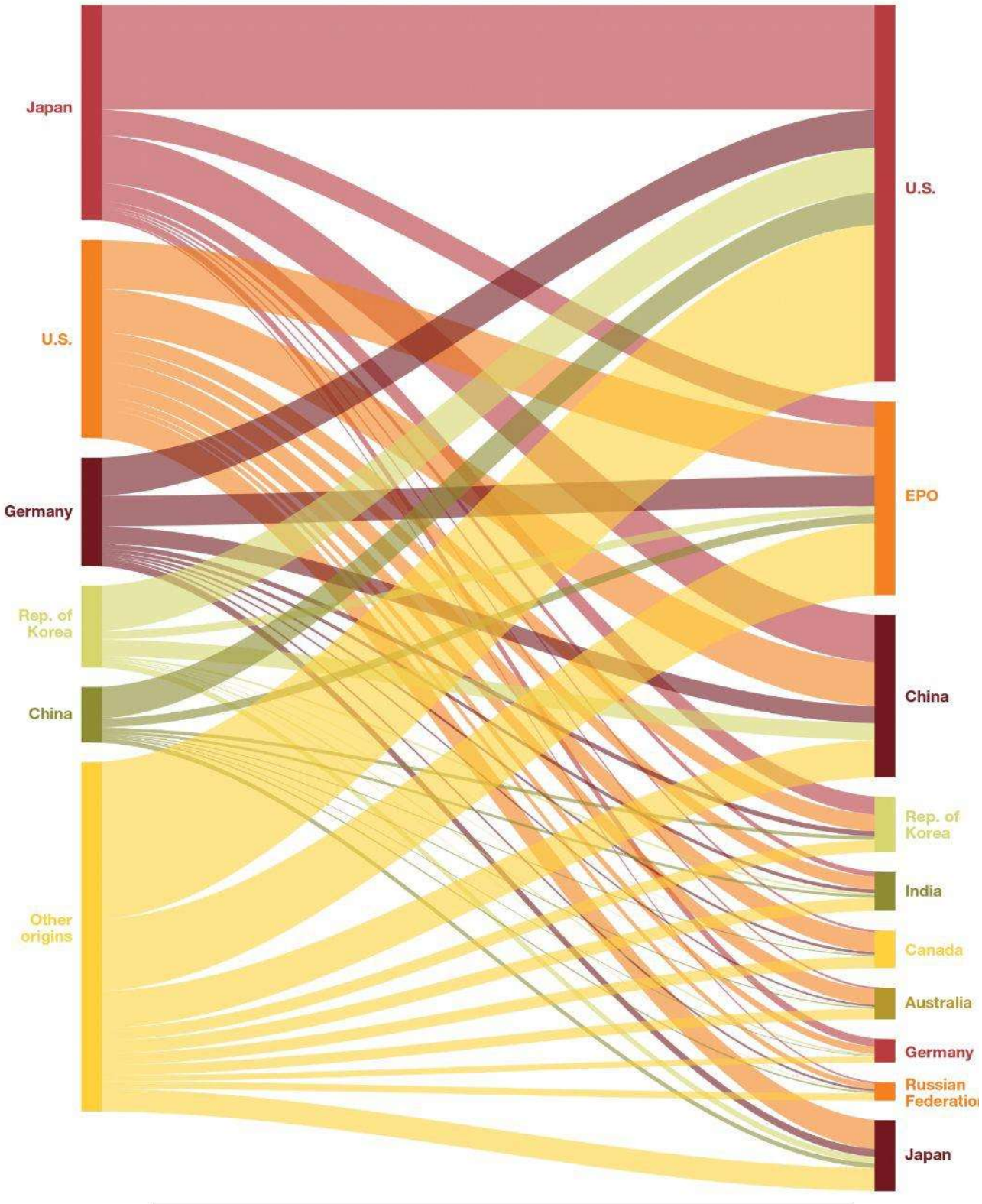


Figure 10 - Flow of non-resident patent applications between the top 5 origins and the top 10 offices, 2016.

The increase in patent filings can be explained as the result of different conditions.

Firstly, in a knowledge economy where companies' market values are strongly related to their intangible assets, corporations are willing to spend more to protect it. As an example, Microsoft had a worth of $10.1 B in intangible assets in 2017[18]. Secondly and from a technological perspective, the higher number of patents is a proxy of the increase in technological innovation happened throughout the past decades. Lastly, the expansion of patentability – in some of the biggest patent offices, such as USPTO – to software and business methods had a positive impact on the number of patent applications, broadening the set of patentable innovations.

Nevertheless, as stated in the first chapter, despite the growing importance of patents for the overall economy, its intermediation market is illiquid and inefficient, impeding a complete exploitation of these intangible assets. As a matter of fact, patents are mainly subject of bilateral transactions in the form of sales or licenses between parties. Moreover, market's inefficiency creates profit opportunities for intermediaries pretending to play the role of cost engineers of the system.

2.2. Intermediation players in the patent system

It is possible to distinguish between three different players in the patent system: patent creators, patent consumers and intermediaries. The players become four when taking into consideration public bodies.

Patent creators and patent consumers are the two opposites; patent creators are corporations or individual creators who file patents asking for the ownership of their inventions and patent consumers are corporations or individuals who use those patented invention.

[18] Analysis of Goodwill and Intangible Assets. Available at: https://www.stock-analysis-on.net/NASDAQ/Company/Microsoft-Corp/Analysis/Goodwill-and-Intangible-Assets

Unfortunately, due to the illiquidity of the patent market, creators and consumers have frequently to rely on intermediaries to complete transactions. There is a diverse set of intermediaries with different roles which are, among the others: patent brokers, patent pools and standard-setting associations. Moreover, there are additional new roles played by the intermediaries such as patent aggregators and online auction platforms. An example about the latter, the first of its kind, is Ocean Tomo, born in 2003 as an auction website for patents, trademarks and copyrights with the aim of shortening the distance between IP owners and buyers. Its public auctions also included business method patents and the rights to Jimi Hendrix's music recordings[19].

Each intermediary tries to address the various issues existing in the system. For example, patent brokers aim at reducing their clients' search and transaction costs, or as above defined: they should do cost engineering, operating both on the buy-side and the sell-side.

A controversial case is the one about patent licensing and enforcement companies, also known as non-practicing entities (NPEs) or "patent trolls". They are patent aggregators yet there is no clear definition of what an NPE is. In its essence, an NPE is a company that holds patents, makes money by using them, but does not produce products that involve those patents. There are no goods produced, NPEs acquire patents in order to license them to others – extracting large fees – or to sue any entity violating their property. They do not seem to be benevolent middlemen who take a cut for themselves while improving efficiency by matching buyers and sellers.

Nevertheless, some authors argue that NPEs fulfil a socially valuable function by providing smaller inventors, who lack resources and expertise needed to market their technologies, the opportunity to enforce their patents[20]. Taking the perspective of NPEs as benevolent middlemen, it has been argued how they could provide liquidity and reduce market inefficiency. So, what is the truth? The truth may stand in the fact that NPEs seek for supra-normal returns, hence they are

[19] Jimi Hendrix Steals the Show At Intellectual Property Auction. 200. Wall Street Journal. Available at: https://blogs.wsj.com/law/2006/10/27/jimi-hendrix-steals-the-show-at-intellectual-property-auction/

[20] David L. Schwartz & Jay P. Kesan. 2014. Analyzing the Role of Non-Practicing Entities in the Patent System. Cornell Law Review, 99, 4. Available at: https://scholarship.law.cornell.edu/cgi/viewcontent.cgi?article=4621&context=clr

not just taking a cut for themselves while matching demand and supply. They try to skim as much profits as possible instead.

Indeed, NPEs apply two practices which are economically harmful: suing large numbers of companies and creating the so-called patent hold-up. The former, suing many companies simultaneously, is particularly harmful as the intermediary sues for relatively small amounts hoping that defendants will pay license fees instead of risking costly litigation. This way, NPEs are able to ask for supra-normal fees. The latter, creating a "patent hold-up", is harmful as well as the patent owner – in this case the patent troll – sues a company after it has implemented the technology and it is too late for the defendant to change course. Once more, NPEs are able to ask for supra-normal fees. Authors David L. Schwartz and Jay P. Kesan in their paper "Analyzing the Role of Non-Practicing Entities in the Patent System"[21], estimate that about 60% of new patent lawsuits were filed by NPEs in 2010. Moreover, J. Bessen, J. Ford and M.J. Meurer in their working paper published by the Boston University School of Law[22] claim that between 2006 and 2010 the annual aggregate loss of market capitalization of defendants in lawsuits filed by NPEs was $ 83 B. Only little of this value was transferred to the actual inventors. In other words, intermediaries such as non-performing entities do find inefficiencies in the patent market but with the aim of creating additional costs, hence additional inefficiencies.

Concluding, it is interesting to see how the three players in the patent system populate supply and demand sides. Indeed, the two following figures show the distribution of buyer and seller type by 2016-2017 sale year[23], elucidating the impact of NPEs on the market. That impact has been equal to the 37% of the total buyer side – up from 32% – and the 13% of the total seller side – decreasing sales for the first time in three years.

[21] Schwartz, David L. and Kesan, Jay P. 2014. Analyzing the Role of Non-Practicing Entities in the Patent System. Cornell Law Review, 99, 2. Available at: http://dx.doi.org/10.2139/ssrn.2117421

[22] J. Bessen, J. Ford and M.J. Meurer. 2011. The Private and Social Costs Of Patent Trolls. Boston University School of Law. Available at: http://www.bu.edu/law/workingpapers-archive/documents/bessen-ford-meurer-no-11-45rev.pdf

[23] Kent Richardson. 2017. Secondary Patent Market: Buyers, Sellers, Pricing, and Trends. ROL Group. Available at: https://www.slideshare.net/sfo2008/secondary-patent-market-buyers-sellers-pricing-and-trends

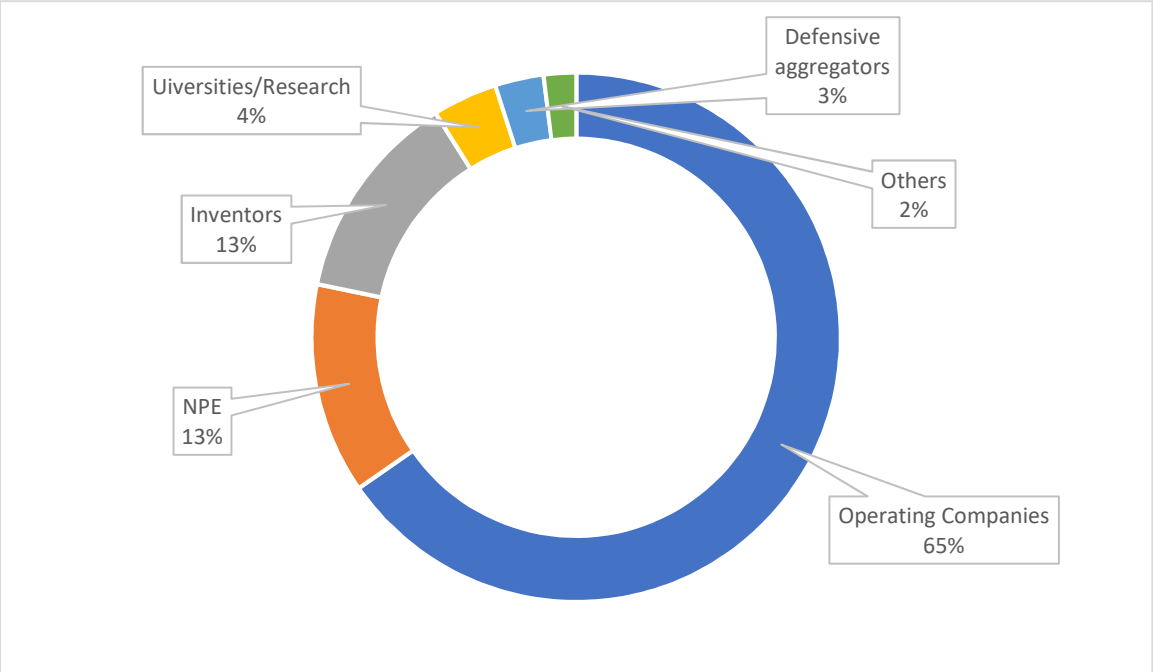


Figure 11 - Distribution of seller type by 2016-2017 sale year.

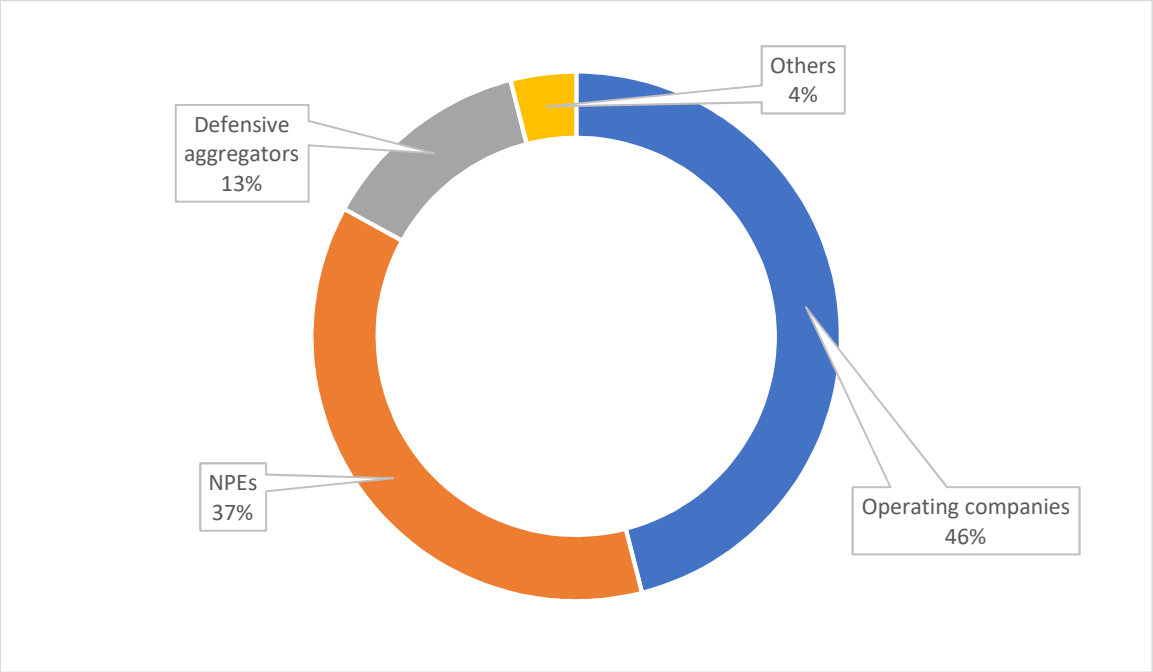


Figure 12 - Distribution of buyer type by 2016-2017 sale year.

2.3. The intermediation inefficiencies in the patent system

As discussed above, the market for patents is illiquid and inefficient and has been criticized for being far from its full potential in promoting innovation around the globe. Indeed, there are shortcomings and structural inefficiencies in the patent market that are the reasons leading to these illiquidity and inefficiency.

All of these issues seem to have in common the fact that they are mainly caused by a lack of info circulation and availability in the intermediation process. Therefore, the problem will be addressed as the lack of info-circulation is the issue underlying all inefficiencies instead of thinking about it as the issue itself.

2.3.1. Patent thicket

The number of patents is increasing at an outstanding pace, especially in certain geographical areas. Specific industries are leading this growth and they mainly relate with high-technologies, digital communications, smartphones and semiconductors.

As an example, take into consideration that tech corporations like Huawei, as of December 31, 2017, had filed 64,091 patent applications in China and 48,758 applications outside the country. Moreover, the EPO's annual report, shows that the Office received nearly 166,000 applications in 2017, 2,398 of which were filed by Huawei, making it the top filer of 2017[24].

Being companies able of similar achievements, what happens is the following:

> *"You pick up your smart phone with its curved sides (US Patent No. D618,677), swipe your finger across the screen to unlock it (US Patent No. 8,046,721), check email that was "pushed" to the phone without a request to the server (US Patent No. 6,272,333), and type a text message using only a few touches as the phone*

[24] Huawei. 2018. Huawei Top Filer with European Patent Office in 2017. Available at: http://www.huawei.com/en/press-events/news/2018/3/Huawei-Top-Filer-European-Patent-Office

automatically completes each word you start to spell (US Patent No. 8,074,172). Guess what? You may be accused of violating these patents or dozens more by using inventions without a valid license. This can occur whether you are using an iPhone, an Android-type device, some other smart phone, or even a yet-to-be-named technology."[25]

In other words, a patent thicket is *[...] a dense web of overlapping intellectual property rights that a company must hack its way through in order to actually commercialize new technology"*[26]. Practically, all the overlapping patented inventions are typically owned by different right holders which makes it very costly for users to license rights or even to make sure that they are not infringing on any existing IP, as patent thickets are most common for components of a modular design such as the above-mentioned smartphones and semiconductors.

Patent thickets are a potential barrier to entry because of the creation of high transaction costs for the user. This situation gets worse especially for individual investors or small entities with no skills in the identification and management of existing IP rights, or with no money and people to be invested on this task. Since the high transaction costs result in the underuse and the infringement – voluntary or not – of the underlying technology, companies apply various solutions for patent thickets:

- Cross licensing;
- Patent pooling;
- Standard-setting organizations;
- Defensive patent portfolios;
- "Fencing" – patenting all around a competitor's invention.

[25] The sky is not falling: Navigating the smartphone patent thicket. 2013. WIPO Magazine. Available at: http://www.wipo.int/wipo_magazine/en/2013/01/article_0002.html

[26] Shapiro, Carl (2001). "Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard-Setting" (PDF). In Jaffe, Adam B.; et al. Innovation Policy and the Economy. I. Cambridge: MIT Press. pp. 119–150. ISBN 0-262-60041-2.

2.3.2. Approval of low-quality patents

Many of the patents granted by the PTO are not held valid when subject to litigation, as it happens that patents are granted for innovations that do not meet the requirements of novelty or non-obviousness. This leads to a situation where the market is populated by a large number of economically viable products protected by weak patents as it happened with the "one-click buying" registered by the e-commerce giant Amazon in 1999. That specific patent has been hardly criticised, hence Amazon bargained with single parties (corporations) licence-free deals in the effort of avoiding any kind of litigation while American and European patent offices were evaluating and re-examinating the patentability of the innovation. During 2006, the USPTO ordered a re-examination of the "1-Click" patent – registered trademark by Amazon.com – based on a request referring to an earlier e-commerce patent and the Digicash electronic cash system as prior art. Later on, in 2007, the USPTO issued an office action in the re-examination rejecting most part of the claims, 21 out of 26. Amazon responded by amending the broadest claims to restrict them to a shopping cart model of commerce and, in March 2010, the re-examined and amended patent was allowed. On the other side of the Atlantic Ocean, the "1-Click" European patent ordering was filed with the EPO but refused.

Easy to say, loose patent granting standards can cause considerable social costs. As an example, corporations may have to pay high amounts in litigations and users may have to pay for the license of invalid patents. Since patent litigations are expensive, it often makes more sense for a defendant to license an invalid patent rather than to fight an infringement claim[27], exactly what Amazon.com was trying to avoid by free-licencing its technology. However, authors have two main different ideas. They argue that the problem is not the large number of invalid patents *per se*, instead, the problem is that patent offices issue a small but worrisome

[27] Paul R. Gugliuzza. 2015. PATENT LITIGATION REFORM: THE COURTS, CONGRESS, AND THE FEDERAL RULES OF CIVIL PROCEDURE. Boston University Law Review. 95, 279.
Available at: http://www.bu.edu/bulawreview/files/2015/02/GUGLIUZZA.pdf

number of economically significant bad patents which may enjoy a strong but undeserved presumption of validity – as noted by Mark A. Lemley in 2013[28].

There are different potential reasons for the increasing number of patents of relatively low quality in the past decades yet the following two are probably the cardinal ones. First, as shown in the previous paragraph in Figure 8, the number of patent applications has been increasing rapidly since the mid-1980s. This rise in combination with the limited funding of patent offices, might incentivise officers to process applications quicker and at the lowest cost, paying less attention to details and working faster.

Second, software and business models are patentable in the United States and they are the most litigated because they cover "grey" inventions. Their boundaries are fuzzy, they are characterized by unclear scope and companies often do not understand what those patents claim as broad language is used to define the innovation. It is difficult to understand how, or why, the system ended up accepting this situation, however it is clear that claims should not be broad and vague. Indeed, according to patent law's essentials, the claims are the heart of a patent and they define the limits of exactly what the patent does, and does not, cover which means they must be written with specific language defining specific scopes.

2.3.3. Difficult valuation[29]

Among the other issues, patents are difficult to value as well. More difficult to value than ordinary goods. This is because:

- Patents are intangible and can be used by multiple parties and in multiple places at one time without exhausting the original one;

[28] Lemley, M.A., 2013. Fixing the Patent Office. Innovation Policy and the Economy. Available at: https://www.journals.uchicago.edu/doi/abs/10.1086/668240

[29] Inspired by: Anne Kelley. 2011. Practicing in the Patent Marketplace. The University of Chicago Law Review, 78, 115. https://chicagounbound.uchicago.edu/cgi/viewcontent.cgi?referer=https://www.google.it/&httpsredir=1&article=5530&context=uclrev

- Patents lack comparables as they are, by definition, novel and unique;
- Patents are rarely of value in isolation, instead they often require complementary assets and patents, especially in industries like semiconductors or high-tech consumer electronics which, as above-mentioned, are the industries leading the exceptional IP growth.

Because valuation work is complex, costly and not so reliable, greater transparency about pricing and other terms in patent sales would benefit the market. More specifically, disclosing more patent data across the industry would help to make the marketplace more efficient. However, prior transaction information is useful only when parties can accurately compare those transactions to the one of interest, but transactions involving the most valuable patents are usually so unique that there are no real comparables. Moreover, pricing differences reflect both perceived patent quality and potential impact in the hands of the particular buyer. Due to these inherent differences, it is not possible to avoid costly patent analysis and due diligence. Fortunately, as written in the following chapters, active players in the industry already have aggregated large amounts of public and private data to drive detailed and highly specific automated analyses and, probably, more public information will be available over time.

2.3.4. Limited access for small inventors

It seems that individual inventors and small companies can benefit less from patent markets when compared to bigger firms. While in 2008 about 60% of patents originated from individual inventors, universities, and research labs, this group only received less than 1% of total patent licensing revenue. The remaining 99% of licensing revenue went to large corporations which only filed 40% of all patents.[30] The gap between the two players can be

[30] Andrei Hagiu and Julian Wright. 2015. Multi-Sided Platforms. Harvard Business School. Available at: http://www.hbs.edu/faculty/Publication%20Files/15-037_cb5afe51-6150-4be9-ace2-39c6a8ace6d4.pdf

ascribed to the lack of resources and management expertise needed to successfully license or enforce patents by individual inventors and small companies, meaning that costs of litigation are not bearable and that patents rights are difficult to be enforced by them (patent hold-out[31]). In other words, individual inventors and small companies have lower bargaining power in the market of intermediation, which leads to the unfair condition where they cannot offer vast portfolios and do not fight patent infringements.

2.3.5. High search costs & high likelihood of expropriation

Both patent owners and patent users face high search costs. For patent owners, it is costly to find out all the current users of their patents and the uses they are making out of it. Indeed, disclosures or access to any idea may allow users to expropriate inventions, especially when the patent owner is a small player – individual inventor or small business – not able to enforce its rights. In addition, finding prior art is a resource-intensive process as patent applications only disclose the minimum information necessary to obtain a patent and use broad and vague claims on purpose.

About the high likelihood of expropriation, it is of the essence to recall that patents are intangible and nonrival by definition. Indeed, entities are capable of using an invention without the patent holder knowing about it. A patent holder willing to protect its IPRs from infringement would have to bear, on average, about $ 2 M costs for patent litigation, which is often too much for individual investors or small corporations. Therefore, the threat of litigation would not be credible and patent infringements may go without consequences.

[31] Patent hold-out is the practice of companies routinely ignoring patents and resisting patent owner demands because the odds of getting caught are small.

3. INTELLECTUAL PROPERTY AND CORPORATE STRATEGY: PATSNAP & INNOGRAPHY CASES

3.1. Introduction[32]

One important remark when dealing with IP strategy is to understand that IP rights are not just a by-product of R&D or papers that some remote internal legal office has to collect.

IP is generally more pervasive than commonly thought and the implications of its management can be extraordinarily complex.

Assessing the value of IP is a process based on the difference between its value, cost and price, which requires as much information as possible. On the one hand, the cost of IP is relatively easy to know and measure as it depends on taxes, renewal fees, professional fees for prosecution etc. On the other hand, price should be determinable because – even if there are no market comparables – it is usually defined in arm-length negotiations. However, the real issue is the economic value, which is a proxy for a price in a transactional context and for damages in litigation, but it is neither certain nor determinable.

At its bottom, IP is nothing more than information and one of the basic tenet of IP management is that information is an input for the creation of further information. The raw material for creating IP is information and information is usually distinct by mere knowledge.

One important dimension of IP protection is that information must be codified first, then described through the usage of language. Hence, the use of language is fundamental to fix creations and inventions and make them available over time, for use, transfer and improvement.

Once information has been created, retrieved or discovered, managers have to take the decision of protection, that is, to generate IPRs out of corporate knowledge and information.

[32] Inspired by: Massimiliano Granieri. 2014. Intellectual Property for Managers – Law, Practice and Strategy. LUISS University press. ISBN: 9788861051874

This is an important and critical decision for at least three reasons:

a) It has to be taken early in advance, when the value of IP is still speculative;
b) It determines costs for the company, especially if protection is sought abroad as it should be for rewarding technologies with potentially vast markets;
c) It requires a choice among difference forms of protection – for instance patents vs. trade secrets.

Indeed, the ultimate truth about IP management is that it fundamentally is risk management. At the protection stage, it can be extremely challenging to predict whether the technology will become a viable and safe product and it will be bought by costumers. The decision, for the management, is an actual cost today for a possible benefit in the future; any decision process has to privilege quality over quantity, especially in the case of SMEs with reduced financial capabilities.

The issue is: which is the cost of leaving a market uncovered? The organization has to determine which are the markets where it believes it will have an outlet for its products or for its technologies, taking into consideration that: if a market is too appealing to be left to the risk of competition, the opportunity cost could be prohibitively high.

PatSnap and Innography help organisations taking these difficult decisions, providing informative support – both for inventors and managers – throughout the decision processes.

3.2. PatSnap – IP intelligence and information visualisation platform[33]

Founded by Jeffrey Tiong in 2007, PatSnap is an IP analytic and management platform that empowers even non IP-proficient users to gain crucial insights. By making patent search and

[33] PatSnap. 2018. Available at: https://www.patsnap.com/

analysis accessible and usable for non-IP experts, PatSnap provides a new source of information for use during research.

PatSnap is probably the most comprehensive innovation intelligence platform available at the moment. Its solutions are based on the massive amount of data contained in its databases and the deployment of neural networks and data-science techniques for helping R&D professionals and innovators analysing the patent landscape, searching for the state of the art and being given effective search tools together with advanced data presentation.

From inventing new ideas to commercializing them, PatSnap gives access to a register of more than 120 million patents, enriched with company financials, litigation records and technology profiles. Deep learning algorithms find and visualize meaningful patterns within billions of data points, so to answer questions like: “How can I increase the revenue generated from R&D and innovation projects?” “Can I patent my invention and do I have freedom to operate?” “Which patents should I build on and which should I abandon?” “Where is the next wave of opportunity for products that will own future markets?”.

In other words, PatSnap gives a support in taking difficult decisions related to the cost of opportunity in the IP market. The difference between its support and the one from a law firm having a strong expertise in intellectual property rights management is that suggestions from PatSnap are based on the use of deep learning algorithms and information visualisation – a combination of the two.

Patent visualisation, or information visualisation, is the study of interactive visual representations of abstract data to reinforce human cognition. It is the science of analysing patent information to discover relationships and trends that would be difficult to see when working with patent documents on a one-and-one basis.

The abstract data can include both numerical and non-numerical data, such as text and geographic information. This practice enables companies to identify the patents in a particular technology

space, verify the characteristics of these patents, and identify the relationships among them, to see if there are any zones of infringement.

Analytics platforms offer options to visualise specific data within patent documents by creating topic maps, priority maps or IP landscape reports, thanks to a software which converts patents into infographics or maps, to allow the user to get insight into the data and draw conclusions.

Given that patents contain both structured data – such as publication numbers – and unstructured text – such as its title, the abstract, claims and visual info – to different need to be applied: structured data are processed by data-mining and unstructured data are processed with text-mining.

As an example, crossing dates and locations offers a global vision of a technology in time and space while the study of filing patterns of competitors locates main patent filers within a specific area of technology. This approach can be helpful to monitor competitors' environments, moves and innovation trends and gives a macro view of a technology status.

3.2.1. Research & Development and Intellectual Property Assessment by PatSnap[34]

R&D is a race against time and competitors. By the time a company learns that a competitor has brought a new product to market, its team could already be years behind. Using PatSnap, it is possible to track competitors and set up searches and alerts on key technology areas to identify new competitors as they emerge, getting real time notifications of new developments such as patent filings, grants or expiry, as well as litigation cases or new licensing deals.

At the same time, during the ideation stage of R&D, researchers might pursue thousands of potential projects trying to figure out which one will be the next blockbuster. With PatSnap is

[34] PatSnap. 2018. R&D Solutions & IP Solutions.
Available at: https://www.patsnap.com/solutions/rd & https://www.patsnap.com/solutions/ip

possible to check if ideas are novel, providing tech trends, licensing and grant data to save man hours and accelerate time-to-market.

Figure 13 - Landscape by PatSnap

In an environment where the number of patents awarded each year continues to rise, protecting IP is an ever-growing challenge. Indeed, PatSnap offers a wide range of tools and visualisations enabling experts to pinpoint specific changes in selected statuses of patents or within a group of patents relating to any technology areas of IP portfolios of choosing. PatSnap is designed to improve the efficiency of identifying which patents in a portfolio should be licensed, sold, donated or abandoned, by combining insights with out-of-the-box charts and graphs that get to the heart of business questions. This way is possible to expedite any analysis of IP portfolios, and where they fall within an overall patent landscape, which will rapidly uncover the right course of action for each.

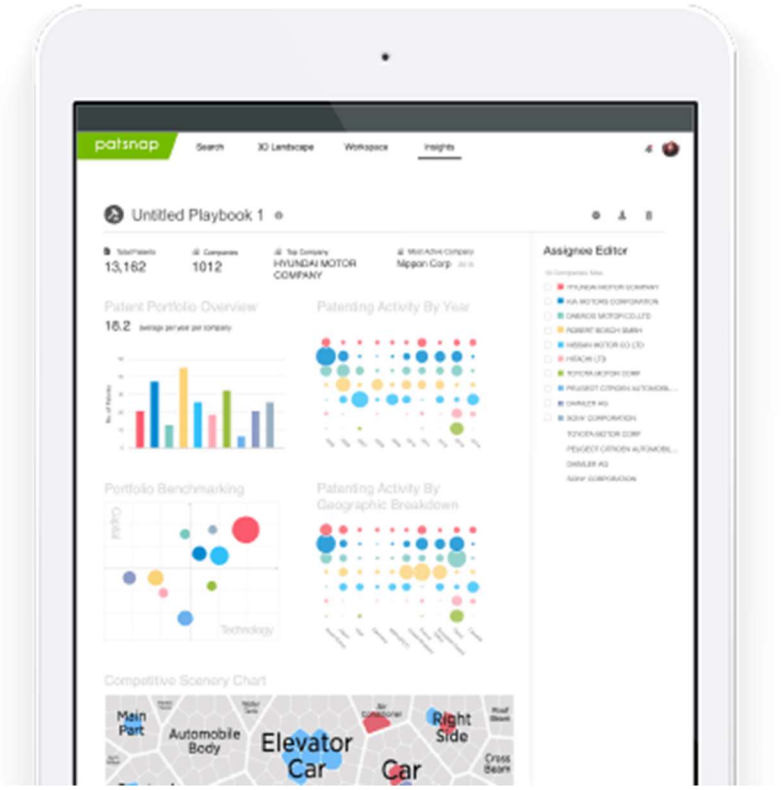


Figure 14 - Competitor Intelligence by PatSnap

Knowing how a competitor, partner, customer or supplier is innovating is hugely important in strategic planning and in decision-making as well. It is important in almost all parts of the organisation. Indeed, with the aim of knowing competitor's next moves in advance, patent activity can highlight technological areas of focus, allowing a company to plan and react accordingly.

3.2.2. Patsnap for academic and governmental institutions[35]

Intellectual property plays a key role across all stages of the research and technology transfer functions at academic institutions. From providing insight into newly protected invention, to

[35] PatSnap. 2018. Patent analysis tool for tech transfer professionals. Available at: https://www.patsnap.com/solutions/academia

ideas for cross-application of technology, and from partner and technology scouting to the data behind commercialisation activity.

Researchers and scientists need no patent experience to perform deep searches into highly specialised fields, while university tech transfer departments can access patent valuation, licensing and litigation data to help build a complete picture of commercialization opportunities for a given technology.

By making patent search and analysis accessible and usable for non-IP experts, PatSnap provides scientists with a source of information for use during research.

In addition, with the funding data available, teams can quickly identify technology areas receiving research investment. Using the graphical landscaping tool, researchers and scientists can precisely pinpoint their particular area of focus and immediately see any funding associated with that field.

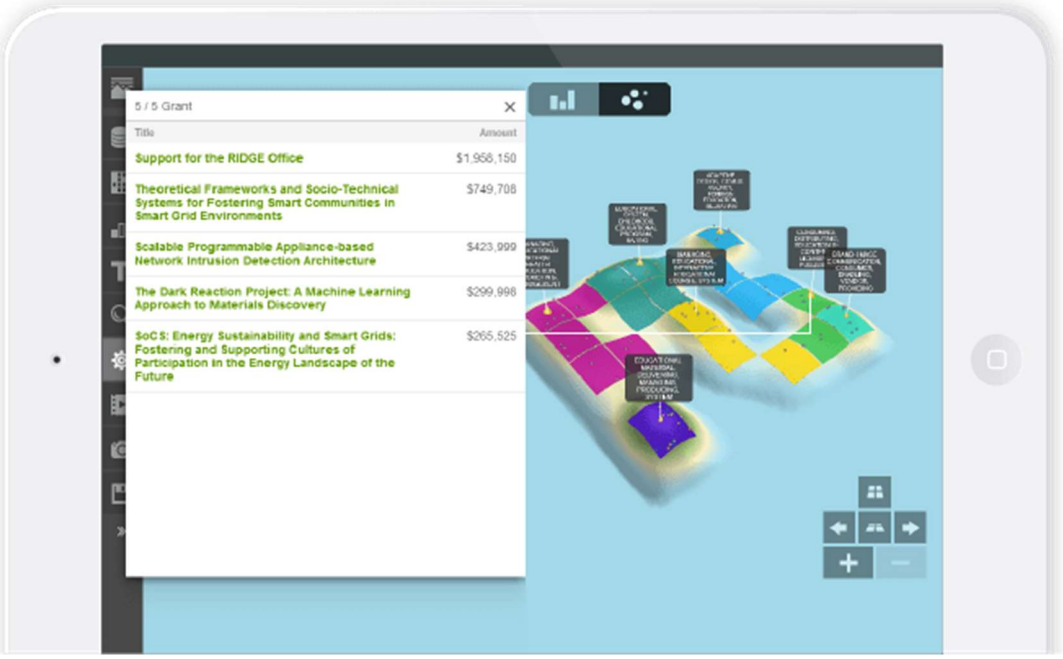


Figure 15 - Landscape describing investments per technology area by PatSnap

When research leads to potentially patentable invention, scientists and researchers need to quickly identify whether an idea could be, or should be, protected. By pasting the abstract into the landscaping tool, a researcher can test the idea, verifying whether it stands in a heavily

protected area or not. This gives an indication of patentability without the need for invention disclosure or discussion with a patent attorney. Ideas that appear in relatively 'open' areas can then be pursued through the patent teams as normal, saving time, work and money by only taking forward the more likely ideas.

By plotting a new idea – whether patented or not – onto the 3D landscaping map, teams can also generate a short-list of potential buyers or licensors by seeing who else is patenting in a given space.

3.2.3. Customer cases

Dr. Eyal Bressler & Co[36]

Dr. Eyal Bressels & Co is an Israeli firm serving domestic and international clients with legal advice in the field of intellectual property, offering a personal service to each client. Before the Israeli firm meets its clients in the first meetings to talk about their technology, the consultants ask them what they do and during the meeting they already have a presentation containing visual presentations of their field of technology. This is because PatSnap has given them more access to tools they have never had before, like the patent portfolio valuation.

Professionals from Dr. Eyal Bressels & Co perform searches in a much quicker way, saving valuable time and labour, as typical searches would normally take them about two days versus only five hours using PatSnap.

[36] PatSnap. 2018. Dr. Eyal Bressler & Co – PatSnap customer case study.
Available at: https://www.patsnap.com/customers/dr-eyal-bressler-and-co

Richardson Oliver Law Group[37]

Richardson Oliver Law Group is a technology IP strategy firm which helps clients in the IP decision process, guiding them through important situations like the buying and selling of patents, the development of licensing programs, the protection against patent assertions and the creation of a value-driven IP portfolio.

During the daily routine, PatSnap helps Richardson Oliver's lawyers dive into a general technology area, or search results, and get a sense of the landscape very quickly. They can figure out who the primary companies in that specific market are and what kind of assets they hold.

As an example, one of their clients wanted to know everything they could about a specific competitor, and thanks to the PatSnap default analysis lawyers from R.O. Law Group have been able to collect all the valuable insights. In the course of just two hours, they got to know what the target company had been filing and where.

In addition, amongst other activities at R.O. Law Group, they publish an annual report about the secondary patent market named: "Buying and selling of bare patents".

In that report database, there are about 115,000 assets being tracked thanks to PatSnap. This means they look at who is buying those assets, who is selling them, what the prices are, and companies are able to use the report as a baseline on what the market's average price for a patent is. Thanks to the use of data from PatSnap they have also been able to start correlating characteristics of patents, searching for characteristics of more valuable patents.

[37] PatSnap. 2018. Richard Oliver Law Group – PatSnap customer case study.
Available at: https://www.patsnap.com/customers/richardson-oliver-law-group

Perceptron[38]

Perceptron offers an extensive portfolio of dimensional gauging and inspection products along with robotic guidance, gap & flush measurement and 3D laser scanning solutions. Companies rely on Perceptron's metrology solutions to assist in managing their complex manufacturing processes to improve quality, shorten product launch times and reduce costs.

At Perceptron, the big challenge is that technology development is incredibly fast nowadays, as the pace has picked up significantly in the last five to six years, but there are not available information about the competition, what IP they have, and what projects they are working on. Indeed, customer product cycles have significantly shortened. For example, in the automotive industry, product lifecycles have shortened significantly while complexity has increased. Because of this, the demand for quick solutions has significantly gone up.

As Mr. Shyam Keshavmurthy, Chief Engineer at Perceptron, stated: *"It used to take 6-8 months for a solution to arrive on a shop floor. Nowadays, customers expect to have a solution that will work in a pilot form within say, two to three months, then they want that solution to become a global solution in a matter of six to eight months. This basically accelerates the entire product development lifecycle for everybody who is serving that customer base."*

Thanks to PatSnap, keeping the pace in this always accelerating industry is easier. As an example, Perceptron's management sets up automated queries to keep track of patents being filed in target technology areas or applications that have been filed by specific industry players. They track it every fifteen days, generating a monthly report to understand if there is overlap between the product development work they are doing and what is going on in the industry.

[38] PatSnap. 2018. Perceptron – PatSnap customer case study.
Available at: https://www.patsnap.com/customers/perceptron

3.3. Innography[39]

Innography is an IP intelligence software for patent owners and innovators which brings high-value IP intelligence to their customers thanks to various solutions. Among the most noteworthy features there are the semantic search (natural language processing) and the proprietary predictive algorithm (artificial intelligence), which can evaluate the strength of a patent. In other words, Innography enables strategic IP portfolio planning, patent buying and selling initiatives, and research targeting strategies designed to maximize the benefits of IP ownership and development. It also offers insights for litigation strategies; it correlates IP litigation data with patents to get a complete view of trends and threats for litigation purposes, to support key decisions and substantially reduce associated costs.

Given that both PatSnap and Innography provide solutions for the same or similar problems, the following paragraphs are going to focus just on services which differentiate Innography from PatSnap.

3.3.1. PatentStrength®: Software analysis[40]

Innography's PatentStrength® is a proprietary algorithm which can predict patent value by determining the likelihood that a patent will be litigated.

The software analysis of the patent strength was born with the aim of helping managers when they are pressed for time or controlling costs. Indeed, having an expert read for each patent can be something not affordable, out of budget, but using the PatentStrength tool, top patents in any portfolio can be identified and fully examined cutting time and costs – drastically shortening the process of valuation.

[39] Innography. 2018. Available at: https://www.innography.com/

40 Innography. 2018. PatentStrength: Patent Value.
Available at: https://www.innography.com/why-innography/patentstrength

The patent analysis software is designed for evaluating a patent portfolio, such as one that is available for purchase. If company A is taking into consideration the acquisition of a patent portfolio from company B, the algorithm will provide guidance on whether or not to pursue a particular portfolio, assessing its overall quality.

Relative strength can be determined too, as the distribution of multiple portfolios can be compared within a specific technology area. This provides insight into the relative value and protectiveness of different portfolios and also guidance on buying a portfolio, by showing if the additional patents add to the overall portfolio strength.

On top of that, CustomStrength® is a special feature of PatetStrength® thanks to which users may create their own weightings and metrics as it allows to save the valuation formulas you like and compare result sets against any or all of them.

3.3.2. Innography Explorer – Semantic search[41]

Innography Explorer is a patent search and analysis tool that allows users to conduct IP research easily to ensure they are efficiently innovating and are first to file.

In minutes, a team can conduct IP research without the need for extensive training in complex keyword search techniques.

As already mentioned, patents may use vague language, which a narrow keyword search could miss leaving an IP strategy at risk. However, having the ability to conduct a semantic search, finding patents which are relevant to the concepts in a natural language description, could be critical. This way, researchers can enter large blocks of text for semantic searching, patent numbers, keywords, publication numbers, or chemical structures to find highly relevant documents and conduct prior art searches quickly and accurately.

[41] Innography. 2018. Patent Search. Available at: https://www.innography.com/solutions/ip-answers/patent-search

Why is semantic search (natural language processing) so important for patent searching?

Semantic search is an essential tool in patent search as it finds hidden patterns in patents claims that keyword search could miss.

In their seminal paper about semantic search[42], the researchers from IBM, Stanford and MIT separate searching into two types:

- Navigational search to find a specific document. Keywords are fast and effective for this kind of search;
- Research search to gather information about a topic across many documents.

With navigational search, for patents, it is possible to enter the patent number, or search on keywords to hone in on the single document as you know that specific information exists. With semantic search, it is possible to find relevant documents and discover information from the collection of documents without knowing any specific detail of what you are searching for. This is an interesting kind of search which, with patents in particular, helps users finding the full set of relevant documents.

Firstly, patents are long-lived assets and documents, terminology changes over time and the commonly accepted terminology can evolve. Secondly, different industries may use different terms and, in the case an interesting patent comes from adjacent industries that use different terms for the same invention, a researcher may not be able to find it. Thirdly, many patent filings are translated from other languages to file in multiple patent offices, giving rise to different terms than expected. Fourthly, some patents have misleading verbiage as patent filers may use terms that obfuscate the technology aiming that the patents will not be discovered by the usual keyword searches. As a result, relying only on keywords to search patents is highly risky as the final aim of patent searching is finding all relevant patents, without missing any of the relevant ones.

[42] R. Guha, R. McCool, E. Miller. 2003. Semantic search. ISBN: 1-58113-680-3. Available at: http://www2003.org/cdrom/papers/refereed/p779/ess.html

Semantic search is able of discovering the concepts behind words in order to find relevant matching documents. In this specific case, Innography's semantic search uses advanced numerical algorithms to examine the word frequency, sequencing and patterns to detect the author's intent.

As a result, semantic search can find patents that use different keywords than expected, saving hours of time thinking about all the keyword phrases to be used.

This technology delivers consistent results when dealing with quick searching about a concept, because it quickly returns the most relevant and similar documents. On top of that, it is even more valuable as it requires no training, allowing anyone to complete a search simply pasting a paragraph describing a concept into the search box.

As an example, pasting the "camera" definition from Wikipedia into Innography's semantic search tool, this is part of the output:

Figure 16 - Result of a semantic search

Giving concrete use cases, many of Innography's clients utilize semantic search for:

- Prior art searches: it is possible to find early seminal patents that were written when the technology terminology was not finalized yet;

- Invalidation research: it is also possible to uncover relevant previous patents that may have been missed with keyword search;
- Possible infringement: semantic search is an essential support for checking whether there are same technologies in other industries that may use other terms;
- Entering new markets: during the evaluation of new technology areas, running a semantic search is helpful to find out where knowledge of the players has not been developed yet.

Concluding, semantic search can be defined as an essential tool for both casual patent searchers and expert patent searchers since it returns the most relevant patent documents, regardless of the terminology that has been used for describing the technology.

3.3.3. Patent Market Tracker – PMT[43]

As already mentioned, it is not possible to determine the price or transaction value for a patent based on its comparables, because there are no comparables since each patent is unique. However, for the parties involved in a transaction, owning the information about market prices would at least be helpful as descriptive.

As an example, information around patent transactions can offer insight into understanding current and predicting future shifts in the market. But chances are anyone will hear about them at all if not through a press release.

The Patent Market Tracker by Innography uncovers patent transactions, including many that are not publicly announced as it combines and cleans the USPTO database. While gathering and providing details about the market of transactions, this tool separates out the inter-

[43] Innography. 2018. Patent Market Tracker.
Available at: https://www.innography.com/solutions/products/patent-market-tracker

company transfers, deleting unrepresentative operations, and fixes company names for determining the companies involved.

Thanks to Innography's company-name cleansing and company hierarchy algorithms, it is possible to:

- Normalize company names;
- Harmonize legal entities;
- Categorize conveyance types;
- Remove false-positives.

The resulting data provides reliable insight into which companies are actually buying and selling patents, how strong patents are and what impact they have on the market.

3.3.4. Competitive analysis[44]

Information about intellectual property can provide competitive intelligence months, or even years, before companies announce new products to the public. But how?

Patent mapping visualizations are an excellent way for understanding how a particular market or a technology is evolving. Indeed, Innography's patent mapping software allows its users to create competitive landscapes which give a view of patent ownership in the fields of interest. The software completes the analysis with litigation data, product and technology standards into the map, enhancing the ability to understand what competitors are doing, helping discovery of new and emerging competitors and opportunities. By segmenting the market and clustering companies by size or revenue, it is easy to identify acquisition, out-licensing or partnership candidates.

[44] Innography. 2018. Competitive Analysis.
Available at: https://www.innography.com/solutions/ip-answers/competitive-analysis

In other words, defining the competitive landscape allows a company to identify main competitors in the technology space, to identify emerging R&D trends and visualize how the market landscape changes over time.

Moreover, tanks to the mapping activity, companies can discover which patents and competitors are involved in patent litigation preventing litigation risks.

3.4. The positive impact of PatSnap and Innography

In the second chapter, the five main issues of the IP intermediation market have been listed and explained. They are: patent thicket, approval of low quality patents, difficult valuation, limited access for small inventors, and high search costs and likelihood of expropriation. But, how what has just been said about PatSnap and Innography impacts these inefficiencies?

About the patent thicket, the landscapes produced by PatSnap and the mapping provided by Innography, show to inventors which are the technology areas with the most number of patents filed, indicating the markets with no thicket as the markets to file in.

Thanks to the massive datasets and the use of artificial intelligence for the processing, cleansing and understanding of the natural language describing the inventions, both solutions could reduce the approval of law quality patents if they were used by patent examiners during their daily activities. The natural language processing would impact the quality of the SOA search reducing the risk of bad patents approval. In addition to that, the predictive algorithm by Innography could test the patent strength before final validation.

For the same reasons, these two technological solutions could lower the cost of SOA and market trends searches. Saving money, time and labour to be deployed on value-adding activities.

Moreover, both PatSnap and Innography provide tools that are easy to use – no training is required – and run as web applications, meaning that potentially any inventor, small or big, can use these services, improving the accessibility to the patent market for small players.

4. RELIABILITY OF SOURCES AND IMPLEMENTATION OF NEW SOLUTIONS. OROPO FOUNDATION & CHAMBER OF DIGITAL COMMERCE CASES

4.1. ORoPO Foundation

As extensively discussed, several inefficiencies are affecting the patent market. Patent thicket, approval of low quality patents, difficult valuation, limited access for small inventors and high search costs are the five main issues.

The OROPO Foundation[45] – Open Register Of Patent Ownership – is a foundation which aims at directly reducing the high search costs implementing a global database of patent ownership verified by companies committed to openness and transparency.

In a few words, each company contributes to an open register submitting the information about their own patent portfolio, updating the data in case a patent is sold or licenced, making possible to creating an up-to-date register of who owns which patents.

The participation in ORoPO foundation is voluntary, open and non-profit.

It is voluntary as the participation of each company in ORoPO is not bound to any rule, law or industry guideline; it is a commitment to openess. Indeed, it is also open given that all data uploaded is free of restrictions and is made available to the public as open data. Last but not least, it is a non-profit entity.

ORoPO's mission is to improve transparency and openness around patent ownership data, including verified details of patents owned by organizations in the database.

[45] ORoPO Foundation. Official website available at: http://oropo.net/

4.2. Who owns the world's patents?

Patent ownership data accuracy is a ground problem worth solving, as the information about who owns which patents should be considered as an infrastructure for the market.

Indeed, Sir Nigel Shadbolt, Chairman and Co-Founder of the Open Data Institute, said: *"Knowing the facts of the matter about who alleges rights over patents is one of the absolutely essential components of what I would describe as the national information infrastructure"*.

It is clear how the marketplace would work most effectively in an environment of transparency able to enhance inventors and innovators of making smarter investments, creating jobs and driving economic growth. On top of that, as Michelle Lee, Director of the USPTO, stated: *"The economic benefits of greater ownership transparency are truly international in scope; the more awareness there is of the technologies out there, the more cross-licensing opportunities there are across borders"*

Unfortunately, no-one can be sure about who owns the world's patents, and this gives rise to an issue: without clear ownership information, the full value of intellectual property will not be realised, as innovation is the starting point for technological progress and patents sit at the epicentre of the economical exploitation of this process.

Various estimates from reliable sources, including an assessment made by Yo Takagi, an Assistant Director-General at WIPO, and David Kappos, former Undersecretary of Commerce for Intellectual Property and Director of the US Patent and Trademark Office, suggest that as much as 25% of the world's patent ownership data may be inaccurate. On the same line 78% of corporate executives think the information from public patents' registers is neither accurate nor reliable[46].

[46] ORoPO Foundation. 2015. Who owns the world's patents?
Available at: http://oropo.net/oropo_report_20150615.pdf

At this point there are three questions[47] seeking for an answer:

- How can it be that so much uncertainty surrounds patent ownership (it is said that 25% of all data are incorrect) given that public disclosure is the fundamental concept to the existence of the right in the first place?
- What is the impact of this inaccuracy?
- How to make sure that patent ownership data is accurate?

4.2.1. Patent ownership uncertainty

In today's globally connected knowledge economy, IPRs are rapidly coming to the fore again – patents in particular. Patents have emerged as the assets defining enterprise value.

It is said that intangibles like patents account for up to 70% of enterprise asset value, which is outstanding if compared to decades ago, when physical assets were enjoying a similarly dominant position.

Just take as an example Google buying Motorola Mobility for $12.5 billion. That time, Google bought Motorola Mobility for $12.5 billion then sold the business to Lenovo – pay attention: without patents – for $2.91 billion. This can give an idea of how intangible-oriented the valuation of a business currently is. It is not difficult to find thousands of other similar transactions, both for large and small companies.

Going on, a first reason why there is so much uncertainty about patent data may be that *"The laws that govern patent ownership recordation were set out a long, long, long time ago before this information really did need to be updated as much as it does now. The stakes weren't as high as they are now, and there weren't as many different vehicles for moving and leveraging*

[47] ORoPO Foundation. 2015. Who owns the world's patents?
Available at: http://oropo.net/oropo_report_20150615.pdf

things like intangible assets as there are now" as stated by David Kappos, Cravath former Director of the US PTO.

Secondly, the lack of control over corporate identifiers has an impact as well. For instance, two or more companies from different countries may be recorded as the owner of patents which are not in their portfolio. This happened to "CSR", which has been recorded as the owner of several patents, including the ones owned by a Bluetooth company in the UK, a Chinese railway company and a mining company in Australia as they have the same three-letter abbreviation.

Thirdly, as stated by Tony Clayton, who is former Chief Economist at UKIPO *"The cost of changing assignments for a patent portfolio across countries can quickly mount up to millions of pounds just in direct costs, never mind the administrative cost in agents' and managers' time. This is one of the reasons why reassignment is not notified".*

Fourthly, there is no guarantee patent ownership data will remain accurate for the whole life of the patent – up to twenty years. Indeed, there are several things that can change in the patent ownership, such as: M&As, patent sales and corporate name changes. Whether simply to reflect a change in name, or to record a transfer of ownership, these changes and transactions should be followed by changes of the relevant patent information contained in registries. However, in many cases, these changes simply do not happen, creating further inefficiencies in the patent system.

Updating every patent register, with new and accurate information, is not a simple process because there is no unified mechanism, meaning that each register must be updated separately with different procedures. Indeed, 96% of corporate executives think that having an accessible record of who owns which patents is of the essence[48].

[48] ORoPO Foundation. 2015. Who owns the world's patents?
Available at: http://oropo.net/oropo_report_20150615.pdf

4.2.2. The impact of patent data inaccuracy

A study by the University of Tokyo and the OECD[49] found that 64% of European companies doing patent licensing, out license less than 20% of their patents to entities located in a different country. As well, 85% of Japanese companies doing licensing, out license less than 20% of their patents to foreign companies.

Why so? It is possible to argue that the market – in its current shape – started holding back further growth because of its intrinsic features, which reached the maximum capacity. These features, creating inefficiencies such as high search costs, are most probably directly related to the inaccuracy in ownership data.

As Roger Burt, formerly Head of patents for IBM Europe, put it *"If you don't trust the register, why would you approach someone for a patent license? The true owner might be a friend, might be an enemy, or might be someone you are already in litigation with. Better data would enable more informed decisions but in the meantime, if you don't know, you have to assume the worst."*

Related to this, the Forrester Research analyst Navi Radjou has been able to estimate that American companies annually waste $1 trillion in underused intellectual property assets[50].

Hence, a negative effect is due to the absence of a reliable register, containing up to date information about who owns which patents. Unfortunately – because of the creation of high costs – this problem affects SMEs the most, meaning that knowledgeable transacting only occurs in very large corporations which can afford the very high cost.

49 Zuniga, P. & Guellec, D. 2009. Who Licenses out Patents and Why? Lessons from a Business Survey. OECD Science, Technology and Industry Working Papers, 2009/05, OECD Publishing.

50 IBM Corporation. 2010. An Overview of the Critical Importance of IP and IP Analysis. Available at: http://www.tiec.gov.eg/backend/Presentation%20Files/01122010_IPCD_IBM%20Presentation%20Excerpt.pdf

4.3. How to fix the issue (ORoPO)

The need to resolve the issues related to patent ownership is pressing, especially if taking into consideration the current situation in which 25% of the assets representing 70% of enterprise value have uncertain ownership.

This problem may be framed as a matter for policy makers and, eventually, that is true. However, the issue with waiting for a policy maker-led solution is related to complexity and timing. The complexity of this issue asks for the intervention of dozens of governments, and their patent offices, to agree on a common solution to be universally undertaken and implemented. Hence, here come the question: how long could the IP intermediation market wait for the definition and implementation of a common solution?

The ORoPO Foundation proposes a simple and efficient solution, which is actually a market self-help. It proposes to implement a free and global open register to sidestep the complexities and obstacles associated with regulatory approaches, decreasing the efforts needed to solve the inefficient context.

This is an interesting and feasible solution for businesses, 98% of corporate executives would be supportive of a free and open global register which allows patent owners to verify ownership information[51].

ORoPO is simple and can be defined as follows:

- It is an online repository containing data about the ownership of patents;
- It is freely accessible to all;
- Participation in ORoPO is voluntary, and open to any company that owns a patent;
- Participants are in charge of uploading details of patents they own into the repository;
- Participants can update their records as and when patent ownership changes – once for all territories;

[51] ORoPO Foundation. 2015. Who owns the world's patents?
Available at: http://oropo.net/oropo_report_20150615.pdf

- All patents are registered under the name of the ultimate holding company that controls them overcoming corporate naming complexities.

In the case ORoPO becomes widely adopted, there is potential for it to support patent officies in validating entries in their own local registries. Moreover, 95% of corporate executives think greater data openness around patent ownership would increase licensing activity. According to the executives, on average, it would increase by around 6%.[52]

4.4. ORoPO's potential

As broadly discussed in the previous paragraph, ORoPO can be a game changer in the collection and distribution of patent information, potentially helping thousands of companies get the most from their intermediation activities.

Thanks to ORoPO Foundation, more companies could make informed decisions about buying, selling and/or licencing intellectual property rights, fostering innovation and creating economic value for the players in the market.

The increase in efficiency is undeniably considerable, yet it may be even bigger as there is some untapped potential. By now, the mission of ORoPO is to help companies and intermediaries providing them with a free and global open register, but this solution could be improved by collecting a wider set of information about IPRs and implementing the register using blockchain technology.

Firstly, about collecting a wider set of information, the proposal is to move from a solution where the only one shared information is who owns which patents to a solution where the register gathers:

[52] ORoPO Foundation. 2015. Who owns the world's patents?
Available at: http://oropo.net/oropo_report_20150615.pdf

I. Who owns which patents;

II. Patent statements and commitments[53];

III. Royalty or transaction fee.

One addition is the "patent statements and commitments" section. This is about collecting all the commitments from IP owners about their renounce in claiming economic returns from their IPRs, in the case they are exploited by a certain kind of company or for a certain use.

As an example, ORoPO could add to its register all the companies committing to the free use of their patents if the users meet one of the following three requirements:

- Dimension: such as small companies in terms of employees (i.e. less than 25 people);
- Revenue or income: companies with modest income not able to pay high licencing fees (i.e. revenues lower than €500,000);
- The use: special use cases like the non-profit activities.

After the "patent and statements commitments", another suggested addition is the "royalty or transaction fees" section. Its addition would be fundamental for creating a sort of comparabales' database, helping the pricing of other IPRs. The data collected and shared should be about both past transactions (closed deals) and proposed royalty or licencing fees; this way ORoPO could provide historical data about past transactions while describing which is the current supply side expectation. Obviously, everyone is aware that each patent has a specific value depending on several factors, i.e. the portfolio or the market it is inserted in, however owning the information about market prices would at least be helpful as descriptive.

Secondly, it is suggested to develop the register using the blockchain technology, with the aim of obtaining a non-centralized, up-to-date solution. The idea is to have a database that is safe and easy to update as well.

[53] Inspired by the "Non-SDO Patent Statements and Commitments" from the Washington College of Law. Available at: http://www.pijip.org/non-sdo-patent-commitments/

When describing the architecture of the blockchain technology, in paragraph 1.4.3, it has been described how it may be categorised in various families. First:

- Permissionless: any participant could update the chain;
- Permissioned: only the authorised members can update the chain.

Second:

- Public: anyone can read and submit transactions on the chain;
- Private: the permission of reading and submitting information is restricted to a group of users.

According with these possible configurations, ORoPO should never be the central authority of the register, instead, it should identify the companies – its representatives – and authenticate them. Once the companies have been authenticated they should be able to access the register having the possibility of updating the data at any time, depending on the level of authorisation they have been given.

Relying on the blockchain, the solution delivered would be easier to manage as soon as it will get bigger in terms of participants filling in information.

Do you know how many patents are granted to the big players every year? Just consider that Huawei registered 2,398 patents in Europe[54], during 2017, and imagine how difficult it would be to manage all these updates for ORoPO. That is why a blockchain architecture with the right level of authorisation is needed.

[54] WIRED. 2018. Brevetti, Huawei in testa alla classifica europea. Available at: https://www.wired.it/mobile/smartphone/2018/03/09/huawei-brevetti-europa/

4.5. Private sector's leadership – The Chamber of Digital Commerce

At this point, a remark has to be made: the technological migration proposed for the ORoPO Foundation must happen in an environment which is characterised by the leadership of private entities. This technological shift calls for the initiative of corporations and other private institutions to avoid waiting for governments' intervention.

In this regard, institutions such as the Chamber of Digital Commerce[55] (CDC) may be the facilitators for pursuing an alternative route to the digitation of the existing intermediaries.

This kind of institutions can potentially bring together the private sector with the aim of educating it to the use of new technologies, and to bring out the needs and the ideas of each player designing a more comprehensive solution. In other words, the Chamber of Digital Commerce could be the glue for stakeholders and the vehicle for an effective transition toward a new paradigm.

But what is the Chamber of Digital Commerce? It is the world's leading trade association representing the digital asset and blockchain industry. Its mission is to promote the acceptance and use of digital assets and blockchain-based technologies, through education, advocacy and working closely with policymakers, regulatory agencies and industry.

The Chamber of Digital Commerce membership consists of the world's leading innovators, operators and investors in the digital asset and blockchain technology ecosystem, including start-ups, software companies, global IT consultancies, financial institutions, investment firms and law firms[56].

The initiatives and working groups of the CDC are member-driven and reflect the priorities relevant to the blockchain ecosystem. This means that member companies are welcome to initiate

[55] Digital Chamber of Commerce. 2018. Available at: https://digitalchamber.org/

56 Digital Chamber of Commerce. 2018. Available at: https://digitalchamber.org/membership/

new platforms for industry collaboration. There are several initiatives and each one has a specific scope[57]:

- Token Alliance, fostering best practices and frameworks for the responsible issuance of tokens;
- Smart Contracts Alliance, promoting real-world application of smart contracts to enhance the way business is conducted;
- Blockchain Intellectual Property Council, balancing the protection of proprietary information with the openness necessary for innovation;
- Digital Assets Accounting Consortium, developing accounting and reporting standards for digital assets and blockchain-based technologies;
- Global Blockchain Forum, working with the world's leading blockchain policy experts to develop industry best practices and help shape global regulatory interoperability;
- State Working Group, engaging with state and local governments on the regulation and implementation of blockchain-based technologies;
- DC Blockchain Center, Washington DC's entrepreneurial resource for technology providers and governments investing in and innovating with blockchain-based technologies;
- Blockchain alliance, the public-private forum for the blockchain community and law enforcement to help combat criminal activity.

About the Blockchain Intellectual Property Council (BIPC): it is an initiative of the Chamber of Digital Commerce promoting blockchain technology and helping businesses better navigate IP decision-making processes. In a rapidly growing ecosystem which is largely built on open-source technology, but where the protection of IPRs remains a cardinal concern, the BIPC helps

[57] Digital Chamber of Commerce. 2018. Available at: https://digitalchamber.org/initiatives/

businesses in balancing the protection of proprietary information against the transparency required for innovation.

However, many intermediaries fearing obsolescence through technological disintermediation might block the adoption of blockchain aiming at their survival.

In overcoming this issue, third parties have to understand what financial benefits they can derive from technological progress. Indeed, *"The fact that three of the largest collection societies have joined forces to build a blockchain-based solution to simplify licensing demonstrates that even a private and permissioned blockchain can solve some of the industry's problems"*[58].

Managers and companies now need to understand that the blockchain is not disruptive per se, yet it is an enabler of transparency and availability of information.

[58] Music Business Worldwide, 2017. ASCAP, PRS and SACEM join forces for blockchain copyright system. Music Business Worldwide. Available at: http://www.musicbusinessworldwide.com/ascap-prs-sacem-join-forces-blockchain-c opyright-system/

CONCLUSION

At the very beginning, it has been given an overview of the base-line functioning of blockchain and artificial intelligence technologies, so to facilitate the understanding of the topic for the reader in case he or she was not confident with the two discussed technologies.

Secondly, the inefficiencies of the patent market have been analysed:

- Patent thicket;
- Approval of low quality patents;
- Difficult valuation;
- Limited access for small inventors;
- High search costs.

Furthermore, blockchain-based and AI-based solutions have been explored presenting four business cases: PatSnap and Innography for the artificial intelligence solutions, the ORoPO Foundation and the Chamber of Digital Commerce for the blockchain solutions. About the ORoPO Foundation, personal ideas of the author have been exposed as well, consisting in the proposal of an open register based on blockchain technology and inclusive of two additional sets of information:

- Patent statements and commitments;
- Royalty or licencing fees.

Concluding, two main patterns in the application of artificial intelligence and blockchain on the patent intermediation market have been identified. About the former, the application seams easier and already successful. As shown in Chapter 3, PatSnap and Innography can provide inventors with AI-based solutions able of cutting off inefficiencies in the market. About the latter, blockchain has an untapped potential which has not been converted in a practical solution yet. This technology is still in its infancy in terms of adoption and needs to be catalysed to the market through private initiative. Indeed, considering the innovation adoption lifecycle, it should be possible to position blockchain somewhere between the “innovators” and the “early adopters” phase.

SUMMARY

Nowadays, each one of us is surrounded by a multitude of technologies which are the means for sharing information among people and entities; we are living in the so called “knowledge society”. But what does that mean? It means that our lives are affected by information dissemination, circulation and availability in any dimension of it. As an example, businesses and individual innovators face several issues when it comes to intellectual property rights (IPRs) management due to inefficiencies in the dissemination, circulation and availability of information in the market. The market for patents is both highly inefficient and illiquid, featuring a large number of intermediaries involved between idea creators and consumers, which capture significant shares of the value created. Hence, the research question seeking an answer is the following: *Could cutting-edge technologies, such as artificial intelligence and blockchain, reduce inefficiencies in the IPRs’ intermediation?*

On the one hand, blockchain was born in 2008, when an anonymous author – using the false name of "Satoshi Nakamoto" – published the paper "Bitcoin: A Peer-to-Peer Electronic Cash System"[59] disclosing blockchain in the form of a cryptocurrency, thinking that an electronic payment system based on cryptographic proof instead of trust was needed. The blockchain is a distributed ledger based on a network of nodes, which records transactions securing them with cryptographic hashes. The network of nodes manages and verifies transactions without the need of a trusted – or centralised – intermediary and this is probably the most status-changing feature of the technology. It is a disintermediating technology which can validate a transaction, safeguard its process and store the records without involving any central authority, as it would otherwise happen.

The fact that blockchain is designed as a peer-to-peer (P2P) network of nodes with no single point of control means that there is no single party who can shut the system down. Indeed, even if one or several nodes in the blockchain network fail, transactions can be completed anyway.

[59] Satoshi Nakamoto. 2008. Bitcoin: A Peer-to-Peer Electronic Cash System. Available at: https://bitcoin.org/bitcoin.pdf

On the other hand, artificial intelligence focuses on several topics and the general problem of simulating intelligence has been broken down into sub-problems: artificial general intelligence, computer vision, knowledge reasoning, machine learning, natural language processing, planning and robotics. However, just some of these sub-problems need to be investigated for the understanding of this thesis. Where to start from then? The words of Jerry Kaplan, published in his book "Artificial intelligence: what everyone needs to know" in 2016, may be of some help: *"Machines are able to perform lots of tasks that people can't do at all, and many such performances certainly feel like displays of intelligence. A tsunami warning system may sound an alarm based on barely perceptible changes in ocean heights that mirror complex undersea geography; […] The essence of AI — indeed, the essence of intelligence — is the ability to make appropriate generalizations in a timely fashion based on limited data. […] Whether it does so the same way people do, and whether it appears to be self- aware as people are, would seem to be irrelevant."*

By now, machine learning is probably the most discussed field of artificial intelligence and there is a lot of hype around the topic. It attracts people of any kind: academics and professionals, experts and amateurs, IT specialists and non-specialists; this is because learning is an important aspect of human intelligence and it is astonishing how computers can perform something similar. What is the novelty here? The novelty stands in the vast scale – millions of files for learning a task – and the computational techniques that seem to mimic certain aspects of the human brain, giving machines the ability to learn as humans do. Firstly, this new data-centric approach has been applied to all sciences and it goes by several names, most commonly machine learning and big-data. Secondly, the computational techniques that seem to mimic certain aspects of the human brain are called neural networks and they are a specific approach to machine learning. Indeed, *"an artificial neural network is a computer program inspired by certain presumed organizational principles of a real neural network (such as your brain)."*[60]

[60] Jerry Kaplan. 2016. ARTIFICIAL INTELLIGENCE – WHAT EVERYONE NEEDS TO KNOW. Oxford University Press. Available at: https://global.oup.com/academic/product/artificial-intelligence-9780190602390?cc=it&lang=en&

As a matter of fact, the natural language processing (NLP) – which is the ability of processing natural (human) language – did not improve its performances until the machine learning approach arrived. The machine learning approach mainly required access to large computer-readable bodies of text, which are now easily available, avoiding the creation of hand-crafted solutions as AI is able to automatically find correlations between the source and the target examples thanks to the million files analysed during the instruction process, when the machine learns to correlate different texts to the same meaning.

Moving from technologies to IPRS, it is possible to distinguish between three different players in the patent system: patent creators, patent consumers and intermediaries. Patent creators and patent consumers are the two opposites; patent creators are corporations or individual creators who file patents asking for the ownership of their inventions and patent consumers are corporations or individuals who use those patented invention. Due to the illiquidity of the patent market, creators and consumers have frequently to rely on intermediaries to complete transactions.

A controversial intermediation case is the one about patent licensing and enforcement companies, also known as non-practicing entities (NPEs) or "patent trolls". They are patent aggregators yet there is no clear definition of what an NPE is. In its essence, an NPE is a company that holds patents, makes money by using them, but there are no goods produced. NPEs acquire patents in order to license them to others – extracting large fees – or to sue any entity violating their property. NPEs seek for supra-normal returns, hence they are not just taking a cut for themselves while matching demand and supply; they try to skim as much profits as possible instead.

The market for patents is illiquid and inefficient and has been criticized for being far from its full potential in promoting innovation around the globe. Indeed, there are shortcomings and structural inefficiencies in the patent market that are the reasons leading to these illiquidity and inefficiency.

Firstly, the number of patents is increasing at an outstanding pace, creating what is called "patent thicket". The patent thicket is *[...] a dense web of overlapping intellectual property rights that a*

company must hack its way through in order to actually commercialize new technology"[61]. Practically, all the overlapping patented inventions are typically owned by different right holders which makes it very costly for users to license rights or even to make sure that they are not infringing on any existing IP. Patent thickets are a potential barrier to entry because of the creation of high transaction costs for the user. Secondly, many of the patents granted by the PTO are not held valid when subject to litigation, as it happens that patents are granted for innovations that do not meet the requirements of novelty or non-obviousness. This leads to a situation where the market is populated by a large number of economically viable products protected by weak patents as it happened with the "one-click buying" registered by the e-commerce giant Amazon in 1999. Thirdly, patents are more difficult to value than ordinary goods. This is because they are intangibles, they lack comparables as they are, by definition, novel and unique and they are rarely of value in isolation.

Fourthly, it seems that individual inventors and small companies can benefit less from patent markets when compared to bigger firms. While in 2008 about 60% of patents originated from individual inventors, universities, and research labs, this group only received less than 1% of total patent licensing revenue. The remaining 99% of licensing revenue went to large corporations which only filed 40% of all patents.[62] The gap between the two players can be ascribed to the lack of resources and management expertise needed to successfully license or enforce patents by individual inventors and small companies, meaning that costs of litigation are not bearable and that patents rights are difficult to be enforced by them (patent hold-out[63]). Last but not least, both patent owners and patent users face high search costs. For patent owners, it is costly to find out all the current users of their patents and the uses they are making out of it. Indeed, disclosures or access to any idea may allow

[61] Shapiro, Carl (2001). "Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard-Setting" (PDF). In Jaffe, Adam B.; et al. Innovation Policy and the Economy. I. Cambridge: MIT Press. pp. 119–150. ISBN 0-262-60041-2.

[62] Andrei Hagiu and Julian Wright. 2015. Multi-Sided Platforms. Harvard Business School. Available at: http://www.hbs.edu/faculty/Publication%20Files/15-037_cb5afe51-6150-4be9-ace2-39c6a8ace6d4.pdf

[63] Patent hold-out is the practice of companies routinely ignoring patents and resisting patent owner demands because the odds of getting caught are small.

users to expropriate inventions, especially when the patent owner is a small player not able to enforce its rights.

In addition, finding prior art is a resource-intensive process as patent applications only disclose the minimum information necessary to obtain a patent and use broad and vague claims on purpose. In this regard, with the aim of overcoming these inefficiencies, several initiatives are coming to life. Founded by Jeffrey Tiong in 2007, PatSnap is an IP analytic and management platform that empowers even non IP-proficient users to gain crucial insights. PatSnap is probably the most comprehensive innovation intelligence platform available at the moment. Its solutions are based on the massive amount of data contained in its databases (more then 120 million patents) and the deployment of neural networks and data-science techniques for helping R&D professionals and innovators analysing the patent landscape, searching for the state of the art and being given effective search tools together with advanced data presentation. Deep learning algorithms find and visualize meaningful patterns within billions of data points, so to answer questions like: “Which patents should I build on and which should I abandon?”. In other words, PatSnap gives a support in taking difficult decisions related to the cost of opportunity in the IP market.

Given that patents contain both structured data – such as publication numbers – and unstructured text – such as its title, the abstract, claims and visual info – structured data are processed by data-mining and unstructured data are processed with text-mining. In an environment where the number of patents awarded each year continues rising, protecting IP is an ever-growing challenge. Indeed, PatSnap is designed to improve the efficiency of identifying which patents in a portfolio should be licensed, sold, donated or abandoned, by combining insights with out-of-the-box charts and graphs that get to the heart of business questions. This way is possible to expedite any analysis of IP portfolios, and where they fall within an overall patent landscape, which will rapidly uncover the right course of action for each. When research leads to potentially patentable invention, scientists and researchers need to quickly identify whether an idea could be, or should be, protected. By pasting the abstract into the landscaping tool, a researcher can test the idea, verifying whether it stands in a heavily protected area

or not. This gives an indication of patentability without the need for invention disclosure or discussion with a patent attorney. Ideas that appear in relatively 'open' areas can then be pursued through the patent teams as normal, saving time, work and money by only taking forward the more likely ideas.

Talking about concrete use cases, the two most interesting ones are Dr. Eyal Bressler & Co and Perceptron. Dr. Eyal Bressler & Co[64] is an Israeli firm serving domestic and international clients with legal advice in the field of intellectual property, offering a personal service to each client. Before the Israeli firm meets its clients in the first meetings to talk about their technology, the consultants ask them what they do and during the meeting they already have a presentation containing visual presentations of their field of technology. This is because PatSnap has given them more access to tools they have never had before, like the patent portfolio valuation. Professionals from Dr. Eyal Bressels & Co perform searches in a much quicker way, saving valuable time and labour, as typical searches would normally take them about two days versus only five hours using PatSnap.

Perceptron[65] is a company offering an extensive portfolio of dimensional gauging and inspection products along with robotic guidance, gap & flush measurement and 3D laser scanning solutions. Companies rely on Perceptron's metrology solutions to assist in managing their complex manufacturing processes to improve quality, shorten product launch times and reduce costs. At Perceptron, the big challenge is that technology development is incredibly fast nowadays, as the pace has picked up significantly in the last five to six years, but there are not available information about the competition, what IP they have, and what projects they are working on. Indeed, customer product cycles have significantly shortened. For example, in the automotive industry, product lifecycles have shortened significantly while complexity has increased. Because of this, the demand for quick solutions has significantly gone up. Thanks to PatSnap, keeping the pace in this always accelerating industry is easier. As an example, Perceptron's management sets up automated queries to keep track

[64] PatSnap. 2018. Dr. Eyal Bressler & Co – PatSnap customer case study.
Available at: https://www.patsnap.com/customers/dr-eyal-bressler-and-co
[65] PatSnap. 2018. Perceptron – PatSnap customer case study.
Available at: https://www.patsnap.com/customers/perceptron

of patents being filed in target technology areas or applications that have been filed by specific industry players. They track it every fifteen days, generating a monthly report to understand if there is overlap between the product development work they are doing and what is going on in the industry. Technological solutions with a similar goal also come from Innography. Innography is an IP intelligence software for patent owners and innovators which brings high-value IP intelligence to their customers thanks to various solutions. Among the most noteworthy features there are the semantic search (natural language processing) and the proprietary predictive algorithm (artificial intelligence), which can evaluate the strength of a patent. In other words, Innography enables strategic IP portfolio planning, patent buying and selling initiatives, and research targeting strategies designed to maximize the benefits of IP ownership and development.

Innography Explorer is a patent search and analysis tool that allows users to conduct IP research easily to ensure they are efficiently innovating and are first to file. Patents may use vague language, which a narrow keyword search could miss leaving an IP strategy at risk. However, having the ability to conduct a semantic search, finding patents which are relevant to the concepts in a natural language description, could be critical. This way, researchers can enter large blocks of text for semantic searching, patent numbers, keywords, publication numbers, or chemical structures to find highly relevant documents and conduct prior art searches quickly and accurately.

Why is semantic search (natural language processing) so important for patent searching? Semantic search is an essential tool in patent search as it finds hidden patterns in patents claims that keyword search could miss. With semantic search, it is possible to find relevant documents and discover information from the collection of documents without knowing any specific detail of what you are searching for. This is an interesting kind of search which, with patents in particular, helps users finding the full set of relevant documents. Firstly, patents are long-lived assets and documents, terminology changes over time and the commonly accepted terminology can evolve. Secondly, different industries may use different terms and, in the case an interesting patent comes from adjacent industries that use different terms for the same invention, a researcher may not be able to find it.

Thirdly, many patent filings are translated from other languages to file in multiple patent offices, giving rise to different terms than expected. Fourthly, some patents have misleading verbiage as patent filers may use terms that obfuscate the technology aiming that the patents will not be discovered by the usual keyword searches. As a result, relying only on keywords to search patents is highly risky as the final aim of patent searching is finding all relevant patents, without missing any of the relevant ones. Innography's semantic search uses advanced numerical algorithms to examine the word frequency, sequencing and patterns to detect the author's intent. As a result, semantic search can find patents that use different keywords than expected, saving hours of time thinking about all the keyword phrases to be used.

Innography's PatentStrength® is a proprietary algorithm which can predict patent value by determining the likelihood that a patent will be litigated. The software analysis of the patent strength was born with the aim of helping managers when they are pressed for time or controlling costs. Indeed, having an expert read for each patent can be something not affordable or out of budget, but using the PatentStrength tool, top patents in any portfolio can be identified and fully examined cutting time and costs – drastically shortening the process of valuation. The patent analysis software is designed for evaluating a patent portfolio, such as one that is available for purchase. If company A is taking into consideration the acquisition of a patent portfolio from company B, the algorithm will provide guidance on whether or not to pursue a particular portfolio, assessing its overall quality.

But, how what has just been said about PatSnap and Innography impacts the five intermediation inefficiencies? About the patent thicket, the landscapes produced by PatSnap and the mapping provided by Innography, show to inventors which are the technology areas with the most number of patents filed, indicating the markets with no thicket as the markets to file in. Thanks to the massive datasets and the use of artificial intelligence for the processing, cleansing and understanding of the natural language describing the inventions, both solutions could reduce the approval of law quality patents if they were used by patent examiners during their daily activities. The natural language processing would impact the quality of the SOA search reducing the risk of bad patents approval. In

addition to that, the predictive algorithm by Innography could test the patent strength before final validation. Moreover, both PatSnap and Innography provide tools that are easy to use – no training is required – and run as web applications, meaning that potentially any inventor, small or big, can use these services, improving the accessibility to the patent market for small players.

Technology is not the only one driver for growth, private initiative is fundamental too. The OROPO Foundation[66] – Open Register of Patent Ownership – is a foundation which aims at directly reducing the high search costs implementing a global database of patent ownership verified by companies committed to openness and transparency. In a few words, each company contributes to an open register submitting the information about their own patent portfolio, updating the data in case a patent is sold or licenced, making possible to creating an up-to-date register of who owns which patents. ORoPO's mission is to improve transparency and openness around patent ownership data, including verified details of patents owned by organizations in the database.

Patent ownership data accuracy is a ground problem worth solving, as the information about who owns which patents should be considered as an infrastructure for the market. It is clear how the marketplace would work most effectively in an environment of transparency able to enhance inventors and innovators of making smarter investments, creating jobs and driving economic growth. On top of that, as Michelle Lee, Director of the USPTO, stated: *"The economic benefits of greater ownership transparency are truly international in scope; the more awareness there is of the technologies out there, the more cross-licensing opportunities there are across borders"*

Unfortunately, no-one can be sure about who owns the world's patents, and this gives rise to an issue: without clear ownership information, the full value of intellectual property will not be realised, as innovation is the starting point for technological progress and patents sit at the epicentre of the economical exploitation of this process.

[66] ORoPO Foundation. Official website available at: http://oropo.net/

Various estimates from reliable sources, including an assessment made by Yo Takagi, an Assistant Director-General at WIPO, and David Kappos, former Undersecretary of Commerce for Intellectual Property and Director of the US Patent and Trademark Office, suggest that as much as 25% of the world's patent ownership data may be inaccurate. On the same line 78% of corporate executives think the information from public patents' registers is neither accurate nor reliable[67].

As Roger Burt, formerly Head of patents for IBM Europe, put it *"If you don't trust the register, why would you approach someone for a patent license? The true owner might be a friend, might be an enemy, or might be someone you are already in litigation with. Better data would enable more informed decisions but in the meantime, if you don't know, you have to assume the worst."*

Hence, a negative effect is due to the absence of a reliable register, containing up to date information about who owns which patents.

The need to resolve the issues related to patent ownership is pressing. This problem may be framed as a matter for policy makers and, eventually, that is true. However, the issue with waiting for a policy maker-led solution is related to complexity and timing. The complexity of this issue asks for the intervention of dozens of governments, and their patent offices, to agree on a common solution to be universally undertaken and implemented. Hence, here comes the question: how long could the IP intermediation market wait for the definition and implementation of a common solution?

The ORoPO Foundation proposes a simple and efficient solution, which is actually a market self-help. It proposes to implement a free and global open register to sidestep the complexities and obstacles associated with regulatory approaches, decreasing the efforts needed to solve the inefficient context. ORoPO can be a game changer in the collection and distribution of patent information, potentially helping thousands of companies get the most from their intermediation activities. Thanks to ORoPO Foundation, more companies could make informed decisions about buying, selling and/or licencing intellectual property rights, fostering innovation and creating economic value for the players

[67] ORoPO Foundation. 2015. Who owns the world's patents?
Available at: http://oropo.net/oropo_report_20150615.pdf

in the market. By now, the mission of ORoPO is to help companies and intermediaries providing them with a free and global open register, but this solution could be improved by collecting a wider set of information about IPRs and implementing the register using blockchain technology.

Firstly, the author's proposal is to move from a solution where the only one shared information is who owns which patents to a solution where the register gathers: who owns which patents, patent statements and commitments[68] and royalty or transaction fee. The "patent statements and commitments" section is about collecting all the commitments from IP owners about their renounce in claiming economic returns from their IPRs, in the case they are exploited by a certain kind of company or for a certain use – let us say small companies and NGOs.

One more suggested addition is the "royalty or transaction fees" section. Its addition would be fundamental for creating a sort of comparabales' database. This way ORoPO could provide historical data about past transactions while describing which is the current supply side expectation. Obviously, everyone is aware that each patent has a specific value depending on several factors, i.e. the portfolio or the market it is inserted in, however owning the information about market prices would at least be helpful as descriptive.

Secondly, it is suggested to develop the register using the blockchain technology, with the aim of obtaining a non-centralized, up-to-date solution, potentially relying on various architectures:

- Permissionless: any participant could update the chain;
- Permissioned: only the authorised members can update the chain.

Second:

- Public: anyone can read and submit transactions on the chain;
- Private: the permission of reading and submitting information is restricted to a group of users.

According with these possible configurations, ORoPO should never be the central authority of the register, instead, it should identify the companies – its representatives – and authenticate them.

[68] Inspired by the "Non-SDO Patent Statements and Commitments" from the Washington College of Law. Available at: http://www.pijip.org/non-sdo-patent-commitments/

Once companies have been authenticated they should be able to access the register having the possibility of updating the data at any time, depending on the level of authorisation they have been given.

Relying on the blockchain, the solution delivered would be easier to manage as soon as it will get bigger in terms of participants filling in information.

As final point, a remark has to be made: the technological migration proposed for the ORoPO Foundation must happen in an environment which is characterised by the leadership of private entities. This technological shift calls for the initiative of corporations and other private institutions to avoid waiting for governments' intervention.

In this regard, institutions such as the Chamber of Digital Commerce[69] (CDC) may be the facilitators for pursuing an alternative route to the digitation of the existing intermediaries. This kind of institutions can potentially bring together the private sector with the aim of educating it to the use of new technologies, and to bring out the needs and the ideas of each player designing a more comprehensive solution. In other words, the Chamber of Digital Commerce could be the glue for stakeholders and the vehicle for an effective transition toward a new paradigm.

But what is the Chamber of Digital Commerce? It is the world's leading trade association representing the digital asset and blockchain industry. Its mission is to promote the acceptance and use of digital assets and blockchain-based technologies, through education, advocacy and working closely with policymakers, regulatory agencies and industry.

The Chamber of Digital Commerce membership consists of the world's leading innovators, operators and investors in the digital asset and blockchain technology ecosystem, including start-ups, software companies, global IT consultancies, financial institutions, investment firms and law firms[70]. The initiatives and working groups of the CDC are member-driven and reflect the priorities relevant to the blockchain ecosystem. This means that member companies are welcome to initiate new

[69] Digital Chamber of Commerce. 2018. Available at: https://digitalchamber.org/

70 Digital Chamber of Commerce. 2018. Available at: https://digitalchamber.org/membership/

platforms for industry collaboration. Among the other initiatives they have the "Blockchain Intellectual Property Council" (BIPC), balancing the protection of proprietary information with the openness necessary for innovation. The BIPC is an initiative of the Chamber of Digital Commerce promoting blockchain technology and helping businesses better navigate IP decision-making processes. In a rapidly growing ecosystem which is largely built on open-source technology, but where the protection of IPRs remains a cardinal concern, the BIPC helps businesses in balancing the protection of proprietary information against the transparency required for innovation.

However, many intermediaries fearing obsolescence through technological disintermediation might block the adoption of blockchain aiming at their survival. In overcoming this issue, third parties have to understand what financial benefits they can derive from technological progress. Indeed, *"The fact that three of the largest collection societies have joined forces to build a blockchain-based solution to simplify licensing demonstrates that even a private and permissioned blockchain can solve some of the industry's problems"*[71].

Managers and companies now need to understand that the blockchain is not disruptive per se, yet it is an enabler of transparency and availability of information.

[71] Music Business Worldwide, 2017. ASCAP, PRS and SACEM join forces for blockchain copyright system. Music Business Worldwide. Available at: http://www.musicbusinessworldwide.com/ascap-prs-sacem-join-forces-blockchain-copyright-system/

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