Does pooling patents with procompetitive licenses enhance development of, and global access to, technology? Contrast between the digital and bio-pharmaceutical markets

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Contents Page

Abstract

Using patent data pertaining to the digital and bio-pharmaceutical industries, this paper identifies that procompetitive patent pooling, incentivized patent pools' members to develop new technical inventions, which they subsequently patented internationally. Other inventors, i.e. non-pool members, from both the developed and developing economies indiscriminately accessed, the information disclosed through such pooled patents, and used them in their respective inventions. Development and access with respect to the digital technologies outweighed those that occurred in the bio-pharmaceuticals, probably due to higher demands on additional technologies that the digital markets exerted on its respective pool.

The paper argues that patents pooled with procompetitive licenses can confer to the pool members sufficient legal certainty about the deterrence of various behavioural retrains on free and fair competition that commonly distort trade, and limit welfare, in addition to their following renowned potential. (1) Facilitating manufacturing, interoperability and market adoption of standard requiring integration of complementary patents held by various parties; (2) Clearing royalty stacking and holdups, and (3) Relieving transaction costs associated with multiple-licensing agreements among those parties. Thanks to that deterrence, pool members can gain

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sufficient prospects to develop new technologies required to upgrade their respective standard products, achieve better profit margins, and contribute to welfare, on fair and non-discriminatory grounds.

Procompetitive licensing legislations on patent pools are proposed as viable alternatives worth contemplating and pursuing by policy makers to stimulate cost-effectively technology learning, development and access. Such legislations can significantly facilitate product and process innovation in a number of technology-intensive areas, including, in health; food processing; transport; telecommunication; manufacturing; clean energy; water; and climate change. The results can inform the contemporary multilateral debates seeking appropriate policies to support implementation of several sustainable development goals in both the developed and the developing countries.

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1. Introduction

The idea that procompetitive patent pools (i.e. which adopt optimal legal standards regarding the kind of patents admissible in, and licensing agreements between the pool members and third parties) can enhance both economic efficiency and welfare has gained a significant impetus in the antitrust legislations of many industrialized economies over the past decades. Notably, such standards help to deter various behavioural retrains on free and fair competition that commonly distort trade. Thanks to that deterrence, the trading parties can gain sufficient prospects for achieving better profit margins and contributing to welfare enhancement, on fair and non-discriminatory grounds. This idea has had a large resonance in the recent past in competition, and law and economics scholarships (Cory 2007; Daulestina 2015; Bekkers, et al. 2011; Priest 1997; Denicolo 2002; Gilbert 2002; Posner 2005; Immordino, et al. 2014; Carlson 1999; Lerner and Tirole 2004; Gilbert 2010; Gallini 2011).

Whereas most of the aforesaid scholarships focussed on the manufactured standard products (in tangible form) and their trade, empirical works addressing the exact effects of such optimal antitrust standards on development and dissemination of follow-on technological knowledge (in intangible form through quotations, for example) are relatively meagre. Such a limitation must be set, particularly, because the said technology is key in rolling out the implementation of the sustainable development goals fully endorsed by most Heads of States. Mainly, the operationalization of such goals will entail decoupling of economic growth from energy and resource intensity, decreasing waste and stress on the environment using appropriate technological knowledge and leadership, and extending further benefits to the poor and the marginalised. In other words, technological access will help to sustain much greener industries; efficient infrastructures, availability of better-quality goods such as consumer electronics, food products and pharmaceuticals, and enhanced service delivery.

This paper aims to bridge that gap by exploring empirically, and using patents pooled with procompetitive licenses as the analytical unit, the following questions:

1. Does pooling patents with procompetitive licenses encourage inventors of patents admitted in the pools to develop new technological knowledge?
2. Does such procompetitive patent pooling help other technology developers, such as rivals and innovators situated outside the pools, to access the patented knowledge in the pool?

The answers to such questions can contribute to theory and practice of antitrust laws, patent laws, technology policy and laws and economics. They can also contribute to the emerging debates in the multilateral forum seeking to understand and harness the potentials of intellectual property and competition laws and respective policies in the implementation of some of the sustainable development targets, which heavily rely on technology access.

To examine those questions closely, this paper adopts as a generic model, the antitrust legislations from the *European Union Commission* and *U.S. Department of Justice and Federal Trade Commission* (hereinafter *DOJ-FTC*), which considerably have been amended over the past years and comprise the most essential features. Briefly, the pooling of patents into a single licensing package occurs voluntarily among patent holders intending to manufacture and trade their products whose constituents are technically interdependent and covered by overlapping rights. To avert various antitrust behaviours such as restrictions on freedom to compete, and predatory, exploitative and exclusionary treatments among parties, which generally distort free and fair trade, the legislators in a number of industrialized countries are increasingly pushing for *fair, reasonable and non-discriminatory (FRAND)* terms in the licensing agreement that govern patent pools. Such procompetitive licenses can:

(a) Significantly mitigate the transaction costs associated with negotiations and agreements among right owners;
(b) Facilitate the licensing of patent rights among their members and third parties through a single licensing package;
(c) Clear royalty stacking and hold-up that generally occur when they are gathered bilaterally by the right owners;
(d) Sufficiently, and reasonably, alleviate potential infringement suits and litigations that conventionally arise subsequent to trade of products involving various holdings (WIPO 2016; Elauge 2009; Daulestina 2015; Llannes and Trento 2012; The *U.S. DOJ-FTC* 1995; Lerner and Tirole 2010).

To rationalize the analysis, this paper posits that patents pooled through *FRAND* licensing terms will likely 1) generate sufficient certainty within the pool, which will in turn 2) reassure the licensors that the risks, which conventionally threaten their business development prospect will be absent. The following conditions will likely enhance such certainty and reassurance:

(e) Composition of the pools that favors essential and complementary patents, while excluding the nonessential and invalid patents, as will be discussed later, and
(f) Terms governing royalty distributions among the pool members and third parties, as defined by the pool management entity that normally should comply with the relevant antitrust guidelines on fair competition.

Because such procompetitive licenses are likely to facilitate fair and non-discriminatory treatment of various participants within the pools and the third parties, thanks to the deterrence referred to early, the rational pool members are likely to feel safe

enough to develop additional technologies, and maximize profit margins associated with the market demand for their inventions. Such an incentive will constitute a positive spillover arising from absence or alleviation of the conventional threats on free and fair competition alluded to early. It will, subsequently increase the rates of: 1) development of technological knowledge within the pool, and 2) spillovers of such development within the pools, and in the downstream markets, notably among the research and development (R&D), and innovation actors.

Section 2 outlines the main features of procompetitive pools focusing on the kind of patents that should be included in, and the adopted licensing terms. It also discusses the potential effects of the patents composing pools on technological development and access in the downstream market, which underlies the foregoing argument. Section 3 summarises the methodology used to collect and analyse the data and section 4 outlines the conclusion and policy recommendations.

2. Main features of procompetitive patent pools

To facilitate successful manufacturing and trade of standard products, which usually require integration of complementary patents held by various parties, the antitrust authorities have been recommending appropriate measures regarding the acceptable (i.e. procompetitive) patents and licensing terms in patent pool programmes. The main features of procompetitive patent pools recommended by the antitrust guidelines of *Article 101-TFEU*[2] and *U.S. DOJ-FTC* recited in Table 1 were selected to help address the research question. The potential effects of such features on technology development and access, which constitute the basis for the assumption made early in section 1, are discussed in sub-sections 2.1 and 2.2. Despite their different wording, the two guidelines: 1) promote pools that are comprised of complementary essential patents; 2) discourage exclusionary, discriminatory and predatory practices, as well as undue accumulation of benefits among parties; 3) encourage free trade and social welfare. Tacitly, pools comprised of substitutes and nonessential patents generally are associated with antitrust concerns and are thus unfavourable.

[2] *TFEU* stands for the *Treaty of Functioning of the European Union*.

Table 1: Main features of patents pooled with procompetitive licenses, pursuant to the antitrust guidelines of *Article 101- TFEU* and *U.S. DOF-FTC.*

Guidelines of *Article 101- TFEU*	Guidelines of *U.S. DOJ-FTC*
1. Prohibit agreements and concerted practices between undertakings operating within the internal market, which may o *affect trade between member States and which have as their object or effect the prevention, restriction or distortion of competition within the internal market directly or indirectly fix purchase or selling prices or any other trading conditions;* o *limit or control production, markets, technical development, or investment* […] 2. Describe procompetitive pools as those in which: o *participation is open to all interested technology right owners;* o *sufficient safeguards are adopted to ensure that only essential technologies are pooled;* o *the pooled technologies are licensed into the pool on a non-exclusive basis;* o *the pooled technologies are licensed in to all potential licensees on* FRAND *terms;* o *the parties contributing to the pool and the licensees remain free to develop competing products and technology.*	1. Encourage procompetitive arrangements, which can promote dissemination of technology. Included are those that may: o *provide procompetitive benefits by integrating complementary technologies, reducing transaction costs, clearing blocking positions, and avoiding costly infringement litigations.* 2. Describe anticompetitive effects of licensing and pooling arrangements as including: o *collective pricing or output restraints in pooling arrangements, such as joint marketing of pooled intellectual property rights with collective price setting or coordinated output restraints, which do not contribute to efficiency-enhancing integration of economic activity among the participants* […]

2.1 Potential effects of patents pooled with procompetitive licenses on technology development and access

Pursuant to the antitrust guidelines of *Art. 101–TFEU* and *U.S. DOJ-FTC*, procompetitive pools should preferably comprise complementary (essential) patents that are not substitutes. Substitute patents are generally non-blocking. They are competing since they cover alternative technologies that are usable in chorus without infringing themselves. It is thus reasonable to regard them as redundant or idles, and predisposed to abuse by their respective owners. As such, they tend to raise antitrust concerns and warrant due scrutiny. Generally, integration, and coordination of such complementary patents yield their intended output or function, as clearly defined in the standard (product). The essentiality of such patents makes standards technically compliant and interoperable. Chiefly, it increases the rates of adoption of standards in the market (WIPO 2014; Mattioli 2014; Lerner and Tirole 2004; Llanes and Trento 2012; Shapiro 2001; Stefano 2014; Bonadio 2013). It is thus rational to argue that: 1) essential patents that can block the functioning of a standard product must be invited and incorporated in the pool; 2) invalid or expired patents must completely be left outside the pool mainly because of their antitrust risks.

The foregoing property, first, implies that the essentiality of patents in pools is not static. It can be lost, and render patents non-essential. This usually happens when essential patents become substitutable in a standard (WIPO 2014). In turn, such non-essentiality may not necessarily lead to illegality, although it may reduce the performance of pools if

it becomes extravagant (Gilbert 2010). Overall, pools loaded with non-essential patents, may still work albeit sub-optimally, without restricting competition, if at least one essential patent is admitted in, and independent licensing of patents by licensors (members) with other right holders are permitted as also echoed by Galini (2011). Such a sub-optimal performance is likely to arise due to concerns about freeriding, distortions of royalty sharing, thence disincentives that such non-essential patents are likely to induce among the owners of essential patents.

Second, complementary patents, if they are predominant in a pool, are likely to act as perfect inputs in production of a standard product as intended. They are thus likely to render such production more efficient pursuant the early discourse and Cournot (1838)'s theorizing. Such a pool is furthermore likely to constitute an important solution to the well-known anti-commons tragedy, a market failure, arising from the inability of various patent owners to use their rights without infringements (Heller; Eisenberg 1988; Gallini 2011). Because all the pooled patents will be regarded as equally important in the production process, they are likely to attract and encourage full-participation of the owners of essential patents and as such increase the rate of manufacturing, and dissemination of the standard products in the markets. Such a dissemination will likely result in lower prices in the markets, and increase demand for the same products or its updated versions, pursuant to Carnot (1838)'s theorem. In the end, this outcome will likely compel the pool members to develop additional technologies to capture the subsequent benefits arising in the markets.

In addition, the equilibrium of royalties' distributions among the foregoing members will very likely be steady and free of distortions that might have otherwise occurred in the presence of large numbers of redundant substitute, or nonessential patents. The latter patents are likely to result in high royalties' payments imposed to the licensees, which unfortunately are likely to be unduly distributed to the respective holders of such patents. In a sense, this case should reasonably be regarded as a sophisticated form of abuse against the licensees, who will have to make payment for inputs that are not essential in the production of costly standard products.

On the contrary, admitting only essential patents in a pool is likely to broaden to their respective members the prospects for accumulating higher profit margins, fairly, given that their (essential) patents are likely to be regarded as equally contributing to the production of the standard products. Second, because the foregoing conditions are conventionally highly favourable to innovation process, they will likely encourage the pool members to augment their technological development efforts to maximize the potential profit margins arsing within and beyond the pool. Subsequently, the rates of: 1) technological development are likely to increase within the pool; 2) spillovers of such development are likely to accrue among other technology developers outside the pool.

In contrast, a pool comprised of pure substitute patents is very likely to offer limited technological choices to its own members and third parties. Such limitations are likewise capable of constraining innovation that generally relies on the supply of a variety of technologies. In a long run, it will likely lead to higher prices of, and constrain access to, standard products in downstream market as also noted by Gallini (2011). This is a negative consequence likely to arise from the scarcity of technologies alluded to early, which can have an opposite effect from that which might have otherwise occurred with a diverse supply of technologies. The latter generally help to lower the costs of production of standard products. From this standpoint, it would not be unseasonable to perceive pools loaded with substitute patents as a disguised stratagem that firms can use to control or fix the market prices, foreclose potential competitors and/or restrict downstream technology and knowledge spillover and licensing process.

Furthermore, such pools can distort the equilibrium of royalties payable to certain licensors (particularly those holding essential patents), if such distribution is a dependent variable of the aver-all population of patents present in a pool. Members holding large amounts of substitute patents are likely to shift such equilibrium to their side and internalise higher and undue benefits to the detriment of the other members holding essential patents. In the end, the owners of essential patents will likely exit such pools due to their respective imbalanced and unfair royalty-sharing scheme. The owners of essential patents, who elect to remain in such pools are likely to relax their expenditures in new technology development and dissemination initiatives because the conventionally pursued and expected payoffs will be prone to distortions, likely negligible and insufficient to sustain their innovation efforts.

2.2 Effects of procompetitive licensing terms on performances of firms in a pools

A number of competition scholarships highlighted some of the assumptions underlying the antitrust guidelines of *Article 101-TFEU and U.S.DOJ-TFC*, such as the causal links between firms' willingness to participate in standard essential patent pool programs and FRAND licenses, over the past decade. In their early studies, for example, Lerner and Tirole (2010), and Aoki and Nagoaka (2004) noted that firms specialized in R&D tended to be less attracted by excessive royalties, which generally are associated with limited market demands. Such firms tended to join pools that offered smaller royalties because the associated chances of capturing the rapidly expanding profits, which they anticipated therein, were high.

It can subsequently be reasonable to assert that firms specialized only in the manufacturing sector will likely tend to participate in pools that offer low royalties to limit their marginal costs of producing standard products. Firms holding high value of patent portfolio will unlikely participate in pools in which royalties' distributions are numerical, i.e. proportional to the total numbers of patents owned in the pools. Firms will be willing to participate in pools offering numerical royalties distributions, when patents contributing to standards are relatively symmetric in value. It is also rational to argue that equal sharing of royalty earnings among the pool members (regardless of the exact contribution of their patents) is likely to act as a disincentive to R&D investment by the highest performers. The later might in the end feel depressed, thence discouraged, by an unfair licensing terms that distribute undue profits to poor performers (owners of idle or weak patents) at their expense.

3. Data and methods

The data on licensing agreements, patent pools and pools' members was obtained from the *U.S. DOJ* and UNITAID's Medicines Patent Pools (based in Geneva). The analysis followed the conventional bibliometric methodology on development of, and diffusion or access to, technological knowledge (OECD 1997; EUC 1997; Moed and Vriens 1989). Patent citations received by the claimed inventions of the essential patents admitted in the pools were used to respond to the second research question: *Does such procompetitive pooling help other technology developers such as rivals and innovators outside the pools to access the patented knowledge?* The follow-on patent applications made by their respective inventors of the essential patents, and pertaining to similar patent classes as those in admitted the standard helped to respond to the first research question: *Does pooling patents with procompetitive licenses encourage inventors of patents admitted in the pools to develop new technological knowledge?*

Patent Cooperation Treaty (PCT) data was used through the analysis because it is the standard indicator for the international scope of a patented technology. It was gathered from the WIPO database. Overall, the research design helped to gauge the extent to which pool members were encouraged to develop additional inventions and contribute to technology development. Replicas of patent applications were screened and duplicates in the respective citations and applications as well as self-citations were discounted in the analysis to avert the conventionally known biases, and pursuant to the customary bibliometrics (Hicks and Katz 1996; Harhoff et al. 2003; Thomson 2016; Lubango and Pouris 2010; Tijssen 1992; Moed and Vriens 1989). In the follow-up of this section, the characteristics of the patent samples, which were selected from the pool based on their validly in jurisdictions they were granted, and subjected to analysis, are outlined.

Patent pools # 1: Bio-pharmaceutical patent pool

Established in 2010 by UNITAID, the Medicine Patent Pool, from which the analysed patent (referred to hereinafter as sample patent) was selected, based on its validly in jurisdictions it was granted, essentiality in the product, and approval or pre-qualification by the Wold Health Organizations Expert Review Panel, has public health mandate. Registered under the laws of Switzerland, with its principal place of business in Geneva, this pool operates on voluntary licensing basis and collaborates closely with pharmaceutical manufacturing firms and patent holders. It aims to: 1) improve access to affordable and quality-assured HIV medicines in the developing countries; 2) facilitate development of formulations adapted to the developing countries' needs such as paediatric formulations and fixed-dosed combinations.

In 2010, the pool signed licenses with seven patent holders (of complementary patents) for 12 HIV medicines. Such licenses complied with several other pro-competitive principles alluded to in the early sections.[3] In 2015, the pool had sub-licenses with about 12 generic manufacturers, who supplied the products to about 7.2 million patients. By 2015, the pool had saved the international community $119, 6 million through the purchase of affordable treatments. Among the said manufacturers or firms, include Bristol-Myers Squibb, Gilead Sciences, Hoffman-La Roche, AbbVie, The *U.S. National Institutes of Health*, and ViiVHealth Care[3].

Characteristics of sample patent # 1

The patent family name is atazanavir (ATV). The exact title of the sample patent is *Quinolines derivatives and their use as mycobacterial inhibitors.* The application date was 05/02/2004 and the patent was subsequently registered through the PCT system, covering many developing countries from Asia, Africa and Latin America and the Caribbean. The inventors and the applicants are resident from Belgium and France. The licensor is Bristol-Myers Squibb. Licensee(s) are Aurobindo, Cipla, Desano, Emcure, Hetero and Mylan. Briefly, the invention relates to novel substituted quinoline derivatives according to the general Formula (Ia) or the general Formula (Ib), the pharmaceutically acceptable acid or base addition salts thereof, the stereochemically isomeric forms thereof, the tautomeric forms thereof and the N-oxide forms thereof. The claimed compounds is useful for the treatment of mycobacterial diseases, particularly those diseases caused by pathogenic mycobacteria such as Mycobacterium tuberculosis, M. bovis, M. avium and M. marinum (WIPO[4]; EPO[5]).

[3] Medicine Patent Pool

[4] http://www.wipo.int/portal/en/index.html.

[5] https://worldwide.espacenet.com/publicationDetails/biblio?DB=worldwide.espacenet.com&II

In particular, the compounds are claimed independently from each other. R<1> is bromo, p=1, R<2> is alkyloxy, R<3> is optionally substituted naphthyl or phenyl, q=1, R<4> and R<5> each independently are hydrogen, methyl or ethyl, R<6> is hydrogen, r is equal to zero or one and R<7> is hydrogen. Also claimed is a composition comprising a pharmaceutically acceptable carrier and, as active ingredient, a therapeutically effective amount of the claimed compounds, the use of the claimed compounds or compositions for the manufacture of a medicament for the treatment of mycobacterial diseases and a process for preparing the claimed compounds. The International Patent Classification (IPC) includes:

A61K31/47; A61K31/4706; A61K31/496; A61K31/5377; A61K31/541; A61P31/06; C07D215/227; C07D215/36; C07D215/48; C07D401/06; C07D401/12; C07D405/04; C07D405/06; C07D409/04; C07D409/06; C07D413/02; C07D417/02; C07D471/04; C07D521/00; C07D215/22; (IPC17): A61K31/47; A61P31/06; C07D215/22; C07D215/36; C07D215/48; C07D221/00; C07D235/00; C07D401/06; C07D401/12; C07D405/04; C07D405/06; C07D409/04; C07D409/06; C07D471/04.

The sample patent was pooled pursuant to the procompetitive licensing terms agreed between UNITAID's Medicine Patent Pool and Bristol-Myers Squibb, to foster competition among the generics' manufacturers; drive down the price of medicines, and stimulate innovation. Notably, such licenses[3] allowed:

i. Manufacturing of generic active pharmaceutical ingredient and finished formulation of Atazanavir anywhere in the world;
ii. Sale in at least 110 countries where 88.5% of people leaving with HIV are concentrated (mainly in law- and middle-income countries);
iii. Manufacturers, who do not rely on Bristol-Myers Squibb' s technology, to sell outside the 110 countries, if no granted patent is infringed;
iv. The foregoing sales to countries issuing compulsory licenses pursuant to TRIPS agreements;
v. Royalty free for paediatric formulations or for sales of adult formulations in Sub-Saharan Africa and India;
vi. Sub-licensees to combine Atazanavir with other antiretroviral and develop new fixed dose combinations;
vii. Data exclusivity waiver in countries, that have the related protection;
viii. Technology transfer package to all sub-licensees.

Patent pools # 2: MPEG-2[6]

MPEG-2 (standard) is a digital video compression technology applicable in many markets, such as video, telecommunication, cable satellite and broadcast television. Eight companies, trustees of Columbia University, initially formed the standard in 1997 because its implementation required licensing of about 27 complementary (essential) patents held by different companies located in Japan, USA and the Netherlands. They were Fujitsu Limited, General Instruments Corp., Lucent Technologies Inc., Matsushita Electric Industrial Co., Ltd, Mitsubishi Electric Corp., Philips Electronics N.V, Scientific Atlanta,

=0&ND=3&adjacent=true&locale=en_EP&FT=D&date=20040205&CC=WO&NR=2004011436A1&KC=A1#

[6] MPEG 2 stands for Moving Picture Experts Group (MPEG). It was created by ISO and IEC to set standards for audio and video compression and transmission. It is the compression scheme for over-the- air digital television ATSC, DVB and ISDB, digital satellite TV services like Dish Network, digital cable television signals, SVCD and DVD V (https://en.wikipedia.org/wiki/MPEG-2)

Inc. and Sony Corp. They were the licensors. MPEG-LA, a separate entity, administered the licenses, and oversaw the essentiality of the patents admitted in the pool. MPEG-2 standard was approved as an international standard by MPEG of the International Organization for Standards (ISO), the International Electrotechnical Commission (IEC), and the International Telecommunication Union Telecommunication Standardization Sector (ITU-T). Additional companies joined the pool the years that followed. Notable among the latter were (in 2011): Apple computer, Inc., Canon Kabushiki Kaisha; Hitachi, Ltd; LG Electric, Inc.;; JVC; Toshiba Corporation, International Business Machine, Mitsubishi Denki Kabushiki Kaisha; Nihon Tokushu Noyaku Seizo K.K.; Samsung Electronics Co, Ltd; and Semiconductor Energy Laboratory Co., Ltd (Layne-Farrar; Lerner 2011).

MPEG-LA assembled and offered a package of hardware and software licenses to the pool's members and distribute royalties among the contributing patent holders on per-patent terms (The *U.S. DOJ-FTC*, 1999). One of the patents, which has randomly been selected for analysis in this paper, belongs to SONY Corporation based in Japan.

Characteristics of sample patent # 2

The selected patent (hereinafter referred to as sample patent) belongs to the broad data storage and transport technology family. It was selected based on its essentiality in the standard, validity in the jurisdiction it was granted and approval by MPEG-LA, pursuant to the *U.S. DOJ-FTC* guidelines. The exact title of the invention is *Coding method and system, and decoding method and system.* The applicant (SONY Corporation) and the inventors are from Japan. The patent's priority date is 26/10/1992, and is registered at the USPTO. Briefly, a coding method, decoding method, coding system, and decoding system for efficiently variable length coding and variable length decoding quantized data compared with existing ones. Input data is variable length coded by using a variable length coding table 23C or 23D selected among a plurality of variable length coding tables 23C and 23D prepared in accordance with a coding efficiency. Thereby, it is possible to further improve a variable length coding efficiency compared with a case for using only one variable length coding table. As a result, when generating information content equal to that generated by using only one variable length coding table, it is possible to process data quantized with smaller quantized size and further improve the quality of information transmitted as coded data (USPTO). The IPC included: H04N7/26; H04N7/30; H04N7/50; (IPC1-7): H04N7/18.

4. Results and discussion

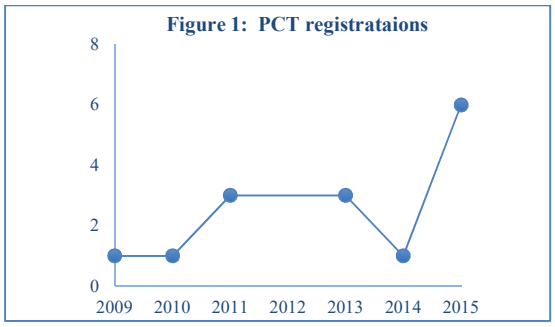
The pattern of PCT registrations and forward patent citations for the two patents selected from their respective pools are discoursed below.

4.1 Technology development

Follow-on patent applications made in the technological classes similar to *Quinoline derivatives and their use as mycobacterial inhibitors*, from pool # 1

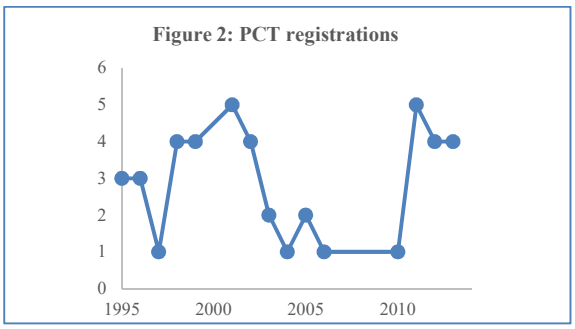
An increase in the number of new PCT registrations made by the inventor(s) of quinoline derivatives building on the sample patent (i.e. pertaining to the same classes) occurred right after the establishment of the pool in 2010 as revealed in Figure 1. In 2013, the number of PCT registrations dropped, and took off rapidly from 2014, reaching in

2015 higher levels than before. This increase indicates that inventors of the sample patent were encouraged to develop more inventions when they joined the pool.



Follow-on patent applications made in the technological classes similar to *Coding method and system, and decoding method and system*, from pool # 2

As outlined in Figure 2, a rapid and significant increase in the number of PCT registrations quoting the patent sample occurred right after the patent was admitted in the pool (1997). The increase that continued until 2001, dropped thereafter significantly, reaching low levels similar to those observed prior to formation of such a pool.

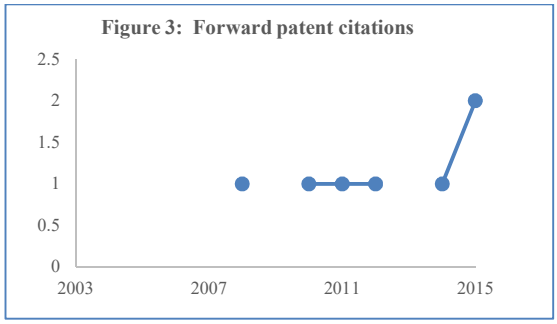


However, from 2006 onward, a steep and steady increase re-emerged, which reached the maximum point in 2012. Undoubtedly, the observed pattern of technology development indicates that inventors of the invention claimed in the sample patent gained sufficient legal certainty that reassured and encouraged them to scale-up their investment in research and development; produced more inventions which they disclosed globally as reflected by the observed expansions in PCT registrations. Indeed, pooling patents on pro-competitive terms gave rise to technology development for the two pools, although in different fashions.

4.1 Technology access (diffusion)

Diffusion from the patent from pool # 1: *Quinoline derivatives and their use as mycobacterial inhibitors*

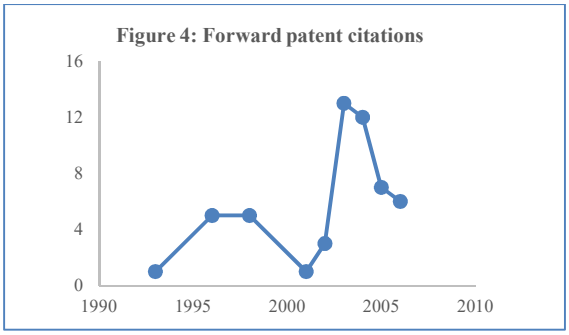
The number of forward patent citations was relatively slow from 2006 as outlined in Figure 3. It increased slightly from 2014 onwards, after the sample patent's admission in the pool. This pattern indicates that the uptake of the related inventions by firms or inventors (outside the pool) through quotations was moderate, although the sample patent had an international protection through the PCT route.



Nevertheless, access to such an invention in its embodied form, i.e. as medicine, was different. If measured by the decrease in median (unit) price of medicines for buyers, access to Atazanavir was enhanced. Price dropped down to much more affordable and accessible levels by a number of countries. In South Africa, for example, such a price of Atazanavir, which was about USD 5.26 in 2007 before the related pool was created, decreased gradually after formation of the pool, reaching USD 0.26 in 2014 and 0.36 in 2015[7]. It is thus reasonable to argue that procompetitive pooling of the sample patent achieved some of its important goals: (1) pushing down the price of medicines to much more affordable and accessible levels by a number of countries, and (2) facilitating access (through quotations by third parties) to technological knowledge claimed in the sample patents.

Diffusion from the patent from pool # 2: *Coding method and system, and decoding method and system*

The pattern of forward patent citations outlined in Figure 4 differed significantly from that seen in the case of the quinoline derivatives. Here, the rise in the number of citations was much faster, and steady from, even ten years after, admission of the sample patent in the pool. Access and use of the technical knowledge of the sample patent through quotation by other technology developers (inventors or innovators) in the downstream markets was fast.



Overall, the various patterns of technology development and access observed on the two industries could reasonably be ascribed to differences in structures and dynamics of their respective markets. On the one hand, the wide spread /access of the essential patent sample of MPEG-2 standard, as well as the related development, were likely enhanced by the

[7] (http://mshpriceguide.org/en/single-drug-information/?DMFId=1283&searchYear=2015).

a. Relatively larger numbers of applications of MPEG-2 standard across sectors, such as digital satellite television services, including dish networks, and digital television signals; which in turn are widely used by large numbers of consumers across markets and societies;
b. Large numbers of multinational companies in the digital, electronics and other markets (such as those alluded to in section 3), with high R&D intensity, and advanced product distribution networks, facilitating adoption of related products and services by various tranches of consumers worldwide, and permanently searching for, and adopting, relevant inventions to support their innovation plans.

On the other hand, the bio-pharmaceutical technologies generally are applicable in products usable by a limited category of consumers in the global market. Atazanavir and related products, for example, are used by relatively few consumers; mostly people leaving with HIV, who largely (88% plus) are concentrated in the low- and middle-income (developing countries), where resources for R&D and follow-on technology or inventions are relatively limited. Because most companies endowed with such resources are established in the developed world, and tend to pursue different research priorities mostly relevant to their respective regions, the overall R&D intensity in HIV and related diseases regarded as mostly concerning the developing countries, will be marginal. Subsequently, adoption and further development or innovation of Atazanavir was enhanced but remained outweighed by that corresponding to the data encoding technology, despite the highly favourable licensing terms of UNITAID's Medicine Patent Pools, which allowed for example:

(1) Non-exclusive and non-discriminatory sub-licenses to multiple-manufacturers;
(2) Sales of medicines outside the territory covered by the licenses agreements, including in jurisdictions affording compulsory licensing pursuant to TRIPS Agreement;
(3) Waver of data exclusivity; and
(4) Technology transfer packages.

5. Conclusion and recommendations

The aim of this paper was to explore whether, and to what extents, procompetitive pool could boost development of, and access, to technological knowledge. The issue was explored empirically using patent samples from the digital and bio-pharmaceutical industries. Using the guidelines for patent pool formation from the *EUC* and *U.S.DOJ* as a generic model for discoursing the effects of procompetitive patent pooling on technology development and access, the paper proposed a set of criteria that are likely to make of patent pools, the springboards of technology development, dissemination and global access. The analysed patents were pooled pursuant to the antitrust guidelines on procompetitive patent pools from the jurisdictions where the pools operated. Compliance with such guidelines, which was a pre-requisite to functioning of pools in such jurisdictions, helped to address the conventional antitrust concerns associated with pools. Notably, the latter are: (1) facilitating manufacturing, interoperability and market adoption of standard products that require integration of complementary patents held by various parties; (2) clearing royalty stacking and hold-ups; (3) alleviating risks of litigations; and (4) reducing transaction costs associated with numerous licensing agreements among those parties.

The observed increases of numbers of PCT applications made by inventors, whose patents were admitted in the pools, indicate that such inventors developed additional technologies, subsequent to admission of their respective patents in the pools. Such move

was probably prompted by the emergence of market demands for the standard products as the latter were disseminated and accessed globally as revealed by the analysis. The need to diversify the product lines, create new market niches; upgrade the existing products or adapt to prospective markets might have prompted pool members to develop such (new) technological knowledge. Cost-effectiveness of investing in technological classes similar to those of patent admitted in the pool as standard essential technologies can also be an additional justification for the propensity of such inventor(s) to develop technologies in the similar rather than alternative classes.

All the observed advantages constitute an addendum to the conventionally recognized attributes of pools. Notably the latter are: increasing product interoperability and marketing, mitigating risks of litigations, royalty staking and transaction costs associated with multiple-licensing agreement among holdings and internalizing higher profit margins on fair grounds. Legislations in favour of procompetitive licensing in patent pools are proposed as other course of actions that policy makers could use in the developing and developed countries to stimulate cost-effectively technology development and dissemination/access that are in great demand globally, to address a number of sustainable development goals.

The results also indicated that the overall effects of procompetitive patent pools on technology development and diffusion/access depend on the market structures and dynamics. On the one hand, the wide spread /access of the essential patent sample of MPEG-2 standard was likely enhanced by the:

c. Large numbers of applications of MPEG-2 standard across sectors such as digital satellite television services; comprising dish networks, and digital television signals; which in turn have wide-reaching uses across markets and societies;
d. Large numbers of multinational companies in the digital, electronics and other markets (such as those alluded to in section 3), with high R&D intensity, and advanced product distribution networks, covering various tranches of consumers worldwide and permanently searching, and adopting, relevant inventions to support their innovation plans.

On the other hand, the bio-pharmaceutical technologies generally are applicable in products usable by a limited category of consumers in the global market. Atazanavir and related products, for example, are used by relatively few consumers; mostly people leaving with HIV, who largely (88% plus) are concentrated in the low- and middle-income (developing countries), where resources for R&D and follow-on technology or inventions are relatively limited.

Because most companies endowed with such resources are established in the developed world, and tend to pursue different research priorities mostly relevant to their respective regions, the overall R&D intensity in HIV and related diseases regarded as mostly concerning the developing countries, will be marginal. Subsequently, adoption and further development or innovation of Atazanavir was enhanced but remained outweighed by that corresponding to the data encoding technology, despite the highly favourable licensing terms of UNITAID's Medicine Patent Pools.

Overall, procompetitive pooling of the sample patent achieved some of its important goals. First, if measured by the decrease in median (unit) price of medicines for buyers, access to Atazanavir was enhanced. Price dropped down to much more affordable and accessible levels by a number of countries. In South Africa, for example, such a price of Atazanavir, which was about USD 5.26 in 2007 before the related pool was created, decreased gradually after formation of the pool, reaching USD 0.26 in 2014 and 0.36 in 2015[7]. Second, if measured through quotations, access to the inventions related to

Atazanavir by inventors situated outside the pool was achieved albeit slightly as revealed by Figure 3.

Finally, it is worth noting that, despite their observed potential in facilitating production and trade of standard products, stimulating technology development and dissemination and enhancing welfare, patent pools are prone to abuses by the right holders, which can distort or limit access to the foregoing benefits. Some examples of such abuses and restrictions were referred to early; either, implicitly in the discussion about the *EUC* and *U.S.DOJ* antitrust guidelines on patent pools, and/or explicitly in the discourse in section 2 about the effects of the kind of patents admitted in, and licensing agreements on performance of pools. Although an empirical analysis of the effects of such abuses on the benefits intended by patent pools is beyond the scope of this paper, future studies are being planned to assess the specific effects of the following antitrust behaviours that are increasingly perceived as capable of rendering patent pools unproductive or welfare decreasing in the contemporary evolving case laws:

- Admitting invalids and/or expired patents;
- Aggregating, and setting a single price for competing technologies;
- Excluding or concealing complementary technologies, particularly those that are likely to block the functioning of pools;
- Bundling in non-essential patents;
- Excluding, based on discriminatory bases, potential licensors;
- Denying members, the right to license out independently their properties;
- Concertedly using royalty rates that are beyond the scope of the portfolio license to frustrate rival competitors.

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