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Abstract

This study examines the efficiency of tools for fighting software piracy in the conditional distributions of software piracy. Our paper examines software piracy in 99 countries for the period 1994-2010, using contemporary and non-contemporary quantile regressions. The intuition for modelling distributions contingent on existing levels of software piracy is that the effectiveness of tools against piracy may consistently decrease or increase simultaneously with increasing levels of software piracy. Hence, blanket policies against software piracy are unlikely to succeed unless they are contingent on initial levels of software piracy and tailored differently across countries with low, medium and high levels of software piracy. Our findings indicate that GDP per capita, research and development expenditure, main intellectual property laws, multilateral treaties, bilateral treaties, World Intellectual Property Organisation treaties, money supply and respect of the rule of law have negative effects on software piracy. Equitably distributed wealth reduces software piracy, and the tendency not to indulge in software piracy because of equitably distributed wealth increases with increasing software piracy levels. Hence, the negative degree of responsiveness of software piracy to changes in income levels is an increasing function of software piracy. Moreover the relationships between policy instruments and software piracy display various patterns, namely: U-shape, Kuznets-shape, S-shape and negative thresholds. A negative threshold represents negative estimates with increasing negative magnitude throughout the conditional distributions of software piracy. We also discuss the policy implications of our study.

JEL Classification: F42, K42, O34, O38, O57
Keywords: Intellectual property rights; Panel data; Software piracy

1. Introduction

It is now widely acknowledged that a competitive environment for twenty-first century development is centered on the knowledge economy (KE), which fundamentally depends on intellectual capital and protection of Intellectual Property Rights (IPRs). In essence, IPRs protection mechanisms play a fundamental role in the development of KE dimensions, namely: innovation, information and communication technologies (ICTs), education, economic incentives and institutional regimes (Asongu, 2014a). In the process of development, while advances in KE and corresponding technologies have resulted in a wider availability of ICT-related commodities, there is some consensus in scholarly and policy circles that reversed-engineering is appropriate to enhance development catch-up because the existing technologies in some less developed countries are more imitative and adaptive in nature than in developed countries (Mansfield, 1994; Maskus & Penubarti, 1995; Seyoum, 1996; Lee & Mansfield, 1996)[1]. The technologies employed to imitate, copy or pirate KE commodities have been proliferating. In our survey of the current literature, even though there are deep concerns regarding the piracy of software[2], the debate on the relevance of IPRs protection in the software piracy industry is still wide open.

Two main schools of thought have animated the mainstream debate on IPRs protection. The first consists of scholars who advocate that economic development is facilitated by enhanced protection of IPRs (Gould & Gruben, 1996; Falvey et al., 2006). According to this school, the positive nexus is facilitated via an appealing effect of stronger IPRs on factor productivity. Conversely, there is another school of thought which views adherence to strict IPRs protection and ratification of international IPRs treaties, as unfavorable to the economic prosperity of developing countries (Yang & Maskus, 2001; Andrés & Goel, 2011, 2012). According to this school, looser IPRs regimes are essential in the short-run (at least) for less advanced countries to enjoy technology spillovers needed for economic development. This position is consistent with studies which demonstrate that software piracy promotes gains by copyright holders (Tunca &

[1] According to the strand of literature, as nations develop, adoption of more stringent IPRs regimes would, *inter alia*: (i) stimulate exports (Maskus & Penubarti, 1995); (ii) favor technology transfers and innovation (Lee & Mansfield, 1996) and (iii) increase the possibility of investment from multinational enterprises (Mansfield, 1994; Seyoum, 1996).

[2] We use the terms 'software piracy' and 'piracy' interchangeably throughout the paper.

Wu, 2012), scientific publications (Asongu, 2014a) and pro-poor development (Asongu, 2014b)[3].

These contending positions on IPRs protection have led to a substantial bulk of qualitative studies (Peitz &Waelbroeck, 2006; Lau, 2006) but a new stream of quantitative literature has been emerging that focuses on socioeconomic determinants of piracy in the copyright industry (Bezmen & Depken, 2004; Banerjee et al., 2005; Bezmen & Depken, 2006; Andrés, 2006a; Goel & Nelson, 2009). The present inquiry partly builds on this stream of the literature to determine socioeconomic factors that deter software piracy.

The literature on fighting software piracy can be discussed in three main themes. The first theme is the fight against software piracy through non-legal mechanisms such as: community engagement, 'making legal easier', online-only offerings and digital rights management (Holm, 2014). The second theme is the use of catch-up techniques for IPRs policy harmonisation (Asongu, 2013). The third theme concerns fighting software piracy through mechanisms of: (i) certainty in punishment (Yoo et al., 2011); (ii) IPRs protection contingent on legal origins (Asongu, 2015) and knowledge of ethics codes in academic institutions (Santillanes & Felder, 2015); (iii) democratic standards (Piquero & Piquero, 2006); (iv) informal institutions like religion (El-Baily & Gouda, 2011); (v) lawsuits against peer-to-peer networks and corresponding consumers (Tunca, 2012); (vi) the equity theory or fairness (Glass & Wood, 1996; Douglas et al., 2007)[4]; (vii) good governance (Andrés & Asongu, 2013); (viii) human development and good institutions (Driouchi et al., 2015) and (xi) Software User Identity Module (SUIM) (Adu et al., 2014).

The third theme is closest to the present inquiry. In the broader framework of the third theme, this study aims to make a twofold contribution. First, it builds on the documented mechanisms of fighting software piracy to present a more holistic global perspective on fighting piracy. Both macroeconomic and IPRs protection variables are used for this purpose. Second,

[3] Intuitively, software piracy promotes pro-poor development by making pirated technologies available to less developed countries but this piracy is harmful for copyright holders because they lose the benefit of having the copyright and they are mainly in the developed countries. The positive impact of piracy on scientific publications is because the scholars in third world countries are able to use the software that is pirated and which they would not be able to use if it was not pirated. Fighting individual piracy can also backfire on copyright holders because: (i) commercial piracy can increase the copyright holders' profits due to a higher population of consumers and (ii) considerable detection and prosecution of individual piracy can also reduce the profits of copyright holders (Tunca & Wu, 2012). The last point while counter-intuitive can be partly explained by the fact that the substantial use of a product, even if pirated could artificially increase publicity and purchase of legal versions of the same product.

[4] If people think piracy is unfair, they are less likely to engage in the use of pirated software.

we steer clear of the engaged literature which has assessed tools in the fight against software piracy by modeling piracy at the mean of the software piracy distribution (see Andrés, 2006b; Asongu, 2015; Andrés & Asongu, 2013). Therefore, we assess the effect of mechanisms deterring software piracy throughout the conditional distribution of software piracy. In this manner, we distinguish countries with low- medium and high-initial levels of software piracy. The policy relevance of accounting for existing levels in software piracy in the modeling exercise builds on the intuition that instruments in the fight against software piracy are unlikely to be effective unless they are contingent in initial software piracy levels and hence, tailored differently across countries with low-, medium- and high-levels of software piracy. For a quantitative examination of this question, we employ contemporary and non-contemporary quantile regressions on panel data pertaining to 99 countries.

Organisation of the paper: Section 2 discusses linkages between software piracy, IPRs protection and development. The data and methodology are covered in Section 3. The empirical analysis and discussion of results are engaged in Section 4. We conclude our discussion in Section 5.

2. Software piracy, IPRs protection and development

2.1 IPRs and development

There are two main mechanisms through which the strength of IPRs laws and intellectual property (IP) can influence development and economic growth, notably: (i) a direct analysis on the degree by which IPRs affect the creation and diffusion of knowledge within and across countries and (ii) an analysis of the impact of a country's IPRs laws on trade and international transaction, hence an indirect effect of growth (See Bezmen & Depken, 2014; Asongu, 2015).

In the first strand on creation and dissemination of information, the need for IPRs regimes is justified by endogenous theoretical underpinnings of economic growth which suggest that by investing in research and development (R&D), investors and society are respectively rewarded with higher returns and knowledge. According to Romer (1990) and Grossman and Helpman (1991), the accumulation of knowledge, essential for economic prosperity is facilitated by the decreasing cost borne for future innovations. The intuition behind the narrative is that restrictive and/or stringent IPRs laws are fundamentally based on the idea that IPRs protection encourages innovations and inventions which engender positive externalities on growth. There is a growing demand for tighter IPRs regimes by newly industrialised nations, which are requesting for more stringent regulations in regional, multilateral and bilateral arrangements (Asongu 2015).

Bezmen and Depken (2004) in the second strand sustain that the development of a country is influenced by IPRs regimes through the country's international engagements, such as technology transfers, foreign direct investment (FDI) and trade. According to Todaro and Smith (2003), theoretical underpinnings on endogenous growth are consistent with the perception that international trade is an important stimulus to growth, since it is likely that human resources within an economy would be more fully utilized as a country becomes more exposed to world markets. Furthermore, with the relevant absorptive capacities, openness facilitates technology transfer by enabling foreign investors to engage with research-intensive and resource sectors.

Unfortunately, owing to initial conditions or country-specific factors, there is no consensus in the literature that international openness promotes economic growth under all circumstances for all countries under consideration (Henry, 2007; Kose et al., 2011)[5]. There is a wealth of literature sustaining that tight IPRs laws are relevant in stimulating exports (Maskus & Penubarti, 1995), technological transfers (Lee & Mansfield, 1996) and investment from multinational companies (Mansfield, 1994; Seyoum, 1996). Conversely, as highlighted in the introduction, there is also a stream of literature with the position that strict IPRs may have negative effects on scientific publications, copyright holder profits and pro-poor development (Yang & Maskus, 2001; Tunca & Wu, 2012; Asongu, 2014ab).

2.2 Piracy and IPRs protection

Patents and copyrights are the two key areas of IPRs (Shadlen et al. 2003; Asongu 2015). A form of expression such as artistic work and written material is protected by a copyright while new ideas that result in industrial processes or products are protected by patents. Computer software has traditionally been protected by ordinary copyright law. However, more recently patent protection has been granted to software developers. When patents and copyrights

[5] Also see recent literature focusing on the effects of globalisation, in *inter alia*: (i) trade (Shuaibu, 2015); (ii) employment (Anyanwu, 2014; Foster-McGregor et al., 2015); (iii) growth (Kummer-Noormamode, 2014; Tumwebaze & Ijjo, 2015) and (iv) welfare (Makochekanwa, 2014).

are not enforced by governments, an artistic creation or invention process is subject to traditional collective action. In essence, the design of IPRs is intended to address concerns about collective action by endowing authors and investors with some vocational selective incentives or temporal monopolies. Ultimately, while copyrights and patents are in the interest of IP producers, adopting very stringent IPRs regimes may not be attractive to consumers who cannot afford the high price of the protected commodities.

An optimal level of IPRs protection is tailored towards managing the delicate trade-off between producers and consumers of knowledge. The process is complex because IPRs are intangible commodities and, hence, are not the same as normal property rights. In addition, the same idea protected by IPRs can be exploited simultaneously and repeatedly by an unlimited number of users without depleting the stock of idea. Hence, for certain patents like those associated with the treatment of HIV/AIDS in poor countries, the standard rationale for granting patent owners extensive rights may be inhumane, unfeasible and - against the principles of inclusive growth. In essence, endowing IP owners with rights to perpetually restrict usage and control the distribution of commodities is irrelevant because some IP-related commodities are non-excludable by definition. Conversely, in the absence of genuine motivations to producers, innovations may be under-supplied.

Consistent with Yang and Maskus (2001), limited use of ideas would also freeze the idea and hence stifle innovation. Accordingly, tight IPRs would decrease incentives for new technologies and innovations (see Helpman, 1993; Maskus, 2000; Bessen & Maskin, 2000). As emphasised by Shadlen et al. (2005), surplus production can lead to a substitution of the ‘tragedy of the commons’ with the ‘tragedy of the anti-commons’, essentially because downstream innovation may be negatively affected by limited access to upstream innovation. It follows that the unavoidable challenge in the management of IPRs is such that, incentives for ‘knowledge creation’ are provided without necessarily restricting distribution of corresponding knowledge.

Lessig (2001, p. 252) has emphasised that granting extensive copyrights and patent protection renders IPRs effectively permanent because by the time some applications and systems of operations are brought to the public domain, they are almost obsolete. The caveat entails the introduction of: (i) lengthier periods of protection, (ii) more protection scope for owners of copyright and (iii) software under copyright law. Much recently, in addition to the challenging trade-off between limited diffusion of new knowledge and innovation, there has been an evolving policy concern of understanding mechanisms by which software piracy can be minimised. We extend this stream by assessing how macroeconomic variables and IPRs mechanisms can be used to fight software piracy, contingent on initial levels of software piracy.

3. Data and Methodology

3.1 Data

We examine panel data for 99 countries for the period 1994-2010 from the: Business Software Alliance (BSA); World Bank Development Indicators (WDI); Financial Development and Structure Database (FDSD) and World Intellectual Property Organisation (WIPO). Limitations to the number of countries and periodicity are due to constraints in data availability.

The proxy for software piracy is defined as "*the unauthorized copying of computer software which constitutes copyright infringement for either commercial or personal use*" (SIIA, 2000)[6]. According to this narrative, software piracy is multidimensional and could take one of the following forms, *inter alia*: business or commercial piracy, individuals' piracy and organised copying. Three main types of software piracy are distinguished by the BSA, namely: counterfeiting, downloading and end-user copying. Owing to these variations, a concern in the literature has been to obtain an accurate indicator of software piracy. The level of software piracy is estimated as the difference in demand for new software applications (computed from PC shipments) and the legal supply of software. This line of inquiry measures software piracy as the percentage of software (business software for the most part) that is installed illegally (without a license) in a given country on a yearly basis. The corresponding variable is presented in percentage scale from no piracy (0%) to a scenario where all software installed during a given year is of pirated origin (100%). More insights into the measurement are available in BSA (2007, 2009)[7]. It is important to note that the BSA is an industry and its data on software piracy, though inherent of some upward bias[8], is the most widely used in the literature.

The control variables or mechanisms for fighting software piracy are discussed in two main categories, notably: (i) seven institutional, ICT-related and macroeconomic factors and (ii) six 'IPRs laws'-oriented factors. The first category consists of: Gross Domestic Product (GDP)

[6] SIIA stands for Software and Information Industry Association.

[7] Data from the BSA primarily measures commercial software piracy. The interested reader can refer to Traphagan and Griffith (1998) and Png (2008) for more insights into the reliability of piracy data.

[8] This data has been used extensively in the piracy literature (Marron & Steel, 2000; Banerjee et al., 2005; Andrés, 2006a; Goel & Nelson, 2009).

per capita, R&D expenditure, internet penetration, finance, life expectancy and rule of law. Internet penetration has been established to determine piracy (Asongu, 2013). From intuition, the supply of money which is our indicator of financial development is very likely to mitigate piracy because people using pirated software have been documented to lack the financial means to purchase the right commodity (Moores & Esichaikul, 2011). Moreover, the overall impact of money supply on piracy is contingent on the income-levels of those strongly associated with money velocity (Asongu, 2015)[9].

Life expectancy, demographic change, economic development (GDP per capita), institutional development (e.g rule of law) and knowledge economy (e.g research and development) have also been documented to determine the level of piracy (Andrés & Goel, 2011, pp. 7-8). In line with Goel and Nelson (2009), GDP per capita is expected to mitigate piracy because, with increasing wealth, if the fruits of economic prosperity are evenly distributed, 'citizens would have the money to buy the right thing'. The rule of law is expected to keep piracy in- check (Driouchi et al., 2015).

The second category entails IPRs laws, namely: *constitution*, *main IP laws*, *IPRs laws*, *WIPO Treaties*, *multilateral treaties* and *bilateral treaties.* Many empirical studies have documented significant nexuses between IPRs laws, international treaties, legal frameworks and software piracy (Holm, 2003; Van Kranenburg & Hogenbirk, 2005; Ki et al., 2006; Baghci et al., 2006; Andrés, 2006a; Driouchi et al., 2015). The IPRs indicators are obtained from the WIPO. IPRs laws and main IP laws are those that are enacted by the legislature and enforced by institutions while WIPO administered treaties are defined from the day they enter into force for the contracting party. IP relevant bilateral and multilateral treaties are also computed according to the date they are enforced by contracting parties. The above-mentioned IPRs variables have been used in recent software piracy literature (Asongu, 2015).

Definitions of variables and corresponding sources are presented in Appendix 1, the summary statistics in Appendix 2 and the correlation matrix in Appendix 3. The purpose of the correlation matrix is to mitigate potential issues of multicollinearity. In light of the substantial

[9] According to the narrative, piracy is strongly associated with poverty or the proportion of the population in the low income strata. This position is in accordance with the argument made by Moores and Esichaikul (2011, p.1) that the motivations for software piracy is related with the cultural and economic circumstances of those indulging in software piracy.

degree of substitution between some variables, two specifications are adopted in the modelling exercise.

3.2 Methodology

We have already justified the need to examine mechanisms in the fight against software piracy throughout the conditional distributions of software piracy. For this purpose, we are consistent with the literature on conditional determinants by using quantile regressions (QR) as our estimation technique (Billger & Goel, 2009; Okada & Samreth, 2012). The procedure consists of accounting for initial levels of the dependent variable (Keonker & Hallock, 2001), notably countries with low-, medium- and high-levels of software piracy.

Previous studies on the fight against software piracy have reported parameter estimates at the conditional mean of piracy (Andrés, 2006ab; Andrés & Asongu, 2013). While mean effects are important, we extend the stream of literature by employing QR in order to account for existing levels of software piracy. For instance, whereas the Ordinary Least Squares (OLS) approach used by Andrés (2006b) is based on the assumption that software piracy and errors terms are normally distributed, the QR approach is not based on the hypothesis that error terms are distributed normally. Hence, this technique enables the line of inquiry to assess the effect of tools against software piracy with particular empahsiss on bad, worse and worst countries in terms of software piracy. Accordingly, with QR, estimates of parameters are derived at multiple points of conditional distributions of software piracy

The θ^{th} quantile estimator of software piracy is obtained by solving the following optimization problem, where $\theta \in (0,1)$.[10]

$$\min_{\beta \in R^k} \left[\sum_{i \in \{i: y_i \geq x_i'\beta\}} \theta \left| y_i - x_i'\beta \right| + \sum_{i \in \{i: y_i \geq x_i'\beta\}} (1-\theta) \left| y_i - x_i'\beta \right| \right], \tag{1}$$

As opposed to the OLS which is fundamentally based on minimising the sum of squared residuals, under the QR technique, the weighted sum of absolute deviations are minimised. For

[10] The quantile estimator is disclosed without subscripts in Eq. (1) for the purpose of simplicity and ease of presentation.

instance the 25th or 75th quintiles (with θ=0.25 or 0.75 respectively) are assessed. The conditional quintile of software piracy or y_i given x_i is:

$$Q_y(\theta / x_i) = x_{i'}\beta_\theta \qquad (2)$$

where unique slope parameters are modelled for each θ^{th} specific quantile. This formulation is analogous to $E(y/x) = \beta x_{i'}$ in the OLS slope where parameters are investigated only at the mean of the conditional distribution of piracy.

For the model in Eq. (2), the dependent variable y_i is the software piracy indicator while x_i contains a constant term, *GDP per capita*, *research and development expenditure (R&D), internet penetration, rule of law, life expectancy, financial development, constitution, main IP law, IP law, WIPO treaties, multilateral treaties* and *bilateral treaties*. The specifications in Eq. (1) are tailored to mitigate multicollinearity issues identified in Appendix 3.

4. Empirical results

4.1 Presentation of results

Empirical findings are presented in Tables 1-2 below. While the left-hand-side (LHS) of the tables corresponds to contemporary estimations, the right-hand-side (RHS) entails non-contemporary regressions. The purpose of lagging the independent variables on the RHS by a year is to have some bite on endogeneity (see Mlachila et al., 2014, p. 21). It is important to note that in the modelling exercise, the number of observations in contemporary specifications may be lower than those in non-contemporary specifications because of issues with degrees of freedom. This is essentially the case when combinations between the dependent variable and regressors are more apparent in non-contemporary regressions. Consistent differences in estimated parameters between OLS and quintiles (in terms of sign, significance and magnitude of significance) justify adoption of the empirical strategy. Hence, distinguishing mean effects and conditional mean effects avails more room for policy implications.

Since the effects of piracy protection tools are examined throughout the conditional distributions of software piracy, corresponding tendencies are likely to take several patterns, namely: U-shape, Kuznets or inverted U-shape, S-shape and positive or negative threshold shapes. Positive thresholds within the context of this study are established when corresponding estimates of software protection tools consistently display decreasing negative magnitudes and/or increasing positive magnitudes throughout the conditional distributions of software piracy. On the other hand, negative thresholds are established by consistent increasing negative or decreasing positive magnitudes from estimated coefficients. The latter threshold perspective aligns with our line of inquiry because the purpose of the study is to identify instruments by which software piracy can be mitigated. Overall, the evidence of threshold supports the intuition for modelling the effects of software piracy throughout its conditional distributions, with the view that the tools against piracy may consistently decreases or increase concurrently with increasing levels of software piracy.

The following findings can be established from Table 1. First, there is evidence of a negative threshold from: (i) GDP per capita and internet penetration throughout the distributions of software piracy and (ii) R&D and main IP law from the 0.25th to the 0.90th quintile. Second, there is a U-shape nexus from multilateral treaties, with a trough at the 0.50th quintile. In other words, the degree of negativity increases up to the 0.50th quantile, then decreases through the 0.90th quintile. Third, the *constitution* and WIPO treaties have negative effects on software piracy exclusively at the highest quintile while the negative effect of bilateral treaties are more apparent in the bottom half of the distribution through the 0.75th quintile. Fourth, the effects of population growth and IP laws are positive. Fifth, findings on the LHS are broadly consistent with those of the RHS.

Table 1: Conditional Determinants (First Specification)

	Contemporary						Non-Contemporary					
	OLS	Q.10	Q.25	Q.50	Q.75	Q.90	OLS	Q.10	Q.25	Q.50	Q.75	Q.90
Constant	2.562	1.482***	2.351***	2.416***	3.125***	3.795***	2.874***	2.448***	2.640***	2.910***	3.443***	3.822***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Gross Domestic Product	-0.51***	-0.353***	-0.483***	-0.501***	-0.619***	-0.747***	-0.566***	-0.505***	-0.533***	-0.585***	-0.689***	-0.745***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Research and Development	-0.078***	-0.089***	-0.059***	-0.078***	-0.093***	-0.112***	-0.082***	-0.071***	-0.067***	-0.076***	-0.093***	-0.122***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Internet Penetration	-0.090***	-0.049***	-0.069***	-0.099***	-0.126***	-0.136***	-0.045**	0.014	-0.020	-0.040**	-0.100***	-0.115***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.011)	(0.130)	(0.176)	(0.010)	(0.000)	(0.000)
Population	0.043*	0.039**	0.014	0.050***	0.063***	0.073***	0.005	-0.042**	-0.021	-0.0005	0.039	0.054**
	(0.065)	(0.012)	(0.481)	(0.006)	(0.005)	(0.000)	(0.798)	(0.030)	(0.252)	(0.975)	(0.104)	(0.016)
Constitution	-0.004	0.013	0.016	0.076***	-0.020	-0.145***	0.002	0.026*	0.027	0.073***	-0.020	-0.133***
	(0.857)	(0.549)	(0.486)	(0.000)	(0.427)	(0.000)	(0.916)	(0.089)	(0.192)	(0.001)	(0.442)	(0.000)
Main Intellectual Property Law	-0.026***	-0.031***	-0.012**	-0.012***	-0.018***	-0.018***	-0.025***	-0.028***	-0.014***	-0.015***	-0.015***	-0.016***
	(0.000)	(0.000)	(0.010)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)
Intellectual Property Law	0.006***	0.007***	0.004*	0.0002	0.006***	0.008***	0.007***	0.008***	0.001	0.001	0.008***	0.009***
	(0.000)	(0.000)	(0.073)	(0.907)	(0.005)	(0.005)	(0.000)	(0.000)	(0.382)	(0.367)	(0.001)	(0.000)
WIPO Treaties	0.002	0.005	-0.0005	0.010*	-0.004	-0.020***	0.004	0.012***	0.008	0.011**	-0.004	-0.025***
	(0.736)	(0.298)	(0.941)	(0.089)	(0.514)	(0.009)	(0.459)	(0.009)	(0.157)	(0.049)	(0.591)	(0.000)
Multilateral Treaties	-0.015***	-0.010	-0.012***	-0.015***	-0.013***	-0.009***	-0.016***	-0.012***	-0.013***	-0.015***	-0.012***	-0.008***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Bilateral Treaties	0.001	-0.006*	-0.005	-0.008***	-0.007**	0.015***	0.001	-0.005	-0.006	-0.008***	-0.005	0.019***
	(0.807)	(0.085)	(0.207)	(0.009)	(0.030)	(0.002)	(0.672)	(0.116)	(0.117)	(0.008)	(0.162)	(0.000)
R^2/Pseudo R^2	0.721	0.493	0.512	0.505	0.511	0.523	0.745	0.509	0.531	0.526	0.526	0.548
Fisher	207.27***						240.32***					
Observations	729	729	729	729	729	729	743	743	743	743	743	743

***,**,*: significance levels of 1%, 5% and 10% respectively. WIPO: World Intellectual Property Organization. OLS: Ordinary Least Squares. R^2 (Pseudo R^2) for OLS (Quantile Regressions). Lower quantiles (e.g., Q 0.1) signify nations where Software Piracy is least. The number of observations in contemporary specifications is lower than in non-contemporary specifications because of issues in degrees of freedom. This is essentially because combinations between software piracy and regressors are more apparent in non-contemporary regressions.

Table 2: Conditional Determinants (Second Specification)

	Contemporary						Non-Contemporary					
	OLS	Q.10	Q.25	Q.50	Q.75	Q.90	OLS	Q.10	Q.25	Q.50	Q.75	Q.90
Constant	1.371***	1.247**	2.252***	1.182***	1.290***	0.499	1.553***	1.553***	2.699***	1.609***	1.550***	1.287***
	(0.001)	(0.014)	(0.000)	(0.000)	(0.005)	(0.390)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Rule of Law	-0.265***	-0.219***	-0.270***	-0.313***	-0.278***	-0.252***	-0.273***	-0.273***	-0.269***	-0.312***	-0.271***	-0.250***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Life Expectancy	-0.118	-0.273	-0.750***	-0.075	0.004	0.699	-0.245	-0.245	-0.998***	-0.314**	-0.160***	0.180
	(0.591)	(0.320)	(0.001)	(0.621)	(0.984)	(0.023)	(0.225)	(0.225)	(0.000)	(0.033)	(0.405)	(0.403)
Money Supply	-0.078***	-0.045	-0.011	-0.050***	-0.120***	-0.151***	-0.070***	-0.070***	-0.026	-0.046***	-0.119***	-0.145***
	(0.000)	(0.129)	(0.616)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.171)	(0.001)	(0.000)	(0.000)
Population	-0.066***	-0.071***	-0.065***	-0.061***	-0.055***	-0.084***	-0.067***	-0.067***	-0.066***	-0.063***	-0.057***	-0.078***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constitution	0.028	0.007	0.020	0.023	-0.003	0.023	0.028	0.028	0.003	0.020	0.029***	0.038**
	(0.206)	(0.746)	(0.286)	(0.112)	(0.879)	(0.400)	(0.162)	(0.162)	(0.841)	(0.172)	(0.000)	(0.036)
Main Intellectual Property Law	-0.034***	-0.034***	-0.019***	-0.021***	-0.032***	-0.046***	-0.032***	-0.032***	-0.023***	-0.021***	-0.030***	-0.042***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Intellectual Property Law	0.009***	0.013***	0.007***	0.007***	0.009***	0.012***	0.008***	0.008***	0.009***	0.007***	0.007***	0.010***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
WIPO Treaties	-0.025***	0.0004	-0.013**	-0.028***	-0.034***	-0.047***	-0.019***	-0.019***	-0.007	-0.025***	-0.026***	-0.041***
	(0.000)	(0.944)	(0.035)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.110)	(0.000)	(0.000)	(0.000)
Multilateral Treaties	-0.013***	-0.010***	-0.011***	-0.009***	-0.017***	-0.023***	-0.012***	-0.012***	-0.010***	-0.008***	-0.016***	-0.019***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Bilateral Treaties	-0.005*	-0.008***	-0.009***	-0.006***	-0.002	0.015***	-0.004	-0.004	-0.008***	-0.006***	-0.004*	0.022***
	(0.096)	(0.008)	(0.001)	(0.002)	(0.331)	(0.000)	(0.129)	(0.129)	(0.000)	(0.001)	(0.069)	(0.000)
R^2/Pseudo R^2	0.716	0.523	0.544	0.528	0.490	0.445	0.760	0.544	0.573	0.559	0.528	0.495
Fisher	271.30***						353.57***					
Observations	839	839	839	839	839	839	855	855	855	855	855	855

***,**,*: significance levels of 1%, 5% and 10% respectively. WIPO: World Intellectual Property Organization. OLS: Ordinary Least Squares. R^2 (Pseudo R^2) for OLS (Quantile Regressions). Lower quantiles (e.g., Q 0.1) signify nations where Software Piracy is least. The number of observations in contemporary specifications is lower than in non-contemporary specifications because of issues in degrees of freedom. This is essentially because combinations between software piracy and regressors are more apparent in non-contemporary regressions.

In discussing the findings in Table 2, we first confirm those established in Table 1. First, the effect of main IP laws is consistently negative with a negative threshold from the 0.25th to the 0.90th quintile on the LHS and 0.50th to 0.90th quintiles on the RHS. Second, consistent with Table 1, the effect of *constitution* is not very apparent. Third, the previously established U-shape from multilateral treaties is now S-shape on the LHS and Kuznets shape on the RHS. Fourth, the effect of WIPO treaties is no longer limited to the highest quintiles, but now more apparent in the top quintiles with a negative threshold (or increasing negative magnitude). Fifth, IP laws are still positive but now consistently significant throughout the software piracy distributions. Sixth, consistent with the evidence from Table 1, the effect of bilateral treaties are more apparent in the bottom half of the distribution up to the 0.75th quintile. Seventh, the previously scanty evidence of a negative effect from population growth is now consistently negative throughout software piracy distributions.

On the new findings, the following can be established. First, money supply decreases software piracy with a negative threshold or increasing negative magnitude in the top quintiles. Second, the negative effect of rule of law is U-shape throughout the distribution on the LHS and from the 0.25th quintile on the RHS. Third, the effect of life expectancy is negative and more apparent in the middle distributions on the RHS.

4.2 Further discussion, policy implications and caveats

In this section, we engage with four main categories, notably: (i) assessing the notions of income, equity and equality in light of the established linkage between GDP per capita and software piracy; (ii) discussing another development-oriented category with emphasis on R&D, financial development and governance; (iii) understanding nexuses between IPRs regimes and software piracy and (iv) elucidating some unexpected relationships.

In the first category on 'income, equity, equality and software piracy', the negative effect of GDP per capita on software piracy is consistent with the empirical literature and the predictions of economic theory. Accordingly, the role of income-levels in fighting piracy is consistent with the stream of literature sustaining that software piracy is more apparent in less developed countries (Moores & Esichaikul, 2011; Asongu, 2014a). This is essentially because low income countries lack the financial resources to boost R&D and innovation. Hence, they are more likely to engage in reversed engineering because their technologies are more imitative and adaptive in nature than those in developed countries. This narrative is broadly consistent with Bezmen and Depken (2004), Tunca and Wu (2012) and Asongu (2014ab) notably, on the position that less stringent IPRs on software piracy could *inter alia*: (i) increase FDI; (ii) boost scientific publications (Asongu, 2014a); (iii) increase the profits of copyright holders (Tunca & Wu, 2012) and (iv) facilitate pro-poor development (Asongu, 2014b). The narrative also aligns with a recent finding from Driouchi et al. (2015) on a Kuznets (or inverted U-shaped) nexus between GDP per capita and piracy rates from a sample of world economies.

Conversely, the fact that effectively fighting software increases with incomes may not augur well with a theme of the literature. According to that theme, emphasising that stringent protection against software piracy in low income countries would increase development by: (i) improving exports (Maskus & Penubarti, 1995); (ii) facilitating innovation and the transfer of technology (Lee & Mansfield, 1996) and (iii) boosting investment from multinational companies (Mansfield, 1994; Seyoum, 1996). In light of the findings, it is reasonable to infer that IPRs regimes on software piracy should be consolidated concurrently with increasing levels of income. This inference doubles as a policy recommendation.

There is also an ethical dimension to the findings that merits emphasis. In essence, citizens of poor countries are likely to engage in the use of pirated software because they lack the financial resources to buy the 'correct thing'. This aligns with the equity theory (Glass & Wood, 1996) and empirical insights into the validity of the equity theory (Douglas et al., 2007). The underlying intuition in the equity theory is that individuals are less likely to use pirated software if they view such usage as unfair. Hence it is reasonable to deduct that a situational state of income deprivation might induce a perception of fairness in the usage of pirated software (see Glass & Wood, 1996). 'Equity constructs' employed by Douglas et al. (2007) in the same stream of literature can be traceable to the notions of income-inequality and pro-poor growth, which lead us to briefly discuss how our findings on GDP per capita are consistent with a stream of literature on the nexus between income-inequality and software piracy.

The intuition for engaging with this third dimension builds on the fact that the GDP per capita variable is computed as an average and hence, it inherently assumes equity in the distribution of fruits from economic prosperity. Accordingly, inequality increases software piracy (Andrés, 2006b) and software piracy also decreases income-inequality (Asongu, 2014b).

It follows that the issue of fairness extends beyond perceptions to macroeconomic evidence in poor countries.

As a policy implication, equitably distributed wealth reduces software piracy, and the tendency not to indulge in software piracy because of equitably distributed wealth increases with increasing software piracy levels. In other words, the negative degree of responsiveness of software piracy to changes in income levels is an increasing function of software piracy[11].

This second category aligns with the documented positive relationship between per capita income and human development, which could take several forms, *inter alia*: R&D, financial development and better governance. For brevity, lack of space and the purpose of clarity and consistency, the narrative of this category accords with the discourse of the preceding category that deals with 'income, equity, equality and software piracy'. This analogy is possible if we establish that compared to low-income nations, high-income countries are more positively correlated with dimensions of development, namely: R&D expenditure, financial depth and the rule of law. First, it is logical that high-income countries are more likely to allocate more financial resources for research and development purposes. Second, high-income nations are also associated with higher levels of financial development in terms of financial depth or money supply for at least two reasons: (1) compared to low-income countries, a great portion of the monetary base of high income countries circulates within the formal banking sector (Abu-Bader & Abu-Qarn, 2008; Gries et al., 2009, p. 1851), (2) even the share of monetary base that is withheld within the formal banking sector of low income countries is characterized by substantial issues of surplus liquid liabilities (or bank deposits) (Saxegaard, 2006), hence limiting money supply. Third, high-income countries are associated with higher levels of rule of law compared to their low income counterparts (Rigobon & Rodrik, 2004, p. 533).

After presenting the analogy of high-income and low-income countries, we then proceed to engaging with some more practical insights in the same chronological order of variables. First, we have established that R&D decreases software piracy with a negative threshold or increasing negative magnitude. The finding complements Asongu (2014b) (who has concluded that

[11] In other words, increasing income levels decrease the ability to pirate and the magnitude of the negative relationship increases with increasing piracy levels. For example, *ceteris paribus* a $500 average income (or GDP per capita) decreases software piracy more in countries where initial levels of software piracy are high compared to countries where initial levels of software piracy are low. Moreover, given that piracy levels are higher in low income countries, *ceteris paribus*, the effect of an annual average income of $500 would have a higher decreasing effect in low income countries, compared the same effect in high income countries.

software piracy boosts research for scientific publications) by providing evidence of a reversed effect throughout the conditional distribution of software piracy. Second, the deterring role of money supply with negative thresholds in top quintiles is consistent with our expectation since software piracy is the result of activities from people who lack money to buy the genuine software. This finding has confirmed our expectation by establishing that in countries with comparatively high software piracy rates (or in top quintiles), the negative responsiveness of software piracy to money supply increases with increasing levels of software piracy. Third, the point that the rule of law reduces piracy is consistent with: (i) Yoo et al. (2011) on certainty in punishment; (ii) Driouchi et al. (2015) in relation to good institutions and (iii) Andrés and Asongu (2013) with respect to good governance. We have complemented the existing literature by establishing that the negative effect of governance on software piracy is very likely to be U-shaped, with the trough or highest negative effect in the median (or 0.50^{th}) quintile.

In the third category on IPRs regimes and software piracy, we have established that with the exceptions of *constitution* and IP laws which respectively have insignificant and positive effects on software piracy for the most part, the other IPRs regimes significantly reduce software piracy. The positive effect of IP laws and negative impact from other IPRs channels is consistent with Asongu (2015). Furthermore, subtle differences exist between the findings of this inquiry and those of Asongu (2015), notably: (i) WIPO treaties, main IP laws, and multilateral treaties are negative with increasing negative magnitude at the top end of the software piracy distributions; (ii) bilateral treaties are negative for the most part in the bottom half of the distributions and (iii) the positive effect from IP laws is consistent, regardless of initial levels of software piracy.

The insignificant effect of *constitution* implies that the mere appearance of the term 'copyright' in a country's constitution does not guarantee the respect of software copyright laws by its citizens. Accordingly, the enshrinement of copyright in the constitution needs to be complemented with the adoption and enforcement of IPRs laws. These processes may involve the ratification of bilateral, multilateral and WIPO treaties on IPRs protection. As a policy implication: (i) constitutional support for copyright laws should be complemented with the adoption and enforcement of IPRs laws and treaties in order to achieve a negative effect on software piracy and (ii) the negative effects of IP treaties and laws are more significant with increasing negative magnitudes at the top end of the software piracy distribution or countries in which initial piracy levels are relatively high.

We elucidate some unexpected signs in the fourth category, namely from: population, internet penetration and life expectancy. First, the negative effect from life expectancy is probably because countries with high life expectancies are also associated with high income levels. Therefore, 'software piracy' externalities from life expectancy broadly align with narratives of the first-two categories in this 'discussion of results' section. Second, the negative effect of internet penetration may be traceable to its high correlation with population (see Beck et al., 2013, p. 665-672). Third, the effect of population is not clear-cut when corresponding estimates from both tables are compared.

5. Conclusion and future research directions

This study has examined tools of fighting software piracy throughout the conditional distributions of software piracy in 99 countries for the period 1994-2010, using contemporary and non-contemporary quantile regressions. The intuition for modelling, contingent on existing levels of software piracy is that the effectiveness of tools against piracy may consistently decrease or increase concurrently with increasing levels of software piracy. We have found that GDP per capita, research and development expenditure, main intellectual property laws, multilateral treaties, bilateral treaties, World Intellectual Property Organisation treaties, money supply and respect for the rule of law have negative effects on software piracy. Equitably distributed wealth reduces software piracy and the tendency not to indulge in software piracy because of equitably distributed wealth increases with increasing software piracy levels. Hence, the negative degree of responsiveness of software piracy to changes in income levels is an increasing function of software piracy. Moreover the relationships between policy instruments and software piracy display various patterns, namely: U-shape, Kuznets-shape, S-shape and negative thresholds. A negative threshold represents negative estimates with increasing negative magnitude throughout the conditional distributions of software piracy.

More specifically, the following findings have been established. First, there is evidence of a negative threshold from: (i) GDP per capita and internet penetration throughout the distribution of software piracy and (ii) research and development and main IP law from the 0.25^{th} to the 0.90^{th} quintiles. Second, the simple fact of mentioning 'copyright' in a country's constitution has no significant effect. Third, depending on model and contemporaneous character of specification, negative effects from multilateral treaties are U-shaped, S-shaped and Kuznets shape. Fourth, the negative impact of WIPO treaties is in top quintiles, with a negative threshold. Fifth, the negative effect of bilateral treaties is more apparent in the bottom quintile through the 0.75^{th} quintile. Sixth, whereas money supply decreases software piracy with a negative threshold effect in top quintiles, the impact of the rule of law is U-shaped throughout the software piracy distributions.

In the light of these findings, it is apparent that blanket policies against software piracy are unlikely to succeed unless they are contingent on initial levels of software piracy and tailored differently across countries with low, medium and high levels of software piracy. Hence, modelling software piracy throughout its conditional distribution has availed space for more policy implications, which have been discussed in the preceding section. Unfortunately among the six IPRs law channels used in the study, the effect of *constitution* and *IP law* have been insignificant and positive respectively. Interacting these indicators with the other four (*main IP law, WIPO treaties, bilateral treaties* and *multilateral treaties*) is an interesting future line of inquiry because it might elucidate if the simultaneous adoption of IPRs regimes can improve extant knowledge on the policy relevance of mechanisms which display insignificant and unexpected signs.

Appendices

Appendix 1: Definitions of variables

Variables	Abbreviation	Definition of variables	Sources
Piracy	Piracy	Logarithm of Piracy rate (annual %)	BSA
Growth per capita	GDP	Logarithm of GDP per Capita, PPP (international constant dollars, 2005)	World Bank (WDI)
Research and Development	R & D	Research and Development Expenditure (% of GDP)	World Bank (WDI)
Internet Penetration	Internet	Logarithm of Internet Users per 1000	GMID
PC Users	PC	Logarithm of PC Users per capita	GMID
Population	Pop.	Logarithm of Population	World Bank (WDI)
Rule of Law	R.L	"Rule of Law (estimate): Captures perceptions of the extent to which agents have confidence in and abide by the rules of society and in particular the quality of contract enforcement, property rights, the police, the courts, as well as the likelihood of crime and violence".	World Bank (WDI)
Life Expectancy	Life E.	Logarithm of Life Expectancy at birth (total years)	World Bank (WDI)
Financial Depth	Finance	Monetary base plus savings, demand and time deposits (% of GDP)	World Bank (FDSD)
Constitution	Const.	Dummy variable: Copyright is mentioned in the constitution	WIPO
Main_IP_law	MIPlaw	Main Intellectual Property Law	WIPO
IP_rlaw	IPlaw	Intellectual Property Rights Law	WIPO
Wipotreaties	WIPO	World Intellectual Property Organization	WIPO
Mutilateral	Multi.	Multilateral Treaties	WIPO
Bilateral	Bilat.	Bilateral Treaties	WIPO

WDI: World Bank's World Development Indicators. FDSD: Financial Development and Structure Database. BSA: Business Software Alliance. GMID: Global Market Information Database. GDP: Gross Domestic Product. Log: Logarithm. WIPO: World Intellectual Property Organization.

Source: Authors' calculation.

Appendix 2: Summary Statistics (1994-2010)

Panel A: Summary Statistics

	Variables	**Mean**	**S.D**	**Min.**	**Max.**	**Obs**
Dependent Variable	Software Piracy rate	0.255	0.449	-0.602	1.995	1500
First Set of Control Variables (Institutional, macroeconomic and ICT related)	GDP per capita (log)	4.006	0.433	3.008	4.924	1643
	Research & Development (R & D)	1.079	0.963	0.006	4.864	811
	Internet Penetration (log)	2.807	1.183	-1.000	5.622	1616
	Personal Computer Users (log)	3.009	0.837	0.698	5.464	1557
	Population (log)	7.063	0.712	5.424	9.126	1682
	Rule of Law	0.337	0.956	-1.657	1.964	1082
	Life Expectancy (log)	1.855	0.049	1.622	1.918	1578
	Finance	0.622	0.497	0.061	4.781	1401
Second Set of Control Variables (IPRs laws and treaties related)	Constitution	0.242	0.428	0.000	1	1683
	Main IP Law	2.134	2.550	0.000	20	1683
	IP Law	2.260	4.669	0.000	47	1683
	WIPO Treaties	3.455	1.877	0.000	7	1683
	Multilateral Treaties	10.594	5.816	0.000	25	1683
	Bilateral Treaties	0.998	2.532	0.000	21	1683

Panel B: Presentation of Countries

"Albania, Algeria, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahrain, Belgium, Bolivia, Bosnia, Botswana, Brazil, Bulgaria, Cameroon, Canada, Chile, China, Colombia, Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Estonia, Finland, France, Germany, Greece, Guatemala, Honduras, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Jordan, Kazakhstan, Kenya, Kuwait, Latvia, Lebanon, Lithuania, Luxembourg, Macedonia, Malaysia, Malta, Mauritius, Mexico, Moldova, Montenegro, Morocco, Netherlands, New Zealand, Nicaragua, Nigeria, Norway, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Puerto Rico, Qatar, Romania, Russia, Saudi Arabia, Senegal, Serbia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Spain, Sweden, Switzerland, Thailand, Tunisia, Turkey, Ukraine, UAE, United Kingdom, United States, Uruguay, Venezuela, Vietnam, Zambia".

S.D: Standard Deviation. Min: Minimum. Max: Maximum. ICT: Information and Communication Technology. Scandi: Scandinavian. Obs: Observations.

Source of Panel A: Authors' calculation.

Appendix 3: Correlation Analysis (Uniform sample, n=486)

Piracy	Macroeconomic, institutional and ICT-related control variables								IPRs laws and treaties related control variables						
rate	GDP	R & D	Internet	PC	Pop.	R.L	Life E.	Finance	Const.	MIPlaw	IPrlaw	WIPO	Multi.	Bilat.	
1.000	-0.766	-0.703	-0.503	-0.551	0.009	-0.770	-0.535	-0.421	0.108	-0.405	-0.109	-0.215	-0.534	-0.180	Piracy
	1.000	0.653	0.386	0.482	-0.206	**0.806**	**0.736**	0.476	-0.173	0.285	0.067	0.077	0.376	0.160	GDP
		1.000	0.424	0.530	0.044	**0.711**	0.487	0.367	-0.161	0.221	-0.042	0.035	0.414	0.248	R & D
			1.000	**0.897**	0.609	0.262	0.306	0.227	0.145	0.284	0.196	0.119	0.316	0.299	Internet
				1.000	**0.688**	0.379	0.356	0.258	0.123	0.286	0.197	0.036	0.319	0.340	PCs
					1.000	-0.207	-0.175	-0.055	0.269	0.068	0.179	-0.087	0.031	0.231	Pop.
						1.000	0.591	0.497	-0.150	0.294	0.058	-0.024	0.438	0.115	R.L
							1.000	0.424	-0.093	0.174	0.132	0.263	0.397	0.137	Life E.
								1.000	-0.123	0.204	0.017	-0.175	0.062	0.008	Finance
									1.000	0.075	0.348	0.068	-0.098	0.241	Const.
										1.000	0.513	0.168	0.184	-0.087	MIPlaw
											1.000	0.209	0.147	-0.006	IPlaw
												1.000	0.569	0.176	WIPO
													1.000	0.078	Multi.
														1.000	Bilat.

GDP: GDP per capita. R&D: Research and Development. Internet: Internet penetration. PC: Personal Computer Users. Pop: Population. R.L: Rule of Law. Life E: Life Expectancy. Const: Constitution. MIPlaw: Main Intellectual Property Law. IPrlaw: Intellectual Property Rights Law. WIPO: World Intellectual Property Organization Treaties. Multi: Multilateral Treaties. Bilat: Bilateral Treaties.

Source: Authors' calculation.

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