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Blockchain technology and IP – investigating benefits and acceptance in governments and legislations

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Abstract

The blockchain, as underlying technology of Bitcoins, has implications that reach far beyond the original intent as virtual currency. In this paper, we investigate how blockchain technology can be encompassed in the innovation process and bring huge benefits to the patent system as well as copyrights, trade secrecy, defensive publications, and open innovation. We further explore the institutional support for the technology necessary for a successful implementation, in form of legislations and governmental projects. We find out that numerous authorities have started voting favorable legislations and recognizing the technology as a valid public ledger. Ultimately, we confirm our findings by interviewing three actors involved in the innovation process.

Keywords: Bitcoin, Blockchain, Intellectual property, Legislation, Innovation

1. Introduction

"Virtually all of the economic growth that has occurred since the eighteenth century is ultimately attributable to innovation." (Baumol (2002)), and innovation is the "basis for progress and evolution in all areas of human endeavor" (Granstrand (2003)). It is, therefore, critical for a society to promote innovations. The challenge lies in the creation of an institutional system incentivizing creators and innovators sufficiently while guaranteeing that the community also benefits from their efforts as a whole. Grandstand notes that there are various institutional means to encourage innovation, in the form of social recognition and of monetary rewards. Today, however, many of these methods are subject to issues and demonstrate inadequacies regarding modern developments, failing to provide an appropriate framework to encourage and support innovations. In this context, the rise of the distributed, resilient and transparent blockchain technology could potentially have huge beneficial impacts. The technology being in its early phase, with only few understanding its underlying mechanics and many wary of its trustworthiness, its success will depend on many factors, among which governmental and legislative support could play a central role. Which benefits can be expected from blockchain technology, and what measures are taken by governments and legislators to foster its acceptance? In this paper, we explore the question by introducing the intellectual property system and the possible strategies it provides for companies. Next, we investigate the problems and inefficiencies related with this, summarizing the actual state of discussion. Subsequently, we introduce blockchain technology with the example of Bitcoin and inspect its potential use. Afterward, we summarize all governmental and legislative initiatives which are fostering the acceptance and trust necessary for the technology's success. Finally, we will discuss these findings with the help of interviews designed to compare the theory with practical experience.

2. Intellectual property and its limits

2.1. The intellectual property rights system

One of the oldest institutional incentivizing systems is the intellectual property rights (IPRs) system. Broadly speaking, intellectual property refers to "unique, value-adding creations of the human intellect that result from human ingenuity, creativity, and inventiveness." (Kalanje (2006)). The central objective of intellectual property laws is to "promote progress [...] by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries" (U.S Cons). In other words, innovators are granted a right by the government to exclude others from using the innovation commercially. In exchange for

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this monopoly, the invention must be made public, allowing society to benefit from the innovation, too. After the protection expires, the invention can be used, built on and improved. Intellectual property takes many forms such as patents, trademarks, trade secrets, copyrights and design rights, which despite the common term form a highly heterogeneous set with differing prerequisites and associated rights.

2.2. Intellectual property and innovation strategies

In addition to the strategic options directly derived from the actual property rights, such as patent applications, design or trademark registration and copyrights, several other complementary or alternative strategies exist for innovators in the context of IP and innovation.

2.2.1. Trade secrets

A straightforward approach is secrecy. This method can be motivated by various factors: the innovation may not fulfill the requirements to be patentable or the innovator may want to avoid making the invention public, which is one of the requirements for a patent grant. Another reason can be the will to circumvent the "considerable monetary and opportunity costs" (Henkel et al. (2008)) related to patenting. In some technological fields characterized by numerous incremental inventions, for example, it may not be possible to patent every step of the process, making the patent system ineffective in this kind of context. An ideal candidate for secrecy is an invention that involves a high degree of complexity and a low chance of being discovered independently by a competitor (Barrett (2002)), but an independent invention can never be excluded. The main risk, hence, comes from a competitor inventing the same technology and choosing to patent his invention. Since most patent systems are based on first-to-file and not first-to-invent concepts, this can lead to litigations through the patentee holding the rights to the similar technology, essentially making the secretive innovator an infringer and legally barring him from using his invention. Fortunately, the patent legislations in many countries including members of the European Union, Japan, Canada, Australia as well as the United States contain a defense to patent infringement based on earlier invention and use, also known as "prior use defense" (Kappos and Rea (2012)). To qualify for a prior use defense, a few requirements must be met, restricting the use of prior use defense to qualifying prior use activities by a qualifying prior user in a qualifying time period at qualifying locations (Kappos and Rea (2012)). Kappos and Rea compared the requirements in different countries: Qualifying prior use activities range from prior commercial use to mere possession of the invention, with many of the studied countries applying a hybrid approach. The preparatory works for the utilization of an invention are also a qualifying activity in many legislations (World Intellectual Property Organization, 2014). In most countries, a qualifying prior user can be anyone who acquired the invention before the patent application filing date in good faith, with the exception of Russia, whose law requires the prior user to be the inventor. The third requirement, the time of prior use, is also consistent in most countries: prior use must take place before the earliest date of patent application filing. In the United States, the prior use must precede the application by at least one year. Finally, most countries stipulate that the prior use must take place inside of each respective national border to be valid. If these criteria are met, the prior user has a right to the continuation of the exploitation of the invention, as long as the scope of the activity is not extended. Even though the effect of prior use defense on innovation is not well researched, Shapiro (2006) noted that "awarding one inventor a patent and the other the right to use the invention has very attractive properties." He concluded that competition as well as innovation benefit from such laws. Maurer and Scotchmer (2002) add that "the independent invention defence reduces entry into the race, and thus reduces wasteful duplication."

2.2.2. Defensive publication

Another approach is defensive publication. It can be considered when the invention does not qualify for secrecy, for example: if the invention is self-evident and can easily be reverse engineered, and if the costs of patenting outweigh the benefits. Another reason can be identified in the risks associated with trade secrecy, such as involuntary leaks (Mansfield (1985)). As the name suggests, the strategy consists of disclosing the details of an invention, effectively making it publicly available. One of the main requirements for a patent grant on an invention is that the invention must be new since the objective of the patent system is to promote progress. To verify if an invention is new, it is measured against the prior art publicly available. The prior art contains all information which was made public at anytime, anywhere and in any way before the patent application. Defensive publications hence qualify as prior art and render it impossible for competitors (as well as the original owner of the intellectual property) to get a patent on the published invention. Here again, timeliness plays a central role: for example, legislations in individual countries such as USA, Australia, South Korea, Canada and a few others specify a year-long grace period. In effect, a publication only counts as prior art if it was published 12 months before the invention. It can prove to be a serious challenge to ascertain whether a disclosure has been available for more than a year. The capability to undoubtedly prove the exact time of publication can be the decisive element settling a lawsuit – or invalidating a patent. Theoretically, defensive publications bear massive potential: for the inventor, it guarantees freedom to operate, identified as "the fundamental precondition for appropriation [of value from inventive activity]" by Henkel et al. (2008). Furthermore, the entire society benefits as the invention becomes public, remains unprotected and can thus be used and improved by everyone.

2.2.3. Open innovation

A radically different approach is called open innovation. The father of open innovation describes it as "the antithesis of the traditional vertical integration model" (Chesbrough

(2006)). As he puts it, it is an approach stipulating that firms can and should use external ideas and combine them with their own to generate synergies for value creation, and that internal ideas and developments can be effectively applied outside of the firm's market. It hence represents a big step away from traditional IP management, where progress is promoted by the creation of monopolies and exclusive rights, giving only one firm the advantage over all others. While this approach can be beneficially combined with legal exclusion rights, in which case the firm gives up secrecy without waiving its rights on the published information (Arora et al. (2001)), open innovation can be even more valuable when legal protection is abandoned (Chesbrough and Appleyard (2007)), what Henkel (2006) calls "selective revealing". In that case, a firm may choose to make its technology publicly available to foster collaboration but without any guarantees to obtain it. A recent example that received much attention is the electric car maker Tesla releasing all its patents to the public. In a blog post called "All our patents are belong to you" published in 2014, CEO Elon Musk, "in the spirit of the open source movement", declares that "Tesla will not initiate patent lawsuits against anyone who, in good faith, wants to use [their] technology[1]." He describes patents as tools slowing down progress and reinforcing monopoly positions of large enterprises. Despite the altruistic justification of the decision, others were quick to point out the potential benefits that could flow out of this decision in favor of Tesla: higher share in the market for fast charging standard, increased demand for batteries (of which Tesla is a major producer), more efficient partnerships with companies building on top of Tesla technology and attraction of high performing employees thanks to the positive image of the company (Musille (2015)).

2.3. Problems of today's IP system

Despite the objectives mentioned above and the theoretical advantages of IP rights and strategies, the system is plagued by several problems, ambiguities, and disadvantages.

2.3.1. The internet and copyrights

Works covered by copyrights "range from books, music, paintings, sculpture, and films, to computer programs, databases, advertisements, maps, and technical drawings[2]", making them a very pertinent topic for creativity and innovation. However, they face the problem that "internet technology is developing faster than the laws who govern it[3]." Fraud and art forgery can be as easy as "copy and paste" nowadays (Boucher et al. (2017)). Torrents and streaming made piracy commonplace while legislations struggle to adjust. While uploading a copy of copyrighted content on a website is illegal and punished by law, streaming often is not. Article 5(1) of the EU Infosoc Directive (2001/29/EC) stipulates that "[t]emporary acts of reproduction (...) which are transient or incidental and an integral and essential part of a technological process (...) shall be exempted from the reproduction right." In June 2014, in the context of the Case C-360/13 Public Relations Consultants Association v Newspaper Licensing Agency Ltd, the Court of Justice of the EU ruled that any transient copies that are created as a result of browsing a website fulfill the conditions required for the Article 5(1) exception to apply[4]. Any contrary ruling would have made web browsing illegal in the EU[5], but that decision also effectively made streaming legal. Copyrights are supposed to "confer on the author non-economic rights (i.e. moral rights such as the rights of paternity) and also economic rights such as the right to get fair remuneration (i.e. copyright fees) for the use of their work." (Madiega (2016)) Hence it is evident that this status quo can be problematic, with the ruling making it legal to violate both rights conferred by copyrights. While several lawful services remunerating artists, such as Netflix and Spotify, are gaining in popularity, the remuneration remains meager. McCandless (2015) showed that the revenue of an artist on Spotify is 0.0011$ per play. Furthermore, unregulated streaming services stay vastly popular, with 57.8 billion visits to streaming sites in 2015, according to MUSO's 2016 Global Film & TV Piracy Market Insight Report. The copyright system is in arrears.

2.3.2. The patent system

Boucher et al. (2017) summarize many well-known problems of the patent system. Competitors can sometimes exploit the inventions (which must be made public at least 18 months after the patent application) before the innovator because the patent was not strong enough or because he was not capable of defending the patent against infringements. Coupled with the high costs that can be occurred by related attorney fees and patent searches (which can amount to more than $20.000 according to Quinn (2015), this can prompt a lot of innovators to avoid the patent system altogether. Another problem identified by Boucher et al. is the complexity of the patent systems. There is no unified patent system, and legislations can differ significantly between countries. One relevant example is the grace period, mentioned above, that does not exist in most European patent laws (it was removed from the German legislation in 1968). A worldwide patent protection is virtually impossible to achieve, be it merely on account of the associated costs which can be estimated to $1.000.000 for filing and issuance in each country and another $1.000.000 to maintain the patent to its full term, per Marks (2016). Furthermore, a raising issue is the emergence

[1] https://www.tesla.com/blog/all-our-patent-are-belong-you retrieved 12.03.2017

[2] http://www.wipo.int/copyright/en/ retrieved 28.03.2017

[3] https://ucomm.wsu.edu/the-internet-copyright/ retrieved 28.03.2017

[4] http://curia.europa.eu/juris/liste.jsf?num=C-360/13 retrieved 28.03.2017

[5] http://copyright4creativity.eu retrieved 15.03.2017

of "patent trolls". Patent trolls are defined as "companies that obtain the rights to one or more patents in order to profit by means of licensing and litigation, rather than by producing their own goods and services"[6]. These non-practicing entities (NPE) highjack the original objective of the patent system of promoting progress by not only failing to use them to innovate, but also by preventing others to do so. According to Muller (2015), 90% of high-tech patent suits in the first half of 2015 were filed by non-practicing entities. Even when their claims do not necessarily hold firm legal grounds, many innovators accused of infringement prefer to settle out of court due to lack of necessary funds to cover legal expenses, with median costs of $650.000 for a $1.000.000 claim according to the 2011 Report of the Economic Survey from the American Intellectual Property Law Association[7]. While the European competition authorities are reportedly "investigating high-tech companies to make sure they do not abuse their rights, granted through patents, to disrupt fair competition" (Madiega (2016)), no tangible decision has been taken by any European institution on the matter. Meanwhile, in the United States, the H.R.9 Innovation Act was introduced February 5, 2015 by Rep. Goodlatte with the goal of creating additional requirements as part of the legal process associated with patent infringement in the United States, but was never enacted[8]. U.S. Sen. Leahy (2014) commented on a previous introduction of the Innovation Act that "there has been no agreement on how to combat the scourge of patent trolls on our economy without burdening the companies and universities who rely on the patent system every day to protect their inventions."

One possible way to defend against patent trolls is the prior use defense, but it is apparent this defense is not optimal, either. In the United States for instance, despite the America Invent Act, enacted end of 2011, "significantly expanding the scope of the prior use rights defense", the prior use defense remained mostly unused four years later (Nixon (2015)). Only three cases were reported in which the defense was used. Among the different possible reasons for this unpopularity, the defendant's "additional burden of showing its commercialization of the invention at least one year before the filing date of the patent" (Kim (2012)) is brought forward: "As the burden of proof for establishing the prior user rights defense falls on the prior user who is asserting the defense, by clear and convincing evidence, it may require more effort and increased record keeping on the part of the prior user to assert this defense." (Kim (2012)) Despite the record number of patent litigation cases generated by patent trolls, for which the prior use defense appears like one of the most straightforward defenses, companies are reluctant to use it to their advantage. With no reliable and simple way of proving the exact time and instances of use (in this context, "laboratory notebooks often play a central role, but are very problematic both in terms of completeness and of reliability" (Henkel et al. (2008))) the risk associated with the burden of proof might deter the companies.

2.3.3. Defensive Publication: no reliable platform

A defensive publication should ideally serve two purposes. Firstly, it should guarantee the publisher's freedom to operate by preventing any competitor to get a patent on the invention. Secondly, by being public, it should benefit society by enriching its scientific and technological knowledge base. A defensive publication must, therefore, fulfill certain criteria to reach these goals effectively. The most critical criteria are: form (the publication should be as complete as possible for others to understand and use it), accessibility (in particular, it should be published somewhere accessible by competitors in the same field, as well as the patent office), unambiguous publication date (especially relevant due to the grace period legislations) as well as proof of existence (it is not sufficient for a document to be published at a certain point, it must stay published reliably). Most private places of publication fail to guarantee most of these requirements. A company's website, for example, may be accessible by competitors, but won't necessarily be searched by the patent office during the prior art research, does not have an unambiguous publication date, since it can be edited, and there's no way to prove the document was always accessible since its publication (or remained the same). A workaround for the last two criteria used by the patent office is the "Internet Archive: Wayback Machine[9]", a non-profit digital library that relies on donations to save "snapshots" of the current states of websites since 1996. It is a very rudimentary and unreliable method that potentially disadvantages everybody involved. For some time, IBM offered a suitable solution: the IBM Technical Disclosure Bulletin started in 1958 as a proprietary platform on which IBM published every invention they did not want to patent. It soon became a go-to platform for many innovators who wanted to publish their inventions, for those seeking access to technical details of published inventions as well as for patent office personnel in search of prior art. According to the Delphion (2006), the bulletin has been cited over 48.000 times in various U.S. patents. IBM abandoned the bulletin by 1998. Since then, the only alternative worth mentioning is the platform IP.com, which describes itself as the "first and largest online prior art disclosure service and the only one publicly available, searchable by patent examiners, inventors, and patent attorneys [...] around the world" (Intellectual Property Software). The organization also claims that since 2005, there have been 338 patent rejections as a result of prior art found in their database by examiners. While the platform seems to guarantee freedom to operate to those using it to publish inventions, its biggest drawback lies in the

[6] https://en.oxforddictionaries.com/definition/patent_troll retrieved 21.03.2017

[7] http://www.patentinsuranceonline.com/wp-content/uploads/2016/02/AIPLA-2015-Report-of-the-Economic-Survey.pdf retrieved 21.03.2017

[8] https://www.govtrack.us/congress/bills/114/hr9/ retrieved 21.03.2017

[9] https://archive.org/web/ retrieved 17.03.2017

fee required to access any publication, of which the entirety goes to IP.com and not to the inventor. This feature highly hinders the second aspect of defensive publication, public benefit. Furthermore, the platform is privately and centrally controlled and therefore censorable, since each publication must be accepted by IP.com individually, and vulnerable to tampering and loss of data.

2.3.4. Open innovation: lack of coordination, ethics, and structure

Open innovation is still considered by many as an uncertain and risky business. Two major concerns are the lack of coordination among disparate groups of people and trust issues midst actors that did not engage in sufficiently frequent and repeated interactions (Filippi, as cited by Bollier (2015)). The free rider problem and tragedy of the commons quickly arise and tarnish the optimistic vision of a mutually beneficial cooperation. Why share a technology when one can benefit from everyone else for free, in all impunity? This risk causes demotivation, ineffectiveness, and inertia (Alliance for the open innovation, as cited by Seulliet (2016)). Competition between individuals is a natural phenomenon, and "collective intelligence and cooperation are not easy to bring about" without a system "for recognizing individual contributors" (Seulliet (2016)). In that sense, even though open innovation is an approach that aims to bypass the centralized and institutionalized IP system approach, it still lacks a basic structure to make it effective. Furthermore, ethical problems arise when firms engage in open innovation by involving the community for free. In her book Le travail du consommateur, Dujarier (2014, as cited by Seuillet) pointed out how this "phenomenon of pseudo co-creation results in an uptake of the value created by individuals." Seuillet takes the example of recent discussions about the unfair distribution of value among stakeholders involved in the Uber platform, whose drivers' operating conditions sparked controversies.

3. The potential of Bitcoin and the Blockchain Technology

3.1. Introduction to Bitcoin

Even though the most relevant part of Bitcoin in the IP context is the underlying blockchain technology, it is critical to understand the profound connection between the Bitcoin currency and the technology, as Ølnes (2016) put forward. "One cannot exist without the other." Even though, as we will see, the blockchain technology has various usages that transcend the original intent, such as in IP management, the currency represents a central element in the safeguarding of the entire system's security and functioning.

3.2. Historical context

Bitcoins were unveiled in the white paper "Bitcoin: A peer-to-peer electronic cash system", published in 2008 on the cryptography mailing list at metzdowd.com by an anonymous person or group of persons under the pseudonym Satoshi Nakamoto. Nakamoto (2008) mentions the two-fold problem of today's e-commerce's exclusive reliance on financial institutions, serving as middlemen for transactions, as motivation for the development of Bitcoins: firstly, it is a model reliant on trust in intermediaries, and secondly, intermediaries raise the cost of transactions.

The most relevant issue at the heart of Bitcoins is the trustworthiness of said intermediaries, on which we will focus. In 2008, during the financial crisis, the traditional world banking system almost collapsed and had to be rescued by governments (Guadamuz and Marsden (2015)). After banks had begun selling worthless loans (subprimes), governments bailed the bankrupted banks out by printing money, creating inflation and effectively stripping the population of the value of its savings, while most victims of the crisis were left to their own devices. Bollier (2015) highlights that even the trustworthiness of "reputable" third-party guarantors such as the Securities and Exchange Commission, rating agencies and other oversight authorities can be problematic: "Who guards the guards?". Today, 9 years later, the U.S. federal bank announced that 15 billion new dollars would be printed and put into circulation per month in 2017[10], in addition to those replacing old notes, raising the inflation back to 2,5% in January 2017[11].

3.2.1. Broad technical explanation

The reason a central institution is needed in the traditional online transaction system is the so-called double-spending problem: as opposed to physical cash, virtual money can be duplicated, and without anyone keeping track of the transactions, anybody could pay multiple receivers the same money, hence the intermediaries in the traditional arrangement who check every transaction. Despite several proposals for alternative e- money, no sound method had been found to solve this central difficulty, until Nakamoto presented a "solution to the double-spending problem using a peer-to-peer distributed timestamp server to generate computational proof of the chronological order of transactions."

The first of Bitcoin's aspects that is important to understand, despite what the name suggests, is that there exists no actual Bitcoin "coin", just "unspent transaction outputs" (Narayanan et al. (2016)). Each actor in the ecosystem has a private key (usually a 256-bit number). Private keys are unique, unforgeable and are each associated with a public key, that can be distributed. This public key can be used to verify if a transaction has been signed with the associated private key and hence "identifies" every actor in the system. In other words, anyone with actor B's public key can verify if B was the one who signed the transaction but only B can sign it (with his private key). A coin is consequently defined as a "chain of digital signatures" (Nakamoto (2008)). Each owner can transfer a coin by digitally signing a previous transaction

[10] federalreserve.gov retrieved 10.03.2017

[11] tradingeconomics.com retrieved 10.03.2017

he received (with his public key as recipient) and the public key of the next owner, and adding this information to the end of the coin. Each payee can verify the chain of ownership by checking the signatures.

While this defines what bitcoins are and how transactions are processed, this approach alone does not solve the double spending issue: a previous owner could have signed an earlier transaction, spending the received output. The problem is solved by the innovative blockchain structure introduced by Nakamoto.

Each transaction is publicly broadcasted on the bitcoin network, a peer-to-peer network composed of nodes. New transactions are grouped into blocks, which in turn are again publicly distributed with a timestamp that proves the data has existed at a certain time. Each timestamp includes the timestamp of the previous block as well as a reference to it, forming a chain of blocks, each one reinforcing the validity of the one before. This creates a single chronological history of all transactions in the order in which the network received them. A transaction is only accepted if the owner did not already spend the output in a previous transaction saved in the blockchain. This theoretically provides a solution to double-spending, but a malevolent entity could still hypothetically alter the blocks retroactively.

The bitcoin ecosystem uses a proof-of-work (PoW) approach to make the blockchain tamperproof and therefore guarantee its validity. As explained by Nakamoto, PoW involves "scanning for a value that when hashed, such as with SHA-256 [a hashing function developed by the NSA], the hash begins with a certain number of zero bits [bits equal to zero]." A hashing function is a function that converts any input of any length into a unique output of fixed length (64 bits in the case of SHA-256). The main specifications of such a function are that small alterations in the input lead to big changes in the output, two different inputs never produce the same output, and it is impossible to reverse the function: for a given output, the original input cannot be computed. In the case of PoW, this means that the only way to satisfy the required number of zero bits in the output is brute force: trying millions of inputs until one is found, called nonce, that produces a fitting output. It, however, remains very simple to verify if the found nonce is valid. This nonce is a prerequisite to creating a block of transactions. The number of zero bits required, which represents the difficulty of creating a block, can be adapted depending on what the hash rate is in the system (in other words, depending on how much total CPU power is used by the network to try to find a fitting nonce). In Bitcoin, this number is dynamically adapted so that a nonce is found and a block is added to the chain every 10 minutes on average. Once a block of transactions has been created with a valid nonce, it is impossible to modify its content without redoing the work of finding the nonce. As blocks are added to the chain after the block, the work necessary to alter the block includes redoing the work for all subsequent blocks. Moreover, a copy of the chain of blocks is saved on every node of the network, all agreeing on one single public history. In this way, the blockchain is tamperproof, and consequently, trust is created. Note that the technology is called trustless because no third-party is required; the trust lies in the software only (Ølnes (2016)).

The last challenge is motivating participants to search for a valid nonce: brute force searching requires a lot of CPU power – as of March 2017, the Bitcoin hash rate is approximately 3,5 million of Tera-hashes per second, meaning that every second, 3,5*1018 different hash function inputs are tested, a number which is exponentially growing. This activity could lead to an energy consumption equivalent to Denmark's by 2020 (Deetman (2016)). Naturally, this kind of energy consumption has huge costs, but without it, the entire system would collapse, which is why an incentive is built into the system, commonly named mining. Each created block contains a special transaction with no input and with an output that points to the public key of the miner. Since the transaction contains no input, the output coins are "created" and added to the network. The mechanism is analogous to gold miners retrieving new gold and adding it to circulation, hence the name. It is what incentivizes miners to invest CPU power into mining. The number of new bitcoins created in each block is programmed to decrease over time until the total number of bitcoins reaches 21 million. This way, inflation is avoided.

Finally, it is important to mention that the bitcoin network is permission-less: anyone with an internet connection can join for free and broadcast their own and other's transactions across the network. All this makes the blockchain technology a decentralized public ledger of transactions on a network that is secure, tamper-proof, timestamped and easily accessible.

3.3. The potential of Bitcoin in the IP system

As Swan (2015) points out, the technology behind the cryptocurrency provides two key functions which can be applied and are highly useful in the IP system: hashing and secure timestamping. As explained, the hashing algorithm outputs a short string for any input. Since, per definition, the algorithm is collision-free, meaning no two different inputs can produce the same output, the input can be uniquely and unequivocally identified by its hash. Since the hash function is not back-computable, the file remains private, but every document, genome file, video or any other format can this way be compressed enough to be included in a bitcoin transaction, giving it the additional benefit of the system's incorruptible timestamp. Since a document's hash can easily be computed by running the hash algorithm, the timestamped hash can be compared with the hash of any document to prove that this document existed then, essentially creating an unambiguous proof of existence. Combined with the other characteristics of the blockchain such as low transaction costs (49.720 satoshi ($0,48) for the median transaction[12]), the blockchain's decentralized and distributed na-

[12] https://bitcoinfees.21.co retrieved 19.03.2017

ture, its reliance on mathematics instead of trust, its immutability as well as its transparency (with every transaction and content of transaction publicly available), the technology creates a permanent and public way to cost-efficiently record information and to prove its existence.

Another highly promising aspect of the blockchain is the smart contract concept. Smart contracts are technically enforced on the blockchain instead of the traditional legal enforcement by laws or courts of arbitration (Narayanan et al. (2016)). They define the rules and penalties around an agreement and automatically enforce those obligations. Note that the Bitcoin system is not the most powerful environment in that regard and other blockchains introduced later, such as Ethereum, provide better support for it. This paper, even if it focuses on Bitcoin as the most robust and secure platform, doesn't exclude the potential of other blockchains. Ethereum, being Turing-complete, makes it possible to specify any functionality specifiable on any other computer (Narayanan et al. (2016)), making the range of use cases in IP and beyond virtually unlimited.

3.4. Tangible use cases in IP

3.4.1. Copyrights

Blockchain technology can help creators capture the value they create by introducing the concepts of authenticity, condition, and ownership until then missing online (Tapscott D. (2016)). The Berlin-based startup Ascribe[13] lets artists "lock in attribution, securely share and track where [the] digital work spreads", solving the copyright version of the double spending problem. Promising solutions have started emerging in the troubled music industry, as well: the dotBlockchain project aims to replace traditional music formats such as MP3 and WAV with a new format (.dc) incorporating minimum viable data, which is metadata about who owns the song, who has the right to sell it, to play it, among others. This information would be stored on the blockchain and could be combined with smart contracts, offering functionalities such as restricting playback to legitimate owners only, or executing royalties and licensing agreements in real time. Boucher et al. (2017) advocate the view that blockchain development in the copyright area could lead to "multi-territorial licensing policies and enhanced legal certainty for creators and purchasers while providing effective dispute resolution mechanisms, particularly in relation to tariffs, licensing conditions, entrustment of online rights for management and withdrawal of online rights", rebalancing the rights between creators, buyers and intermediaries, giving copyrights their original purpose back.

3.4.2. Blockchain in the patent system

"Deploying blockchain technology within the patent system could reduce inefficiencies in recording and agreeing the time of registrations in an efficient way, perhaps across several national patent systems" (Boucher et al. (2017)). Boucher et al. suggest that blockchain registration could be the first step in the patent application, providing proof of existence right from the beginning. The entire process could be built on top, providing a streamlined and transparent practice limiting inefficiencies, paperwork as well as potential corruption. More importantly, the technology could prove to be an effective tool to fight patent trolls, by offering companies a cheap and easy way to timestamp and create a trail of records for their inventions and trade secrets. These blockchain certificates could then be used to defend against litigating NPEs as notarized arguments proving existence, ownership, and integrity for the prior use defense. Munich-based startup Bernstein[14] recently launched a pilot test to investigate this possibility. Hancock and Vaizey, in their report Distributed Ledger Technology: beyond blockchain (2015) even envision companies registering their IP within a distributed ledger, skipping the traditional patent application altogether. According to their report, this could reduce the total number of contract disputes, which make up 57% of litigation in the UK. Moreover, this could have substantial cost benefits by reducing the number of complex interactions with local and national governments. One decentralized ledger would also solve the problem of unifying the patent system across countries. This could vastly improve the effectiveness of IP management, speed up the innovation process in companies and foster the distribution of information across them through the ledger.

While the case they make is highly satisfying, it could be regarded as overly optimistic, as well as oversimplifying. The patent system's goal is not only to timestamp and publish inventions. One central role of patent examiners is to assess the novelty of the inventions, a responsibility that builds on massive databases and requires a systematic research of all prior art. This meticulousness sets a very high standard for new inventions, pushing companies who want to register IP to be highly precise and innovative. Patent examiners are absolute experts in their field, can be a great source of knowledge for anyone requesting a prior art report and with their legal background are the most qualified to settle disputes. Consequently, while blockchain technology certainly has great potential to improve a system that has not evolved as fast as the setting in which it operates, it is highly disputable whether it could replace it altogether.

3.4.3. A new platform for defensive publications

One project published on the Open Ecosystem Network, called Smart Defensive Publishing, proposes the "creation of a disclosure service based on the bitcoin blockchain and the Interplanetary File System[15]" (IPFS). IPFS is a publicly distributed version of the web providing several advantages for a defensive publication platform: each file is given a unique

[13] https://www.ascribe.io/ retrieved 19.03.2017

[14] https://www.bernstein.io/ retrieved 20.03.2017

[15] https://www.open-ecosystem.org/projects/smart-defensive-publishing retrieved 27.03.2017

fingerprint, duplications are removed, the platform supports versioning, each network node can choose which content it is hosting, and the database is indexed and searchable[16]. Combined with the benefits of the blockchain's timestamping and proof of existence, the platform could offer a decentralized way to cost-efficiently publish in an uncensored manner and guarantee the accessibility to all documents at any time by anyone, providing an ideal source of prior art. The database could then easily be replicated for specific uses and indexing structure, for example by patent offices.

3.4.4. Open innovation through the blockchain

"Today, traditional issues related to shared common-pool resources—such as the free rider problem or the tragedy of the commons—could be addressed with the implementation of blockchain-based governance, through the adoption of transparent decision-making procedures and the introduction of decentralized incentives systems for collaboration and cooperation" (Filippi, as cited by Bollier (2015)). Communities of companies wishing to engage in open innovation could implement "innovative forms of self-governance" thanks to the "transparent and decentralized nature of the blockchain" (ibid). With every interaction recorded and publicly available on a distributed ledger, a set of indisputable rules could be enforced independently and automatically through smart contracts linking specific interactions to transactions. The blockchain does not only allow for transactions of currency, and by registering assets, property effectively becomes a "smart asset" (Walport (2016)), which is timestamped, uniquely identifiable, traceable, linked to the owner, and can be efficiently traded across the system. This provides the grounds for a "new sophisticated incentive system, which might significantly differ from traditional market-based mechanisms" (Filippi, as cited by Bollier (2015)), by creating a healthy competition among individuals with genuine recognition of each contribution (Seulliet (2016)). Seuillet emphasizes the need for such a recognition since some innovators are always more creative and inventive than others, and eventually emerge as leaders because of their vision and drive (the so-called "lead users"). The blockchain could provide the effective incentives already used in the patent system, namely non-monetary rewards such as recognition, thanks to strong ownership and traceability of ideas and inventions, as well as monetary incentives, automatically enforced through smart contracts. The blockchain further allows the measurement of peer exchange, "even when they take place in a gift / counter-gift logic" (Seulliet (2016)). To summarize, "by allowing stigmergy processes, [the blockchain approach to open innovation] aims to mobilize collective intelligence, introduce a spirit of sharing, pool the contributions of community members, and generate a more natural, fair and motivating cooperation. By managing the individual reputations of the members of a community, blockchain also creates healthy competition between co-creators. Finally, by linking the principle of coopetition to open innovation, it creates a new paradigm, making this open innovation more efficient, productive, and ethical" (Seulliet (2016)).

4. Institutional and legislative support of blockchain technology

4.1. The need for institutional and legislative support of the blockchain

While it may sound counterintuitive to discuss institutional and legislative support for a technology that has been created precisely out of distrust in institutions and which by nature is decentralized and ruled only by the laws of code and mathematics, we show that, for the moment being, and at least for most of the intellectual property field, it is a necessary step.

Most countries have started implementing basic legal principles for bitcoin and other altcoins as currencies: latest was Japan, planning a bill recognizing Bitcoin as a legal payment method in April 2017 (Helms (2017)). However, legislators struggle to keep up with the wave of innovative blockchain use cases, in particular for IP. In this sector, several concerns are central to the efficient application of the technology.

The first is the legal binding of digital signatures used in blockchains. As pointed out by McMullen (2017), not all digital signatures are equally valid: there have been cases of e- signature systems with design and security flaws, which is why governments have set complex standards. Habitually a valid signature is required to make contracts legally valid, a necessary precondition in case of legal disputes. In other words, for the previously explored potential of smart contracts to be unlocked, private key signatures must be recognized.

The second issue also mentioned by McMullen is the use of blockchain based evidence in court. The law stipulates very precise specifications for what is referred to as "admissible evidence"[17]. Many factors come into play in determining admissibility, such as relevance and reliability. McMullen observes that while blockchain evidence can theoretically be admissible in most legal systems, it necessitates the involvement of an expert explaining the fundamentals of the technology and asserting its trustworthiness. It is always possible to prove the reliability of the information since it is mathematically given by the blockchain, but it costs money and time, which drastically decreases efficiency and counterbalances the many advantages the technology could offer.

Another matter brought forward by McMullen is the need for legislations to support the implementation of blockchain technology for copyright protection. As he notes, "copyright

[16] https://ipfs.io/
retrieved 27.03.2017

[17] www.legalmatch.com/law-library/article/what-is-admissible-evidence.html
retrieved 20.03.17

is based on statute. Real reforms to copyright law have to come through government action". Blockchain technology can help creators track their creations and capture the value they generate, which is already a significant step forward compared to today's situation, but it does not solve the problem of unauthorized use: to remove infringing content, they must fall back on legal means (Horbal, as cited by Bitcoin Magazine, 2016).

4.2. Research methodology

There are two ways in which legislations and governments can support the realization of the blockchain potential in the IP system.

The most straightforward approach is the explicit acceptance of the technology in legislations, recognizing it as valid and fitting for specific use cases. This is, of course, the ideal form of legal framework in favor of blockchains. This also includes regulations making the technology admissible without directly mentioning it.

The other investigated form of governmental support is of a more implicit nature and is embodied through the specific use of blockchain technology in government functions. These instances of implementation provide proofs of concept showing the government's recognition of the blockchain as a valid public record. If proven successful, this could have a highly beneficial impact on the technology's image and credibility, therefore potentially accelerating its implementation in IP. As explained by Classon (as cited by PYMNTS, 2017) "the wider adoption of blockchain technology by the government has the potential to validate this software for the rest of the economy and potentially influence how process interactions will flow in and out of government entities, and by extension, among non-government entities."

4.3. Support of blockchain technology in legislations

4.3.1. Copyright legislations

To this date, no concrete legislation has been issued by any country or state which supports the use of blockchain for improved copyrights management. As observed by McMullen however, governments are starting to consider the possibilities of IP on the blockchain. The Report and Recommendations of the Technical Upgrades Special Project Team (Ament (2015)) of the United States Copyright Office makes "specific recommendations" for a "better public record": "One of the ongoing and primary objectives of the Copyright Office is to create and maintain a public database of robust, reliable, and authoritative records of copyright ownership." Even though the blockchain is not explicitly mentioned, some central aspects of the blockchain can be recognized in those requirements. Regarding metadata, the Office might also wish to seek "solutions to harvest this data and make it available", which is also encouraging for new blockchain based formats.

In 2016, both the European Union Intellectual Property Office (EUIPO) and the United States Patent and Trademark Office (USPTO) organized meetings on the topic of blockchains. During the Blockchain Technology Workshop in October 2016, "over 20 leading blockchain specialists from Europe and the US met in Brussels to discuss the future use of the technology in the field of IPR[18]." They focused on areas of protection and enforcement, acknowledging the potential of the technology in "tangible and intangible asset management, smart contracting, track and trace of products17".

Similarly, the Department of Commerce's Internet Policy Task Force hosted a meeting December 9 on Developing the Digital Marketplace for Copyrighted Works at the U.S. Patent and Trademark Office headquarters in Alexandria, Virginia[19]. The aim was to "facilitate constructive, cross-industry dialogue among stakeholders about ways to promote a more robust and collaborative digital marketplace for copyrighted works (ibid)." Notably, members of the teams behind Ascribe and the dotblockchain music format were invited to participate and voice their opinion. According to the website, the background was the identification of several critical issues in the copyright ecosystem, for which the task force plans to "conduct further work" including "on the issue of how the government can facilitate the further development of a robust online licensing environment."

This shows how aware and concerned governments are regarding the copyright situation, and hopefully, this kind of initiatives will allow for a more rapid development of legislations leveraging the benefits of blockchain technology.

4.3.2. Admissibility of blockchain signatures and data, in chronological order

Vermont

The US State Vermont took the lead in blockchain legislation by adopting a bill, signed into effect by Governor P. Shumlin on June 2, 2016, recognizing blockchain data as valid in the court system. Bill H868 states that "A digital record electronically registered in a blockchain shall be self-authenticating" (An act relating to miscellaneous economic development provisions, Nr. 157 § § 1913 Sec. I.1. 12 (2016)). This bill effectively harmonizes blockchain data with Vermont's state law on the kinds of evidence admissible in court, giving any data full legal bearing[20]. On the one hand, the implications for the industry are huge, since use cases go beyond IP, such as authentication of physical objects, which could, in turn, convince other industries to trust the blockchain, leading to further democratization of the technology. On the other hand, this represents a fundamental milestone since it opens the way for other states and countries to follow, giving them a starting point to build on. It also "opens the door to further applications of blockchain within Vermont infrastructure in the future" (ibid).

[18] https://euipo.europa.eu/tunnel- web/secure/webdav/guest/document_library/observatory/documents/newsletter/Observatory-newsletter_December2016_en.pdf
retrieved 25.03.2017

[19] https://www.uspto.gov/learning-and-resources/ip-policy/public-meeting-developing-digital- marketplace-copyrighted-works-dec
retrieved 21.03.2017

[20] https://dcebrief.com/vermont-breaks-new-ground-in-cryptocurrency-technology/
retrieved 22.03.2017

European Union

On July 1st, 2016, the regulatory framework (910/2014/EU) of the European Parliament and of the Council of 23 July 2014 on "electronic identification and trust services for electronic transactions in the internal market"[21] became effective. Section 4 Article 25 on the legal effects of electronic signatures states that:

"1. An electronic signature shall not be denied legal effect and admissibility as evidence in legal proceedings solely on the grounds that it is in an electronic form or that it does not meet the requirements for qualified electronic signatures. 2. A qualified electronic signature shall have the equivalent legal effect of a handwritten signature. 3. A qualified electronic signature based on a qualified certificate issued in one Member State shall be recognised as a qualified electronic signature in all other Member States. " While not referencing the use of blockchain technology directly, the regulation legally makes all electronic signatures admissible as evidence in court, therefore including blockchain signatures, potentially giving them the same legal bearing as handwritten signatures. Furthermore, Article 41 of Section 6 makes it impossible to deny the legal effect and admissibility of a timestamp because it is of an electronic form. Note that none of the stipulations explicitly grant the blockchain data the title of "qualified" evidence, which might still make the appeal to experts necessary in court.

What might be the most important effect is that it automatically invalidates any inconsistent EU member's law, guaranteeing uniform application across the EU (Puterbaugh (2016)). This law is not a guarantee that blockchain data will be accepted as valid, but it makes impossible for any European court to reject the data based on the fact that it is electronic.

Arizona

Meanwhile, back across the Atlantic, the Arizona House Bill 2417 was introduced in February 2017 and is awaiting the governor's signature, after successfully passing the House of Representatives and the Senate[22].

The bill will have several crucial implications for blockchain users. Article 5A establishes that "a signature that is secured through blockchain technology is considered to be in an electronic form and to be an electronic signature.", effectively making blockchain signatures admissible under Arizona law. The bill also recognizes blockchain contracts and records as admissible, and smart contracts "may not be denied legal effect, validity, or enforceability". Lastly, the bill includes a stipulation about who exactly owns the data included on the blockchain (Higgins (2017)). It is established that any person securing information on the blockchain retains the same rights of ownership and use except if the data was part of a transaction made to transfer ownership.

[21] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2014.257.01.0073.01.ENG
retrieved 22.03.2017

[22] https://legiscan.com/AZ/bill/HB2417/2017
retrieved 22.03.2017

4.4. Support of blockchain technology through government use cases

4.4.1. The potential of blockchains in governments

"All governments are a fit. [Anyplace where there is a need for] trusted data repositories is highly conducive to be blockchain-enabled, creating efficiencies in issuance and authentication, and making the entire workflow radically transparent and auditable. Furthermore, states can save billions of dollars from this type of automation." (Boring, founder and president of the Chamber of Digital Commerce, as cited by PYMNTS, 2017). All advantages of blockchain technology as a tamperproof, cheap, distributed, public and transparent infrastructure database make Bitcoin and potentially other blockchains "a promising technology for validating many types of persistent documents in public sector." (Ølnes (2016))

4.4.2. Estonia

The 1.311 million residents strong European country[23] is considered a leading nation in blockchain adoption. Its digital government initiative started in 1997, and in 2001 the government introduced X-Road, a distributed database giving its citizens access to a wide range of services online, such as e-identity, residence registration and electronic tax declaration among others[24]. In this system, all government institutions have access to a (permissioned) blockchain service to "secure access and audit logs"[25]. The Ministry of Justice is using the same blockchain to ensure the integrity of data such as the "Estonian Property Registry, Business Registry, Succession Registry, state's announcements, court files.". Furthermore, the same company behind the technology, Guardtime, has announced a partnership with the Estonian eHealth Foundation, aiming to provide the healthcare record system with the same data security and integrity benefits, making it impossible to alter information without being noticed (Palmer (2016)).

In December 2015, the Estonian government also introduced a public notary service based on the Ethereum blockchain in partnership with Bitnation, giving Estonian residents the ability to notarize all kinds of certificates on the blockchain, such as marriages, birth certificates or business contracts[26]. The Estonia's e-residency program encountered encouraging success and had countries such as Azerbaijan, Namibia, and Japan voice their interest to implement the technology as well (Bershidsky (2015)).

[23] http://data.worldbank.org/country/estonia
retrieved 23.03.2017

[24] https://e-estonia.com/component/x-road/
retrieved 23.03.2017

[25] https://tinyurl.com/guardtime
retrieved 23.03.2017

[26] https://bitnation.co/blog/pressrelease-estonia-bitnation-public-notary-partnership/
retrieved 23.03.2017

4.4.3. Delaware, USA

The Delaware Blockchain Initiative was launched in April 2016 to "embrace the emerging blockchain and smart contract technology industry[27]" While one of the stated objectives to create a welcoming regulatory environment for the development of blockchain applications has yet to produce any legislations, Governor Markell, who gave rise to the initiative, has also announced that the state would investigate own use cases. The startup Symbiont has started working with the Delaware Public Archives to "store state archival records on a distributed ledger (ibid)" (the Assembly blockchain, permissioned[28]). By independently storing the documents on every node of the network, the company promises data recovery as well as cost-savings for the state (Long, as cited by GCN, 2016). The project is furthermore using smart contracts to "automate compliance with the state's document retention and destruction laws" (Tinianow 2017). Starting 2017, companies will also be able to file documents on the state's distributed ledger, such as Uniform Commercial Code (UCC) filings, as smart contract versions.

4.4.4. Illinois, USA

Announced during the Blockchain Conference Chicago, the Illinois Blockchain Initiative is a consortium of private companies as well as five government agencies: the Department of Financial and Professional Regulation, the State Department of Commerce and Economic Opportunity, the Department of Insurance, Cook County's Recorders of Deeds as well as the Department of Innovation & Technology (Castillo (2016)). Schneider, as cited by CoinDesk, stated that two main goals (similar to Delaware's) were pursued. Firstly, Illinois plans on creating a "welcoming regulatory environment for digital currency and blockchain businesses". House Resolution 120 was introduced on February 8, 2017, to create a task force investigating the options. As of March 17, 2017, the bill was awaiting the vote of the house of representatives[29]. The second objective is to "develop specific blockchain prototypes for use by the Illinois government". According to Castillo (2017), five government pilots were unveiled, "one of which is nearing completion": The Cook County and Tech Startup Velox Pilot Program to Integrate Blockchain-Based Real Estate into the Public Record. Similarly to bitcoins, the project allows for the tracking of individual property and its transaction history, yielding the usual blockchain benefits of transparency, efficiency, and integrity. Velox is using the Bitcoin blockchain for this project. The findings of the experiment will be presented during the March 2017 IBREA conference (Torpey (2016)).

4.4.5. Other smart property projects: Sweden and Republic of Georgia

Very similar experiences are being tested in other countries. Chavez-Dreyfuss (2016) reports that it currently "takes months to complete a real estate deal in Sweden from the time the parties agree until the contract is completed." Together with ChromaWay, Kairos Future, Telia Company, SBAB Bank and Landshypotek Bank, the Scandinavian country is investigating ways to speed up the process and to enhance traceability with an implementation on the Bitcoin blockchain. The project was successfully piloted in a test environment and will conclude on March 30, 2017, "with the delivery of a functioning technology platform and a findings report."[30]

Analogous motives have originated a smart registry pilot project in the Republic of Georgia. Partner Bitfury intends to "create a private blockchain tailored for property rights registration that is anchored to the public Bitcoin blockchain" (Shin (2016)). According to Minister of Justice Tsulukiani, the technology will be ready for real estate extracts as soon as 2017[31].

4.4.6. Russia

The Digital Ecosystem project, currently tested by the Russian government, was presented on October 13, 2016, at FINOPOLIS 2016 Innovative Financial Technologies Forum in Kazan. Deputy Director of the Federal Antimonopoly Service of Russia (FAS) Tsarikovsky, explains that a blockchain will be used to transfer communications between the service and external companies, with the objective of securely decreasing the number of paper documents flowing in and out, and the hope of therefore reducing manpower, eliminating information redundancy and speeding up the process, as well as increasing transparency[32]. The blockchain platform used for the project was not specified, but according to Tsarikovsky, the system may go live in the first half of 2017 (ibid).

4.4.7. Dubai

The emirate too is investigating blockchain technology use cases in the government. The Dubai Blockchain Strategy, launched in December 2016 for this intent, builds on three pillars, which are "Government Efficiency", "Industry Creation" and "International Leadership"[33]. The project aims to enable a "paperless digital layer for all city transactions (ibid)", which could bring the government savings of $1.5 billion, and enable use cases range from visa application to

[27] http://www.prnewswire.com/news-releases/governor-markell-launches-delaware-blockchain-initiative-300260672.html
retrieved 23.03.2017

[28] https://symbiont.io/technology/
retrieved 23.03.2017

[29] https://legiscan.com/IL/bill/HR0120/2017
retrieved 17.03.2017

[30] http://chromaway.com/landregistry/
retrieved 23.03.2017

[31] http://cbw.ge/business/georgia-becomes-first-country-register-property-blockchain/
retrieved 23.03.2017

[32] http://www.coinfox.info/novosti/6780-russian-regulator-transfers-all-non-government-paper-flow-to-blockchain
retrieved 23.03.2017

[33] http://www.smartdubai.ae/dubai_blockchain.php
retrieved 23.03.2017

bill payments and license renewals, as well as business opportunities in real estate, healthcare, fin-tech, and tourism (ibid). The government did not disclose on which blockchain the project would be built.

4.4.8. Governments investigating options

While few governments have started implementing the technology through various pilots, several others are showing interest. Governments recognize the potential for the technology and publish reports, resolutions, bills and papers acknowledging it, a potential first step for a later adoption.

In January of 2016, US state Vermont published the Blockchain technology: opportunities and risks report acknowledging the benefits of the technology while arguing that "at present, the costs and challenges associated with the use of blockchain technology for Vermont's public record-keeping outweigh the identifiable benefits.[34]" The European Parliament Resolution of 26 May 2016 on virtual currencies "notes that DLT's [distributed ledger technology] potential to accelerate, decentralise, automate and standardise data-driven processes at lower cost has the potential to alter fundamentally the way in which assets are transferred and records are kept[35]" and "further notes that DLT could be used to increase data sharing, transparency and trust not only between government and citizens (ibid)".

On January 25, 2017, the Hawaii House Bill 1481 was introduced, recognizing "the vast potential for this [blockchain] technology to drastically change and improve public sector operations[36]". The bill aims at establishing a task force to "examine, educate and promote best practices for enabling blockchain technology (ibid)".

Finally, the UK Digital Strategy, a policy paper published on March 1, 2017, by the UK Secretary of State for Culture, Media and Sport Bradley, introduces the Digital Catapult, a center with the goal of finding "new ways to work with personal data with more control and trust, applications of blockchain and smart contracts[37]"

5. Practitioner interviews

5.1. Methodology

For the present study, three interviews were conducted during March of 2017. The goal was to find out how the theoretical results of the research measure up against real-world application and perception. The idea was to create a small sample spread out as far as possible across the "chain of innovation", to collect heterogeneous perspectives from actors with diverging interests. On one end of the chain of innovation we identified companies, who are the innovating entities which the IP system aims to incentivize. Jonathan Woehrstein, the founder of "genetic diagnostics" startup Deoxy in Munich, was interviewed in that regard. On the other end of the innovation chain, we identified the European Patent Office (EPO). The patent office embodies the IP system authority. Its objective is to incentivize innovation by granting patents for companies, and by publishing them after a certain amount of time for the public's benefit. Pia Björk, director of examiners at the EPO in Munich, was interviewed accordingly. Lastly, the goal was to interview someone in the middle of this chain of innovation: Ricardo Cali, a managing partner of evoIP, a "Munich and Mannheim-based engineer service provider in the field of intellectual property" (R. Cali, personal communication, 17.3.2017). Each interviewee was asked specific questions linked to the theoretical structure of this thesis. They were questioned about the need for innovation and a legal framework to support it, the problems of today's IP system, the potential of blockchain technology to improve the situation, and lastly about the acceptance of the technology. It was especially important to compare how blockchain technology was perceived and could improve the situation for players in different situations, as well as what they suppose would drive acceptance.

5.2. Analysis

5.2.1. Perceived importance of the IP system

All interviewees agreed on the importance of the IP system. Naturally, a large part of the interviews revolved around the patent system, in particular, due to it being the most important IP right subsystem. The patent system was identified as highly necessary, but not all interviewees acknowledged the same benefits. P. Björk (personal communication 17.3.2017) described the patent system as a "way of promoting innovation" through money incentives and as a "source of information for the public." Specialized in pharmacology, she underlined the importance of protecting drug-related inventions, which are long and costly to develop, but easy to copy. According to her, the money made through patent monopoly rights is then used for further research, benefiting both the company and the public. On the company side, J. Woehrstein (personal communication, 8.3.2017) insisted on the relevance of patents for small startups: "We need it." He described patents as the central value indicator for startups in the eyes of investors: "If you don't have patents, nobody is going to buy you". R. Cali described the IP system as a "good method to ensure that the knowledge gets spread" but also underlined the competitive edge a good IP strategy can give the company. These findings generally agree with our theoretical identification of the IP system's benefits.

5.2.2. Perceived troubles of the IP system

Once again, all interviewees agreed to say today's IP system is not ideal, mainly citing the troubles in the patent

[34] http://legislature.vermont.gov/assets/Legislative-Reports/blockchain-technology-report-final.pdf
retrieved 25.03.2017

[35] http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P8-TA-2016-0228+0+DOC+XML+V0//EN
retrieved 25.03.2017

[36] http://www.capitol.hawaii.gov/session2017/bills/HB1481_HD1_.HTM
retrieved 25.03.2017

[37] 37https://www.gov.uk/government/publications/uk-digital-strategy/uk-digital-strategy
retrieved 25.03.2017

Table 1: OVERVIEW OF LEGISLATIONS SUPPORTING BLOCKCHAIN TECHNOLOGY (Source: Author's own research)

Location	Legislation	Date	Effect	Status
Vermont (US)	HB868	6.2016	Admissibility of blockchain data in court	Passed
EU	Regulatory framework (910/2014/EU)	7.2016	Admissibility of electronic signatures and timestamps in European courts	Effective
Arizona (US)	HB2417	2.2017	Admissibility of blockchain signatures, smart contracts and definition of ownership	Awaiting governor's signature

Table 2: OVERVIEW OF GOVERNMENTAL USE CASES FOR BLOCKCHAIN TECHNOLOGY (Source: Author's own research)

Location	Project	Date	Use Cases	Blockchain system
Estonia	X-Road	2001-2017	Secured governmental databases; Transparent healthcare record system; Public notary service	Proprietary (permissioned) and Ethereum
Delaware (US)	Delaware Blockchain Initiative	4.2016	Storage of state archival records; Document filling with smart contract integration	Assembly (permissioned)
Georgia	-	4.2016	Property registry	Private blockchain on top of Bitcoin
Sweden	-	6.2016	Property registry	Bitcoin
Illinois (US)	Illinois Blockchain Initiative	9.2016	Property registry	Proprietary structure on top of Bitcoin
Russia	Digital Ecosystem	10.2016	Communication between FAS and companies	Unknown
Dubai	Dubai Blockchain Strategy	12.2016	Paperless city transactions	Unknown

system. In compliance with our findings, the problems cited included the slow and rigid process of patent applications for companies (J. Woehrstein, personal communication, 8.3.2017). R. Cali also mentioned the complexity and cost- intensive structure of the patent system, leading to inefficiencies and "cash burning". Both P. Björk and R. Cali acknowledged the problem of patent trolls. The main difficulty for the EPO identified by P. Björk was information management, in regards to the exponential amount of information through globalization and to the reliability of availability and publication date of information published on the internet.

5.2.3. Perceived potential of blockchain technology in IP

Two of the three interviewees (evoIP and Deoxy) were already part of the Bernstein pilot project (introduced in chapter 3.3.2) before the interview and chosen accordingly. Their interest in blockchain technology in the field of IP is therefore not necessarily representative of the rest of the industry since they are part of the small population of early adopters. It remains interesting to investigate their perception of the potential of the technology in their fields, especially considering that early adopters often lead the way for the majority to follow, according to the innovation adoption theory (Rogers and Shoemaker (1971)). Furthermore, the last interview with the EPO director was conducted independently of prior links to blockchain projects. All three interviewees reported perceiving potential for the IP system at different levels.

Corroborating our thesis, the interviewed company founder J. Woehrstein saw "critical" importance in the ability to indisputably prove the time of invention for the case of patents issues. According to J. Woehrstein, the technology can function as a highly efficient complement to patents in highly technological fields, in particular when used in a prior use defense, considering that many small steps of the innovation patent cannot be patented. He also cited the benefit of indisputable contribution proof, an argument we brought forward for open innovation. According to J. Woehrstein, measurement of involvement in patents remains lackluster, especially in universities, where old e-mails are supposedly being used as proof of participation.

R. Cali, whose company is using the technology to offer its clients a notarization platform for trade secrets and defensive publishing, sees the biggest advantage of blockchain technology in its affordability, in particular for prior use defense against patent trolls.

Table 3: OVERVIEW OF INTERVIEWS (Source: Author's own research)

Date	Name	Position	Duration
08.03.2017	Johannes B. Woehrstein	Founder of Deoxy Technologies	21:10
17.03.2017	Ricardo Cali	Managing director at evoIP	37:00
17.03.2017	Pia Björk	Director of examiners at the European Patent Office	34:05

P. Björk admitted she was not aware of possible investigations of the technology taking place at the EPO, but recognizes the "advantage of the date", since timestamping represents a central point – and difficulty – in the work of patent examiners. She affirmed that she could see the EPO use a publication platform powered by blockchain technology, saying it "would actually address some of the problems we have when we search in internet today." She added that the EPO was constantly looking for more efficient and secure databases, with entire departments dedicated to the task. P. Björk did, however, voice doubts when asked if decentralized open innovation governed by blockchain technology could replace the patent system, naming the expert arbitrator function the patent office provides as the main reason.

5.2.4. Discussion about acceptance of the technology

Each of the interviewees agreed in their opinion that the implementation of blockchain technology in IP would depend mainly on its acceptance by the industry. Both J. Woehrstein and R. Cali expressed serious doubt about the capacity of governments in leading the way for the industry, in particular the German government, deemed as slow to respond and to adapt to innovations. None of the interviewees had heard about the legislative and governmental initiatives. Still, all of them finished on a positive and optimistic note regarding future acceptance in the system: P. Björk stated that "if it is used by many, and the content is there, we will also be looking at it.". To the question "will the adoption in other countries help?", R. Cali answered: "I think it will help." Moreover, J. Woehrstein, when questioned about the possible admissibility of blockchain data in courts, affirmed that even though courts are "always a gamble", he alleged, "I think it's going to work".

6. Conclusion

We have presented a study on the potential of the blockchain technology for IP and innovation, and offered an overview of institutional measures in favor of its acceptance and implementation. We have shown that the blockchain technology provided strong timestamping, proof-of-existence as well as the potential for smart contracts and enabled the creation of distributed, transparent, cost-effective and resilient environments open to all and where each transaction is auditable. We found that when applying these characteristics to the different IP and innovation strategies, it could help copyrights to be enforced more effectively in the context of digitization and render the patent system more efficient and less vulnerable to abuses. We also established that blockchains can support companies wishing to keep inventions secret as well as provide a reliable infrastructure for defensive publications. The technology promises an exciting impact on open innovation, where it could function as the missing framework for prosperous cooperation and solve ethical questions as well as organizational problems. We showed that several institutions across the world have started enacting laws related to blockchain technology, some governments have begun implementing the technology in public functions and even more currently investigate the technology's potential. This trend is likely to further spread and represents an encouraging sign for the future of the technology and its acceptance. Interviews with three actors involved in the innovation process confirmed that the investigated benefits are perceived in practice as well.

This study is however somewhat limited by the novel character of the technology. Even though it was introduced almost ten years prior to the study, its application beyond cryptocurrencies was only recognized much later, meaning only very little research was done on the subject. While the institutional interest in the technology and the will to foster it is tangible, most initiatives are exploratory, and only time will tell if they will yield the expected success. Lastly, the results of the interviews, although promising, are not representative of the majority.

This exploratory study opens up several questions concerning the future of blockchain technology in innovation. While blockchain technology has seen first use cases and pilots in the patent system and for copyrights, secrecy and defensive publication, its impact on open innovation remains highly theoretical and needs further research on possible mechanisms and implementations to unlock its potential. Furthermore, the progression of acceptance will need investigation as the use cases and legislations will likely multiply in the next few years. In particular, the concept of identity on the blockchain is still missing from legislations but is a central issue to IP, innovation and many other fields, and will be a necessary step to unlock further use cases.

We deem it likely that blockchain technology will have tremendous impacts on the way the world innovates and protects innovations. We share one of interviewee's enthusiasm regarding the "fantastic" potential of the technology.

References

Ament, D. Report and recommendations of the technical upgrades special project team, 2015. URL https://www.copyright.gov/technology-reports/reports/usco-technicalupgrades.pdf.

An act relating to miscellaneous economic development provisions, Nr. 157 § § 1913 Sec. I.1. 12 (2016).

Arora, A., Fosfuri, A., and Gambardella, A. Markets for technology and their implications for corporate strategy. *Industrial and corporate change*, 10 (2):419–451, 2001.

Barrett, B. Defensive use of publications in an intellectual property strategy. *Nature biotechnology*, 20(2):191, 2002.

Baumol, W. J. *The free-market innovation machine: Analyzing the growth miracle of capitalism*. Princeton university press, 2002.

Bershidsky, L. Envying estonia's digital government, 2015. URL https://www.bloomberg.com/view/articles/2015-03-04/envying-estonia-s-digital-government. Retrieved March 23, 2017.

Bollier, D. The blockchain: A promising new infrastructure for online commons, 2015. URL http://bollier.org/blog/blockchain-promising-new-infrastructure-online-commons. Retrieved March 15, 2017.

Boucher, P., Nascimento, S., and Kritikos, M. How blockchain technology could change our lives, 2017. URL https://pdfs.semanticscholar.org/0a09/9da451b5be9a5c7fa6cbd66afec33a240c91.pdf. Retrieved from.

Castillo, M. Illinois Blockchain Initiative Unveiled: US State Reveals Sweeping Policy Plan, 2016. URL http://www.coindesk.com/illinois-blockchain-initiative-policy-regulation-bitcoin-blockchain/. Retrieved March 23, 2017, from.

Castillo, M. Illinois Joins R3, Unveils Expansive Blockchain Support Plan, 2017. URL http://www.coindesk.com/illinois-government-unveils-expansive-blockchain-industry-support-plan/. Retrieved March 23, 2017, from.

Chavez-Dreyfuss, G. Sweden tests blockchain technology for land registry, 2016. URL http://www.reuters.com/article/us-sweden-blockchain-idUSKCN0Z22KV. Retrieved March 23, 2017, from.

Chesbrough, H. Open innovation: a new paradigm for understanding industrial innovation. *Open innovation: Researching a new paradigm*, 400: 0–19, 2006.

Chesbrough, H. W. and Appleyard, M. M. Open innovation and strategy. *California management review*, 50(1):57–76, 2007.

Deetman, S. Bitcoin could consume as much electricity as denmark by 2020, 2016. URL https://motherboard.vice.com/en_us/article/bitcoin-could-consume-as-much-electricity-as-denmark-by-2020. Retrieved March 18, 2017, from.

Delphion. Search prior art, 2006. URL https://web.archive.org/web/20060615162220/http://www.delphion.com/search-prior_art. Retrieved March 14, 2017 from.

Granstrand, O. Innovation and intellectual property. In *DRUID Summer Conference*, 2003.

Guadamuz, A. and Marsden, C. Blockchains and bitcoin: Regulatory responses to cryptocurrencies. *First Monday*, 20((12-7)), 2015.

Helms, K. Countdown: Bitcoin Will Be a Legal Method of Payment in Japan in Two Months, 2017. URL https://news.bitcoin.com/countdown-bitcoin-legal-payment-japan-two-months/. Retrieved March 20, 2017, from.

Henkel, J. Selective revealing in open innovation processes: The case of embedded linux. *Research policy*, 35(7):953–969, 2006.

Henkel, J. et al. Defensive publishing-an empirical study. 2008.

Higgins, S. Arizona Bill Would Make Blockchain Smart Contracts 'Legal', 2017. URL http://www.coindesk.com/arizona-bill-blockchain-smart-contracts/. Retrieved March 22, 2017, from.

Intellectual Property Software. Patent Search. (n.d.). URL http://ip.com/. Retrieved March 14, 2017, from.

Kalanje, C. M. Role of intellectual property in innovation and new product development. *World Intellectual Property Organization*, 2006.

Kappos, D. and Rea, T. Report on the prior user rights defense. *United States Patent and Trademark Office*, 2012.

Kim, Q. K., J. Trade Secrets Less Risky Under AIA Prior User Rights?, 2012. URL http://www.skgf.com/uploads/24/doc/Trade_Secrets_Article_PDF.pdf. Retrieved March 29, 2017, from.

Leahy, P. Comment of Senator Patrick Leahy (D-Vt.), Chairman, Senate Judiciary Committee, On Patent Legislation | U.S. Senator Patrick Leahy of Vermont, 2014. URL https://www.leahy.senate.gov/press/comment-of-senator-patrick-leahy-d-vt_chairman-senate-judiciary-committee-on-patent-legislation. Retrieved March 13, 2017, from.

Madiega, T. Patents, pirates and fair play, 2016. URL http://www.europarl.europa.eu/RegData/etudes/ATAG/2016/581965/EPRS_ATA%282016%29581965_EN.pdf. Retrieved from.

Mansfield, E. How rapidly does new industrial technology leak out? *The journal of industrial economics*, pages 217–223, 1985.

Marks, M. Invention City, 2016. URL http://www.inventioncity.com/ask-mike/how-much-does-it-cost-for-international-patents. Retrieved March 13, 2017, from.

Maurer, S. M. and Scotchmer, S. The independent invention defence in intellectual property. *Economica*, 69(276):535–547, 2002.

McCandless. How much do music artists earn online – 2015 remix — information is beautiful, 2015. URL http://www.informationisbeautiful.net/visualizations/how-much-do-music-artists-earn-online-2015-remix/. Retrieved March 13, 2017, from.

McMullen, G. Blockchain & Law in 2017, 2017. URL https://medium.com/ipdb-blog/blockchain-and-law-in-2017-f535cb0e06c4#.96qcsc1mu. Retrieved March 20, 2017, from.

Musille, P. New Era in Open Innovation? Tesla and Open-Source IP, 2015. URL https://www.linkedin.com/pulse/new-era-open-innovation-tesla-open-source-ip-open-innovation. Retrieve March 12, 2017, from.

Nakamoto, S. Bitcoin: A peer-to-peer electronic cash system. 2008.

Narayanan, A., Bonneau, J., Felten, E., Miller, A., and Goldfeder, S. Bitcoin and cryptocurrency technologies, 2016.

Nixon, C. 'Prior User' Defense Still Unpopular With Accused Infringers - Law360, 2015. URL https://www.law360.com/articles/697190/prior-user-defense-still-unpopular-with-accused-infringers. Retrieved March 13, 2017, from.

Ølnes, S. Beyond bitcoin enabling smart government using blockchain technology. In *International Conference on Electronic Government and the Information Systems Perspective*, pages 253–264. Springer, 2016.

Palmer, D. Blockchain startup to secure 1 million e-health records in estonia, 2016. URL http://www.coindesk.com/blockchain-startup-aims-to-secure-1-million-estonian-health-records/. Retrieved March 23, 2017, from.

Puterbaugh, D. Understanding eIDAS – All you ever wanted to know about the new EU Electronic Signature Regulation | Legal IT Insider, 2016. URL https://www.legaltechnology.com/latest-news/understanding-eidas-all-you-ever-wanted-to-know-about-the-new-eu-electronic-signature-directive/. Retrieved March 22, 2017, from.

Quinn, G. The Cost of Obtaining a Patent in the US, 2015. URL http://www.ipwatchdog.com/2015/04/04/the-cost-of-obtaining-a-patent-in-the-us/id=56485/. Retrieved March 13, 2017, from.

Rogers, E. M. and Shoemaker, F. F. Communication of innovations; a cross-cultural approach. 1971.

Seulliet, E. Open innovation, co-creation: Why blockchain is a small revolution, 2016. URL https://medium.com/@ericseulliet/open-innovation-co-creation-why-blockchain-is-a-small-revolution-73e7d0b480d5. Retrieved March 20, 2017, from.

Shapiro, C. Prior user rights. *American Economic Review*, 96(2):92–96, 2006.

Shin, L. Republic Of Georgia To Pilot Land Titling On Blockchain With Economist Hernando De Soto, BitFury, 2016. URL https://www.forbes.com/sites/laurashin/2016/04/21/republic-of-georgia-to-pilot-land-titling-on-blockchain-with-economist-hernando-de-soto-bitfury/#4f1589b044da. Retrieved March 23, 2017, from.

Swan, M. *Blockchain: Blueprint for a new economy*. " O'Reilly Media, Inc.", 2015.

Tapscott D., T. A. The Impact of the Blockchain Goes Beyond Financial Services, 2016. URL https://hbr.org/2016/05/the-impact-of-the-blockchain-goes-beyond-financial-services. Retrieved from.

Torpey, K. Chicago's Cook County to Test Bitcoin Blockchain- Based Property Title Transfer, 2016. URL https://bitcoinmagazine.com/articles/chicago-s-cook-county-to-test-bitcoin-blockchain-based

-public-records-1475768860/. Retrieved March 23, 2017, from.
U.S Cons. Art. i, 8.
Walport, M. G. C. S. A. Distributed ledger technology: Beyond blockchain. *UK Government Office for Science*, 2016.