Global Software Piracy, Technology and Property Rights Institutions

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Abstract

This study extends the literature on fighting software piracy by investigating how Intellectual Property Rights (IPRs) regimes interact with technology to mitigate software piracy when existing levels of piracy are considered. Two technology metrics (internet penetration rate and number of PC users) and six IPRs mechanisms (constitution, IPR law, main IP laws, WIPO Treaties, bilateral treaties and multilateral treaties) are used in the empirical analysis. The statistical evidence is based on: (i) a panel of 99 countries for the period 1994-2010 and (ii) interactive contemporary and non-contemporary Quantile regressions.The findings show that the relevance of IPR channels in the fight against software piracy is noticeably contingent on the existing levels of technology embodied in the pirated software. There is a twofold policy interest for involving modern estimation techniques such as interactive Quantile regressions. *First*, it uncovers that the impact of IPR systems on software piracy may differ depending on the nature of technologies used. *Second*, the success of initiatives to combat software piracy is contingent on existing levels of the piracy problem. Therefore, policies should be designed differently across nations with high-, intermediate- and low-levels of software piracy.

JEL Classification: F42; K42; O34; O38; O57
Keywords: Piracy; Business Software; Software piracy; Intellectual Property Rights

Introduction

Today, it is amply clear that knowledge economy (KE) is a key driver of competitive advantage and cross-country development in the twenty-first century. The former is substantially traceable to dynamics of intellectual capital as well as the regimes of Intellectual Property Rights (IPRs) applicable in the country. Accordingly, IPRs protection channels play a central mission in the drive to promote knowledge-based economies around the world. Moreover, such IPRs are closely linked with the four dimensions of the World Bank's KE index, namely: education, information and communications technologies (ICTs), economic incentives and institutional regime and innovation (Asongu, 2014a; Martínez-Sánchez & Romeu, 2018).

The contemporary relevance of KE extends a longstanding debate on the importance of IPRs in development processes. To be sure, there is some consensus in the literature that in order to facilitate development catch-up processes, reversed engineering in technology is essential, at least in the short term. This evaluation is based on the observation that in developing countries, the architecture of technology is fundamentally more imitative and adaptive (Maskus and Penubarti, 1995; Seyoum, 1996; Mansfield, 1994; Lee and Mansfield, 1996; Asongu, 2017a, 2017b)[1]. To this end, there has recently been a worldwide proliferation of technologies that are used to copy, imitate or pirate KE products and services (Asongu *et al*., 2018; Lee et al., 2018). Indeed, a review of contemporary literature indicates that whereas there are substantial and justifiable worries about the spread of software piracy[2], there is not yet a consensus on the strategies for protecting IPRs in the software industry.

[1] With respect to this strand of the literature, more strict IPRs regimes are adopted as nations make the transition from 'developing countries' to 'developed countries'. Such tight IPRs regimes are likely to, *inter alia*: (i) boosts innovation and technology transfer (Lee and Mansfield, 1996); (ii) favour exports (Maskus and Penubarti, 1995) and (iii) enhance investment by multinational corporations (see Mansfield, 1994; Seyoum, 1996).

[2] Throughout this study, the terms 'piracy' and 'software piracy' are employed interchangeably.

The debate surrounding IPRs protection has fundamentally centered on two dominant schools of thought. According to the first school, strict protection of IPRs facilitates economic development (see Gould and Gruben, 1996; Falvey *et al*., 2006) through its positive impact on productivity enabling factors. By contrast, the second school considers stringent IPRs as very damaging to the catch-up process by poor countries (Andrés and Goel, 2011, 2012; Yang and Maskus, 2001; Kim et al., 2017; Asongu and Tchamyou, 2020). The relevance of this narrative is illustrated by the adoption and ratification of IPRs treaties at the international level. These authors argued that less stringent IPRs regimes are relevant in the short term in order to enable technology spillovers to less developed countries. Such views are supported by recent software piracy literature notably that software piracy increases: scientific publications (Asongu, 2014a), copyright holders' gains (Tunca and Wu, 2012) as well as economic development which are pro-poor (Asongu, 2014b).

The differing positions adopted by academic scholars on the consequences of IPRs protection accords motivated the emergence of qualitative studies (Lau, 2006; Peitz and Waelbroeck, 2006) as well as an evolving strand of quantitative work on the socioeconomic drivers of software piracy in the copyrighting industry (see Andrés, 2006a; Bezmen and Depken, 2006; Banerjee *et al*., 2005; Bezmen and Depken, 2004; Goel and Nelson, 2009; Rishi and Mehra, 2017; Andrés and Asongu, 2013, 2016; Asongu and Meniago, 2016).

Generally speaking, contemporary literature in the battle against software piracy could be discussed under three main categories. The first stream recognizes the importance of adopting non-legal mechanisms in the fight against software piracy. Examples of such non-legal channels may include online-only offerings, community engagements and the management of digital rights (Holm, 2014); social learning and self-control (Burruss et al., 2018; Omar and Ahmed,

2018) and a block chain approach (Bhawna et al., 2018). The second category emphasizes the effectiveness of employing catch-up policy initiatives in the harmonization of global IPRs as well as the implications of such synchronization worldwide (see Asongu et al., 2018). The third classification discusses the characteristics of the formal channels for combating the proliferation of software piracy. These comprised: (i) Software User Identity Module (Adu *et al*., 2014); (ii) good institutions and human development (Driouchi *et al*., 2015); (iii) fairness and equity perceptions (Glass and Wood, 1996; Douglas *et al*., 2007); (v) lawsuits against peer-to-peer networks and related customers (Tunca, 2012); (iv) information institutions such as religion (El-Baily and Gouda, 2011); (v) standard of democracy (Piquero and Piquero, 2006); (vi) certainty in punishment (Yoo *et al*., 2011); (vii) IPRs protection mechanisms that depend on legal origins (Asongu, 2015); (viii) codes of knowledge ethics in institutions of learning (Santillanes and Felder, 2015) and (ix) level of economic development and regulatory quality (Chang et al., 2017).

In the light of the above, the present study is closest to the third category. Noticeably, the corresponding literature leaves space for improvement in the understanding of how technology interacts with formal IPRs mechanisms to successfully tackle the global software piracy problem. We address this gap in the literature by responding to the following research question: how do IPRs regimes interact with technologies to mitigate software piracy when existing levels of software piracy are considered?

By engaging these problem statements, the present inquiry contributes to the existing literature in two key ways. *First*, for the most part, the aforementioned literature on combating global software piracy by means of legal and non-legal IPRs strategies has centered on non-interactive regressions (Asongu *et al*., 2018). We argue that to better understand how IPR

mechanisms affect software piracy, it is essential to consider these IPR systems in conjunction with the technology embodied in the pirated software. Hence, we examine the influence of both IPRs and technology measurements in interactive regressions in order to understand how different IPR channels affect different technologies. The policy relevance of interactive modeling is that IPRs mechanisms may differently affect technologies with which software piracy is used. *Second*, the engaged studies have investigated the effectiveness of macroeconomic factors and IPR systems in tackling software piracy at the conditional mean values (see Andrés, 2006b; Asongu, 2015). This study extends the underlying literature by investigating the effects of IPRs throughout the conditional distributions of software piracy. In so doing, we are able to distinguish between countries with high-, intermediate- and low-initial levels of software piracy. The policy implications of controlling for initial levels in piracy in the empirical exercise is founded on the intuition that initiatives to combat software piracy may not be successful unless they are contingent on existing levels of software piracy. Therefore such policies should be designed differently across nations with high-, intermediate- and low-levels of software piracy.

We are aware of the risk of carrying out empirical measurements without well established theories. However, we argue from intuition, that Property Rights Institutions (PRIs) are designed to discourage the copying and imitation of software technologies. Such is consistent with the argument by Costantini and Lupi (2005) and Narayan et al. (2011) that reporting facts even in the absence of a formal theoretical model is not an inadequate scientific activity. In principle, applied econometrics should not be restricted to the simple empirical exercise of either refuting or validating economic theories.

The rest of the paper is organized as follows. In the next section on "Data and methodology", we discuss the characteristics of data and methodology employed in the study. The "Empirical results" section presents the empirical findings and corresponding explanations. The study explores some relevant policy implications of the findings in the "Further discussion and policy implications" section. The "Conclusion and future research directions" section briefly summarises the main findings of the study before providing some potential directions for future research on software piracy.

Data and methodology

Data

The study comprises a panel of 99 countries with data for the period 1994-2010 from the: World Bank Development Indicators (WDI); Business Software Alliance (BSA) and World Intellectual Property Organisation (WIPO)[3]. Limitations to the periodicity and number of countries are due to data availability constraints.

The dependent variable which is software piracy is defined as "*the unauthorized copying of computer software which constitutes copyright infringement for either commercial or personal use*" (SIIA, 2000)[4]. From a multidimensional perspective, software piracy can be organized, individuals' piracy and commercial or business piracy. According to the narrative, three principal types of software piracy are apparent: end-user copying, downloading and counterfeiting. Due to these different dimensions, a major concern in the literature has been how to derive an adequate software piracy indicator. In this study, the level of software is computed as the difference between the demand for new software applications (calculated as Personal

[3] The countries are presented in Panel B of Appendix 2.
[4] SIIA stands for Software and Information Industry Association.

Computer shipments) and software piracy that is supplied legally. Hence, software piracy is measured in the inquiry as the percentage of software (business software for the most part) that is illegally installed yearly (without a license) in a specific country. The software piracy variable is then defined in percentage terms ranging from a scale of 0 percent in scenarios where no yearly installed software is of pirated origin to 100 percent for situations where all yearly installed software is obtained from a pirated source. More information on the measurement of software piracy is available from BSA (2007, 2009)[5]. The data on software piracy from BSA industry is the most widely used in the literature, though subject to some upward bias[6].

Two technology variables are used: the number of Personal Computers (PCs) and internet penetration. The adoption of the PCs builds on the fact that it is consistent with the definition of software piracy provided above. The internet as a technology mechanism is based on insight and observation from recent KE literature (Tchamyou, 2017).

Six IPR metrics are considered, namely: *constitution*, *IPR laws*, *main IP laws*, *WIPO treaties*, *bilateral treaties* and *multilateral treaties.* Accordingly, there is a wealth of literature on the close connection between software piracy and IPRs laws (including legal frameworks and international treaties) (Driouchi *et al*., 2015; Baghci *et al*., 2006; Ki *et al*., 2006; Andrés, 2006a; Holm, 2003; Van Kranenburg and Hogenbirk, 2005). The data on these IPRs indicators are garnered from the WIPO. We note that regulations relating to the main IP and IPR laws are enforced by a country's relevant institutions after being endorsed by their legislative powers whereas WIPO administered treaties (including bilateral and multilateral treaties) are recognized forthwith from the day they are prescribed for the contracting party. Additionally, we

[5] Data from the BSA primarily measures commercial software piracy. For more insights into the reliability of the piracy data, the interested reader can refer to *inter alia*: Traphagan and Griffith (1998) and Png (2008).
[6]The adopted software piracy data has been used extensively in the literature on piracy (Marron and Steel 2000; Goel and Nelson, 2009; Andrés 2006a; Banerjee *et al*., 2005).

differentiate between main IP and IPR laws in the sense that the former is enacted by the Legislative authority of a country whereas the latter consists of both IP laws issued by the Executive and IPR-oriented laws enacted by the legislature[7].

The adopted IPRs variables have been used in the literature on property rights institutions (see Asongu et al., 2018).

It is important to note that the design of each country's regulations and laws are continually reviewed to facilitate a speedier and less expensive enforcement of IPRs by the legal authorities. Therefore, it is presumed that countries which have carried out fewer modifications to their laws on copyright are more contented with their existing IPR structures and hence, enjoy lower levels of software piracy than those nations which regularly sign new treaties and/or modify their copyright laws in order to strengthen their IPRs. The WIPO is also the source of information used in the construction of legal agreement indicators employed in this study. Three indicators on legal accords are considered, namely: WIPO treaties, bilateral treaties and multilateral treaties. More insights into these variables can be found on the WIPO website[8].

Consistent with recent software piracy literature (see Andrés and Goel, 2011, pp. 7-8; Chang et al., 2017; Asongu *et al*., 2018; Martínez-Sánchez & Romeu, 2018), three main control variables are used in the study, namely: Gross Domestic Product (GDP) per capita, Research and Development (R&D) expenditure and Population density. The first-two are expected to lessen software piracy whereas the third is anticipated to raise it. According to the above mentioned authors, countries with higher levels of per capita GDP are associated with lower levels of piracy. This is principally because in poor countries, citizens do not have the financial resources to purchase the original item (Goel and Nelson, 2009; Moores and Esichaikul, 2011). This

[7] The interested reader can refer to example (e.g. Indonesia) for more insights into how the data is collected: http://www.wipo.int/wipolex/en/profile.jsp?code=ID.
[8] http://www.wipo.int/wipolex/en/

perception is also consistent with the anticipated effect of R&D expenditure given that nations with comparatively higher levels of R&D budget are also relatively wealthier countries. Theoretically, an increasing population density is more likely to escalate software piracy because more people are exposed to pirated commodities with a greater temptation to use them. Appendix 1 provides the definitions of variables and their corresponding sources while Appendix 2 and Appendix 3 respectively present the summary statistics and pairwise correlation matrix.

Methodology

The justification for modelling throughout the conditional distribution of software piracy has already been discussed in the introductory section. For this methodology, we are informed by studies on conditional determinants which employ Quantile regressions (QR) as estimation strategy (Keonker and Hallock, 2001; Billger and Goel 2009; Okada and Samreth, 2012; Asongu, 2013). The estimation process involves the inclusion of existing levels of the outcome variable in order to ensure that its responsiveness to variations in the explanatory variables in the conditioning information set is differentiated across countries with high-, intermediate- and low-levels of software piracy. Hence, as software piracy is regressed on variables in the conditioning information set (i.e. independent variables), it is expected that the response of software piracy to these independent variables will vary with initial levels of software piracy (i.e. low, intermediate and high levels of software piracy).

It is important to note that the majority of previous studies have modelled software piracy at the conditional mean values (see Andrés, 2006ab). Whereas assessment of mean impacts is valuable, we extend this scope by employing QR in order to control for initial levels of software piracy. For example, while the Ordinary Least Squares (OLS) approach used by Andrés (2006b)

is based on the assumption that error terms are normally distributed, the QR method is not based on such a hypothesis of normally distributed error terms. Therefore, the QR technique enables the study to investigate the effect of policy tools in combating the threat of copying and imitation of intellectual work by differentiating the extent of the software piracy problem in countries with worst, worse and bad conditions. Hence, with QR, the estimates of parameters are derived at multiple points on the conditional distributions of the software piracy outcome variable.

The θ^{th} quantile estimator of software piracy is calculated by solving the following optimization problem, where $\theta \in (0,1)$.[9]

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

Contrary to the OLS estimator which is principally based on minimising the sum of squared residuals, with the QR approach, it is the weighted sum of absolute deviations that is minimised. For example the 25$^{\text{th}}$ or 75$^{\text{th}}$ quantiles (with θ=0.25 or 0.75 respectively) are examined. The conditional quantile 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, *internet penetration*, *PC users*, *constitution, main IP law, IP law,*

[9] For ease of presentation and purpose of simplicity, the quintile estimator is disclosed without subscripts in Eq. (1).

WIPO treaties, multilateral treaties and *bilateral treaties, GDP per capita*, *research and development expenditure (R&D)* and *population density*.

In line with the characteristics of the QR method, the data is analysed for five main points on the conditional distribution of the outcome variable —software piracy. Thus, software piracy is regressed on the independent variables at the: (i) first decile (i.e. 10^{th} quantile), (ii) first quartile (i.e. 25^{th} quantile), (iii) median (i.e. 50^{th} quantile), (iv) third quartile (i.e. 75^{th} quantile) and (v) ninth decile (i.e. 90^{th} quantile). The results are presented in the next section.

Empirical results

Presentation of results

Empirical findings are presented in Tables 1-6 below. The first-three tables focus on interactions between PC users and IPRs mechanisms while the last-three tables are dedicated to corresponding interactions between internet penetration and IPRs channels. Given that we have six IPRs regimes; each table is divided into two panels. Hence, the 6 tables corresponds to the twelve combinations between the two technology indicators and six IPRs channels. These twelve combinations are: Personal Computers and the Constitution (in Panel A of Table 1); Personal Computers and Main Intellectual Property (IP) law (in Panel B of Table 1); Personal Computers and Intellectual Property (IP) law (in Panel A of Table 2); Personal Computers and WIPO treaties (in Panel B of Table 2); Personal Computers and Bilateral treaties (in Panel A of Table 3); Personal Computers and Multilateral treaties (in Panel B of Table 3); Internet Penetration and the Constitution (in Panel A of Table 4); Internet Penetration and Main Intellectual Property (IP) law (in Panel B of Table 4); Internet Penetration and Intellectual Property (IP) law (in Panel A of Table 5); Internet Penetration and WIPO treaties (in Panel B of Table 5); Internet Penetration

and Bilateral treaties (in Panel A of Table 6); Internet Penetration and Multilateral treaties (in Panel B of Table 6).

Whereas the left-hand-side (LHS) of the tables corresponds to contemporary regressions, the right-hand-side (RHS) entails non-contemporary estimations. The interest of lagging the independent variables of interest by one year on the RHS is to control for potential endogeneity (see Mlachila *et al*., 2017). It is pertinent to note that the number of observations on the RHS may be higher than the corresponding number of observations on the LHS because of issues in degrees of freedom. This is apparent in an empirical exercise if combinations between the outcome variables and explanatory variables are more noticeable in non-contemporary regressions (see Asongu *et al*., 2018). The consistent variation in the estimated parameters between OLS and the selected quantiles (with respect to signs, significance and magnitude) is regarded as the justification of our decision to adopt the QR empirical approach. Moreover, distinguishing between impacts at mean points and at multiple locations on the conditional distribution of the outcome variable provides more opportunities for the derivation of policy initiatives. The presentation here follows the convention in the literature for reporting and discussing empirical results when there are many tables. We begin by presenting the regression outcomes and then explaining them by comparing and contrasting dominant trends in the tables.

The following findings can be established from the interaction between PC users and IPRs metrics. (i) The inclusion of IPRs in the Constitution and adoption of WIPO treaties tend to discourage the use of pirated software in PCs. This reducing influence appears to be more pronounced amongst users in the 25^{th} and 75^{th} quantiles in the Constitution-oriented regressions and between the 10^{th} and 75^{th} quantiles in the 'WIPO treaties'-related models. The increasing magnitude is an indication that the implied benefits of introducing IPRs in the

Constitution and acceptance of WIPO treaties are greater in countries with higher levels of software piracy. (ii) The establishment of main IP law and IP law do not significantly reduce PC-related software piracy. (iii) The moderating interactive effect with bilateral treaties is observable throughout the conditional distribution of software piracy, with an increasing magnitude in bottom quantiles while the mitigating role of multilateral treaties is only evident in the bottom quantiles and the 75^{th} quantile. The significant control variables have the expected signs.

The following key findings can be established for the interaction between internet penetration and IPRs indicators. (i) The provision of IPRs in the Constitution is associated with a moderating marginal impact in the 50^{th} quantile and top quantiles of the software piracy distribution whereas there is no noticeable marginal impact from the main IP law. (ii) Whereas there are positive and negative marginal effects from IP law in the bottom and top quantiles respectively, there is a (are some) sparse evidence of a positive (negative) marginal effect in the 10^{th} quantile (25^{th} and 50^{th} quantiles) of contemporary and non-contemporary regressions. (iii) While the modulating effects from bilateral treaties are visible throughout the conditional distributions of software piracy with an increasing negative magnitude from the 10^{th} to the 75^{th} quantile, the influence of multilateral treaties is positive (negative) in the 75^{th} (bottom) quantile (s). The significant control variables have the expected signs.

Table 1: Personal Computers, the Constitution and Main IP law

Panel A: Personal Computers and the Constitution

	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	**1.635*** **	**1.725*** **	**1.534*** **	**1.344*** **	**1.957*** **	**1.862*** **	**2.083*** **	**2.752*** **	**1.743*** **	**2.096*** **	**2.131*** **	**2.001*** **
	(0.001)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.002)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.001)**
Personal Computer Users (PC)	**-0.184*** **	**-0.103*** **	**-0.153*** **	**-0.187*** **	**-0.188*** **	**-0.441*** **	**-0.123*** **	0.0009	**-0.124*** **	**-0.101*** **	**-0.140*** **	**-0.395*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.008)**	(0.971)	**(0.000)**	**(0.001)**	**(0.001)**	**(0.000)**
Constitution	**0.225** **	0.067	**0.195*** **	**0.387*** **	**0.439*** **	**-0.253** **	**0.251*** **	0.022	**0.201*** **	**0.379*** **	**0.434*** **	**-0.198***
	(0.011)	(0.481)	**(0.007)**	**(0.000)**	**(0.000)**	**(0.015)**	**(0.002)**	(0.769)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.050)**
Constitution×PC	**-0.072*** **	-0.003	**-0.039***	**-0.104*** **	**-0.139*** **	0.007	**-0.077*** **	0.005	**-0.041** **	**-0.103*** **	**-0.136*** **	-0.0007
	(0.003)	(0.912)	**(0.058)**	**(0.000)**	**(0.000)**	(0.794)	**(0.000)**	(0.822)	**(0.013)**	**(0.000)**	**(0.000)**	(0.981)
Gross Domestic Product	**-0.480*** **	**-0.405*** **	**-0.414*** **	**-0.462*** **	**-0.611*** **	**-0.588*** **	**-0.549*** **	**-0.570*** **	**-0.450*** **	**-0.597*** **	**-0.624*** **	**-0.607*** **
	(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 & Development	**-0.081*** **	**-0.089*** **	**-0.084*** **	**-0.081*** **	**-0.069*** **	**-0.082*** **	**-0.088*** **	**-0.094*** **	**-0.086*** **	**-0.086*** **	**-0.080*** **	**-0.072*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Population	**0.164*** **	0.037	**0.103*** **	**0.191*** **	**0.213*** **	**0.365*** **	**0.111** **	**-0.059** **	**0.079*** **	**0.123*** **	**0.172*** **	**0.325*** **
	(0.000)	(0.150)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.015)**	**(0.020)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
R^2/Pseudo R^2	0.6617	0.4569	0.4891	0.4673	0.4505	0.4573	0.6943	0.4702	0.5109	0.4919	0.4819	0.4819
Fisher	**267.41*** **						**311.98*** **					
Observations	715	702	702	702	702	702	726	726	726	726	726	726

Panel B: Personal Computers and Main Intellectual Property (IP) law

	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	**1.659*** **	**0.551** **	**1.298*** **	**1.159** **	**1.875*** **	**2.417*** **	**2.064*** **	**1.371*** **	**1.635*** **	**1.943*** **	**1.894*** **	**2.247*** **
	(0.001)	**(0.014)**	**(0.000)**	**(0.029)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.001)**	**(0.000)**	**(0.000)**
Personal Computer Users (PC)	**-0.200*** **	**-0.179*** **	**-0.214*** **	**-0.258*** **	**-0.211*** **	**-0.362*** **	**-0.141*** **	**-0.103*** **	**-0.155*** **	**-0.125*** **	**-0.180*** **	**-0.374*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.001)**	**(0.000)**	**(0.000)**	**(0.001)**	**(0.001)**	**(0.000)**
Main IP law	**-0.067*** **	**-0.061*** **	**-0.075*** **	**-0.054***	**-0.053** **	**-0.130*** **	**-0.060*** **	**-0.058*** **	**-0.065*** **	**-0.013**	**-0.028*** **	**-0.130*** **
	(0.001)	**(0.000)**	**(0.000)**	**(0.094)**	**(0.047)**	**(0.001)**	**(0.002)**	**(0.001)**	**(0.000)**	**(0.507)**	**(0.001)**	**(0.000)**
Main IP Law×PC	**0.010** **	**0.010*** **	**0.015*** **	0.010	0.008	**0.027** **	**0.009***	**0.009** **	**0.012*** **	-0.0004	0.001	**0.027*** **
	(0.049)	**(0.009)**	**(0.000)**	(0.235)	(0.271)	**(0.011)**	**(0.072)**	**(0.016)**	**(0.005)**	(0.935)	(0.816)	**(0.001)**
Gross Domestic Product	**-0.424*** **	**-0.211*** **	**-0.333*** **	**-0.326*** **	**-0.467*** **	**-0.578*** **	**-0.490*** **	**-0.341*** **	**-0.391*** **	**-0.485*** **	**-0.525*** **	**-0.562*** **
	(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 & Development	**-0.087*** **	**-0.127*** **	**-0.091*** **	**-0.097*** **	**-0.084*** **	**-0.095*** **	**-0.094*** **	**-0.124*** **	**-0.101*** **	**-0.103*** **	**-0.088*** **	**-0.095*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Population	**0.148*** **	**0.137*** **	**0.127*** **	**0.181*** **	**0.163*** **	**0.252*** **	**0.099** **	**0.061** **	**0.086*** **	**0.100*** **	**0.175*** **	**0.266*** **
	(0.002)	**(0.000)**	**(0.000)**	**(0.001)**	**(0.000)**	**(0.000)**	**(0.021)**	**(0.025)**	**(0.004)**	**(0.004)**	**(0.000)**	**(0.000)**
R^2/Pseudo R^2	0.6854	0.4832	0.4997	0.4667	0.4574	0.4649	0.7157	0.4894	0.5200	0.4899	0.4859	0.4980
Fisher	**272.92*** **						**316.21*** **					
Observations	715	715	715	715	715	715	726	726	726	726	726	726

***,**,*: significance levels of 1%, 5% and 10% respectively. 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 so because the combinations between software piracy and regressors are more apparent in non-contemporary regressions.

Table 2: Personal Computers, IP law and WIPO treaties

Panel A: Personal Computers and Intellectual Property (IP) law

	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	**1.637***	**1.393***	**1.439***	**1.493***	**1.960***	**2.662***	**2.089***	**2.449***	**1.870***	**2.132***	**2.028***	**2.309***
	(0.002)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.001)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.008)**
Personal Computer Users (PC)	**-0.196***	**-0.152***	**-0.187***	**-0.234***	**-0.189***	**-0.332***	**-0.131***	-0.041	**-0.136***	**-0.146***	**-0.174***	**-0.318***
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.001)**	**(0.000)**	**(0.005)**	(0.155)	**(0.000)**	**(0.001)**	**(0.001)**	**(0.000)**
IP law	0.012	**-0.044***	**-0.045***	-0.017	0.029	-0.013	0.021	**-0.025****	**-0.033***	-0.010	0.027	-0.007
	(0.377)	**(0.000)**	**(0.000)**	(0.245)	(0.173)	(0.603)	(0.124)	**(0.023)**	**(0.000)**	(0.502)	(0.153)	(0.809)
IP law×PC	-0.004	**0.011***	**0.011***	0.003	-0.008	0.001	**-0.006***	**0.006***	**0.008***	0.001	-0.007	0.0001
	(0.258)	**(0.000)**	**(0.002)**	(0.341)	(0.148)	(0.803)	**(0.073)**	**(0.057)**	**(0.000)**	(0.634)	(0.126)	(0.98)
Gross Domestic Product	**-0.469***	**-0.375***	**-0.387***	**-0.436***	**-0.581***	**-0.682***	**-0.539***	**-0.531***	**-0.459***	**-0.533***	**-0.599***	**-0.633***
	(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 & Development	**-0.081***	**-0.087***	**-0.091***	**-0.086***	**-0.067***	**-0.084***	**-0.089***	**-0.094***	**-0.098***	**-0.093***	**-0.076***	**-0.087***
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Population	**0.164***	**0.091***	**0.120***	**0.179***	**0.194***	**0.255***	**0.108****	-0.018	**0.077***	**0.104****	**0.185***	**0.262***
	(0.001)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.001)**	**(0.021)**	(0.489)	**(0.000)**	**(0.014)**	**(0.000)**	**(0.001)**
R^2/Pseudo R^2	0.6594	0.4586	0.4883	0.4583	0.4421	0.4302	0.6920	0.4669	0.5097	0.4816	0.4737	0.4584
Fisher	**270.61***						**313.28***					
Observations	715	715	715	715	715	715	726	726	726	726	726	726

Panel B: Personal Computers and WIPO treaties

	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	**1.774***	**1.701***	**1.878***	**1.249***	**1.611****	**3.613***	**2.138***	**2.372***	**2.217***	**1.916***	**2.050***	**3.241***
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.010)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Personal Computer Users (PC)	**-0.107****	**-0.158***	**-0.060****	**-0.134***	**-0.193***	**-0.180****	-0.057	0.0005	-0.009	-0.050	**-0.153***	**-0.163****
	(0.036)	**(0.000)**	**(0.028)**	**(0.000)**	**(0.005)**	**(0.015)**	(0.230)	(0.986)	(0.730)	(0.234)	**(0.009)**	**(0.023)**
WIPO treaties	0.026	**-0.036***	0.011	**0.045****	0.031	-0.033	0.028	**0.024****	**0.027****	**0.058***	0.025	-0.017
	(0.258)	**(0.004)**	(0.457)	**(0.018)**	(0.347)	(0.339)	(0.188)	**(0.015)**	**(0.037)**	**(0.007)**	(0.393)	(0.594)
WIPO treaties ×PC	**-0.018***	**0.010***	**-0.010****	**-0.023***	**-0.020****	-0.007	**-0.018***	**-0.007****	**-0.014***	**-0.025***	**-0.016***	-0.010
	(0.006)	**(0.006)**	**(0.014)**	**(0.000)**	**(0.049)**	(0.476)	**(0.005)**	**(0.016)**	**(0.000)**	**(0.000)**	**(0.065)**	(0.305)
Gross Domestic Product	**-0.486***	**-0.408***	**-0.464***	**-0..429***	**-0.526***	**-0.803***	**-0.545***	**-0.519***	**-0.522***	**-0.543***	**-0.595***	**-0.753***
	(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 & Development	**-0.085***	**-0.083***	**-0.094***	**-0.084***	**-0.081***	**-0.087***	**-0.092***	**-0.101***	**-0.096***	**-0.087***	**-0.086***	**-0.112***
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Population	**0.133***	**0.069****	**0.057****	**0.179***	**0.234***	**0.148***	**0.088****	-0.033	0.015	**0.108***	**0.188***	**0.157***
	(0.006)	**(0.011)**	**(0.033)**	**(0.000)**	**(0.000)**	**(0.004)**	**(0.045)**	(0.252)	(0.553)	**(0.003)**	**(0.000)**	**(0.003)**
R^2/Pseudo R^2	0.6822	0.4541	0.4928	0.4769	0.4718	0.4850	0.7096	0.4657	0.5139	0.4977	0.4962	0.5100
Fisher	**308.41***						**365.51***					
Observations	715	715	715	715	715	715	726	726	726	726	726	726

***,**,*: significance levels of 1%, 5% and 10% respectively. 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 so because the combinations between software piracy and regressors are more apparent in non-contemporary regressions.

Table 3: Personal Computers, Bilateral and Multilateral treaties

Panel A: Personal Computers and Bilateral treaties

	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	**1.377*** **	**1.846*** **	**1.771*** **	**1.231*** **	**1.516** **	1.856	**1.762*** **	**3.242*** **	**2.213*** **	**1.934*** **	**1.774*** **	**1.997** **
	(0.006)	**(0.000)**	**(0.000)**	**(0.005)**	**(0.014)**	(0.139)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.003)**	**(0.031)**
Personal Computer Users (PC)	**-0.203*** **	**-0.077*** **	**-0.132*** **	**-0.202*** **	**-0.215*** **	**-0.303** **	**-0.148*** **	**0.045***	**-0.078*** **	**-0.125*** **	**-0.175*** **	**-0.282*** **
	(0.000)	**(0.001)**	**(0.000)**	**(0.000)**	**(0.001)**	**(0.012)**	**(0.001)**	**(0.063)**	**(0.000)**	**(0.000)**	**(0.005)**	**(0.001)**
Bilateral treaties	**0.086*** **	**0.044*** **	**0.057*** **	**0.066*** **	**0.089*** **	0.099	**0.091*** **	**0.078*** **	**0.084*** **	**0.068*** **	**0.097*** **	**0.093** **
	(0.000)	**(0.006)**	**(0.000)**	**(0.002)**	**(0.003)**	(0.109)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.001)**	**(0.032)**
Bilateral treaties×PC	**-0.017*** **	**-0.008** **	**-0.010*** **	**-0.013*** **	**-0.019*** **	**-0.021***	**-0.018*** **	**-0.014*** **	**-0.015*** **	**-0.013*** **	**-0.020*** **	**-0.019** **
	(0.000)	**(0.014)**	**(0.000)**	**(0.002)**	**(0.002)**	**(0.093)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.001)**	**(0.028)**
Gross Domestic Product	**-0.434*** **	**-0.431*** **	**-0.453*** **	**-0.385*** **	**-0.489*** **	**-0.580*** **	**-0.493*** **	**-0.647*** **	**-0.521*** **	**-0.501*** **	**-0.549*** **	**-0.602*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.005)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Research & Development	**-0.084*** **	**-0.089*** **	**-0.084*** **	**-0.098*** **	**-0.088*** **	**-0.078** **	**-0.092*** **	**-0.092*** **	**-0.087*** **	**-0.097*** **	**-0.092*** **	**-0.085*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.017)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.001)**
Population	**0.180*** **	0.022	**0.082*** **	**0.170*** **	**0.217*** **	**0.285** **	**0.132*** **	**-0.105*** **	0.033	**0.100*** **	**0.194*** **	**0.263*** **
	(0.000)	(0.349)	**(0.001)**	**(0.000)**	**(0.000)**	**(0.013)**	**(0.002)**	**(0.000)**	(0.104)	**(0.003)**	**(0.001)**	**(0.002)**
R^2/Pseudo R^2	0.6691	0.4598	0.4916	0.4675	0.4441	0.4295	0.7038	0.4776	0.5157	0.4939	0.4769	0.4664
Fisher	**333.94*** **						**396.09*** **					
Observations	715	715	715	715	715	715	726	726	726	726	726	726

Panel B: Personal Computers and Multilateral treaties

	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	**1.349*** **	**1.522*** **	**1.387*** **	**1.070*** **	**0.814***	**2.471*** **	**1.847*** **	**2.307*** **	**1.944*** **	**1.730*** **	**1.238** **	**2.545*** **
	(0.006)	**(0.000)**	**(0.000)**	**(0.007)**	**(0.082)**	**(0.004)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.030)**	**(0.000)**
Personal Computer Users (PC)	**0.122** **	**0.054** **	**-0.062*** **	**-0.205*** **	**-0.233*** **	**-0.217** **	**-0.084***	**0.104*** **	-0.002	**-0.137*** **	**-0.182*** **	**-0.265*** **
	(0.017)	**(0.017)**	**(0.006)**	**(0.000)**	**(0.000)**	**(0.031)**	**(0.069)**	**(0.000)**	(0.940)	**(0.001)**	**(0.002)**	**(0.002)**
Multilateral treaties	0.005	**0.021*** **	**0.011** **	-0.005	0.007	-0.020	0.0004	**0.016*** **	**0.012** **	-0.006	0.006	**-0.028***
	(0.496)	**(0.000)**	**(0.011)**	(0.471)	(0.382)	(0.283)	(0.953)	**(0.000)**	**(0.018)**	(0.325)	(0.518)	**(0.079)**
Multilateral treaties×PC	**-0.006*** **	**-0.009*** **	**-0.007*** **	-0.002	**-0.006** **	-0.0007	**-0.004** **	**-0.008*** **	**-0.007*** **	-0.001	**-0.005** **	0.002
	(0.006)	**(0.000)**	**(0.000)**	(0.259)	**(0.010)**	(0.886)	**(0.026)**	**(0.000)**	**(0.000)**	(0.316)	**(0.042)**	(0.552)
Gross Domestic Product	**-0.409*** **	**-0.416*** **	**-0.402*** **	**-0.328*** **	**-0.393*** **	**-0.582*** **	**-0.476*** **	**-0.536*** **	**-0.486*** **	**-0.427*** **	**-0.454*** **	**-0.591*** **
	(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 & Development	**-0.067*** **	**-0.064*** **	**-0.060*** **	**-0.083*** **	**-0.060*** **	**-0.069*** **	**-0.075*** **	**-0.066*** **	**-0.072*** **	**-0.084*** **	**-0.068*** **	**-0.086*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.001)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Population	**0.159*** **	0.019	**0.094*** **	**0.185*** **	**0.288*** **	**0.198** **	**0.108*** **	**-0.045** **	0.038	**0.115*** **	**0.235*** **	**0.206*** **
	(0.000)	(0.370)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.012)**	**(0.009)**	**(0.024)**	(0.121)	**(0.001)**	**(0.000)**	**(0.002)**
R^2/Pseudo R^2	0.7032	0.4664	0.5129	0.4982	0.4909	0.4896	0.731	0.4760	0.5313	0.5200	0.5137	0.5185
Fisher	**337.70*** **						**394.48*** **					
Observations	715	715	715	715	715	715	726	726	726	726	726	726

***,**,*: significance levels of 1%, 5% and 10% respectively. 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 so because the combinations between software piracy and regressors are more apparent in non-contemporary regressions.

Table 4: Internet Penetration, the Constitution and Main IP law

Panel A: Internet Penetration and the Constitution

	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	**2.590*** **	**2.204*** **	**2.245*** **	**2.603*** **	**2.893*** **	**3.782*** **	**2.949*** **	**2.884*** **	**2.675*** **	**3.083*** **	**3.100*** **	**3.942*** **
	(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 (Internet)	**-0.108*** **	**-0.064*** **	**-0.088*** **	**-0.070*** **	**-0.139*** **	**-0.194*** **	**-0.058*** **	-0.0009	**-0.046*** **	-0.017	**-0.077*** **	**-0.157*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.006)**	(0.937)	**(0.000)**	(0.248)	**(0.002)**	**(0.000)**
Constitution	**0.167***	0.002	**0.166*** **	**0.385*** **	**0.249*** **	-0.057	**0.207*** **	-0.021	**0.156*** **	**0.359*** **	**0.364*** **	0.064
	(0.051)	(0.979)	**(0.041)**	**(0.000)**	**(0.045)**	(0.652)	**(0.012)**	(0.769)	**(0.016)**	**(0.000)**	**(0.000)**	(0.523)
Constitution×Internet	**-0.048*** **	0.011	-0.034	**-0.104*** **	**-0.087*** **	-0.024	**-0.058*** **	0.017	-0.026	**-0.097*** **	**-0.115*** **	**-0.050***
	(0.033)	(0.716)	(0.146)	**(0.000)**	**(0.016)**	(0.516)	**(0.008)**	(0.427)	(0.157)	**(0.000)**	**(0.000)**	**(0.095)**
Gross Domestic Product	**-0.604*** **	**-0.474*** **	**-0.518*** **	**-0.669*** **	**0.743*** **	**-0.822*** **	**-0.662*** **	**-0.587*** **	**-0.573*** **	**-0.744*** **	**-0.757*** **	**-0.846*** **
	(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 & Development	**-0.089*** **	**-0.097*** **	**-0.086*** **	**-0.090*** **	**-0.092*** **	**-0.122*** **	**-0.093*** **	**-0.092*** **	**-0.090*** **	**-0.093*** **	**-0.096*** **	**-0.114*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Population	**0.070*** **	-0.005	**0.035***	**0.087*** **	**0.143*** **	**0.123*** **	0.027	**-0.067*** **	-0.014	**0.034*** **	**0.089*** **	**0.088*** **
	(0.006)	(0.732)	**(0.041)**	**(0.000)**	**(0.000)**	**(0.002)**	(0.269)	**(0.000)**	(0.288)	**(0.000)**	**(0.001)**	**(0.007)**
R^2/Pseudo R^2	0.6677	0.4567	0.4859	0.4634	0.4565	0.4572	0.6924	0.4686	0.5033	0.4859	0.4773	0.4789
Fisher	**274.72*** **						**314.69*** **					
Observations	729	729	729	729	729	729	743	743	743	743	743	743

Panel B: Internet Penetration and Main Intellectual Property (IP) law

	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	**2.557*** **	**1.390*** **	**2.174*** **	**2.773*** **	**2.283*** **	**3.558*** **	**2.902*** **	**2.582*** **	**2.401*** **	**2.892*** **	**2.834*** **	**3.777*** **
	(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 (Internet)	**-0.110*** **	**-0.069*** **	**-0.080*** **	**-0.082*** **	**-0.195*** **	**-0.210*** **	**-0.060*** **	-0.00003	**-0.048*** **	-0.030	**-0.145*** **	**-0.179*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.003)**	**(0.000)**	**(0.000)**	**(0.008)**	(0.998)	**(0.003)**	(0.150)	**(0.000)**	**(0.000)**
Main IP law	**-0.043***	**-0.038***	**-0.028***	-0.022	**-0.049***	**-0.092*** **	**-0.035***	**-0.042*** **	**-0.032***	-0.004	**-0.056*** **	**-0.093*** **
	(0.032)	**(0.016)**	**(0.066)**	(0.408)	**(0.068)**	**(0.038)**	**(0.070)**	**(0.015)**	**(0.057)**	(0.809)	**(0.048)**	**(0.003)**
Main IP Law×Internet	0.005	0.003	0.003	0.002	0.007	0.017	0.003	0.005	0.004	-0.002	0.009	**0.018*** **
	(0.329)	(0.299)	(0.343)	(0.693)	(0.332)	(0.173)	(0.511)	(0.161)	(0.276)	(0.702)	(0.245)	**(0.041)**
Gross Domestic Product	**-0.559*** **	**-0.328*** **	**-0.483*** **	**-0.608*** **	**-0.564*** **	**-0.743*** **	**-0.619*** **	**-0.547*** **	**-0.511*** **	**-0.641*** **	**-0.635*** **	**-0.786*** **
	(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 & Development	**-0.095*** **	**-0.143*** **	**-0.105*** **	**-0.106*** **	**-0.091*** **	**-0.108*** **	**-0.099*** **	**-0.114*** **	**-0.118*** **	**-0.109*** **	**-0.094*** **	**-0.110*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Population	**0.060*** **	**0.040*** **	**0.031***	0.038	**0.159*** **	**0.116*** **	0.019	**-0.037*** **	0.001	0.015	**0.097*** **	**0.092*** **
	(0.013)	**(0.009)**	**(0.061)**	(0.181)	**(0.000)**	**(0.004)**	(0.403)	**(0.042)**	(0.948)	(0.481)	**(0.001)**	**(0.001)**
R^2/Pseudo R^2	0.6850	0.4752	0.4900	0.4621	0.4685	0.4735	0.7074	0.4816	0.5084	0.4823	0.4846	0.4947
Fisher	**278.63*** **						**319.29*** **					
Observations	729	729	729	729	729	729	743	743	743	743	743	743

***,**,*: significance levels of 1%, 5% and 10% respectively. 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 so because the combinations between software piracy and regressors are more apparent in non-contemporary regressions.

Table 5: Internet Penetration, IP law and WIPO treaties

Panel A: Internet Penetration and Intellectual Property (IP) law

	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	**2.616*** **	**2.071*** **	**2.092*** **	**2.935*** **	**2.346*** **	**3.692*** **	**2.978*** **	**2.728*** **	**2.295*** **	**3.240*** **	**2.999*** **	**3.842*** **
	(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 (Internet)	**-0.110*** **	**-0.084*** **	**-0.102*** **	**-0.086*** **	**-0.156*** **	**-0.177*** **	**-0.056** **	-0.002	**-0.073*** **	**-0.024**	**-0.086*** **	**-0.147*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000**	**(0.010)**	(0.833)	**(0.000)**	**(0.160)**	**(0.000)**	**(0.000)**
IP law	0.013	**-0.035*** **	**-0.021*** **	-0.011	**0.041*** **	0.022	0.021	**-0.013***	**-0.014** **	-0.008	**0.053*** **	**0.029***
	(0.320)	**(0.000)**	**(0.000)**	(0.318)	**(0.002)**	(0.265)	(0.100)	**(0.078)**	**(0.026)**	(0.393)	**(0.000)**	**(0.088)**
IP law×Internet	-0.003	**0.009*** **	**0.005*** **	0.002	**-0.011*** **	-0.007	**-0.005***	0.003	**0.003***	0.001	**-0.013*** **	**-0.008** **
	(0.255)	**(0.000)**	**(0.003)**	(0.451)	**(0.002)**	(0.153)	**(0.071)**	(0.150)	**(0.061)**	(0.566)	**(0.000)**	**(0.046)**
Gross Domestic Product	**-0.602*** **	**-0.465*** **	**-0.489*** **	**-0.664*** **	**-0.617*** **	**-0.794*** **	**-0.660*** **	**-0.570*** **	**-0.525*** **	**-0.711*** **	**-0.727*** **	**-0.831*** **
	(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 & Development	**-0.091*** **	**-0.097*** **	**-0.099*** **	**-0.095*** **	**-0.094*** **	**-0.110*** **	**-0.096*** **	**-0.099*** **	**-0.108*** **	**-0.103*** **	**-0.089*** **	**-0.113*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Population	**0.066** **	0.018	**0.050*** **	**0.044** **	**0.152*** **	**0.105** **	0.022	**-0.052*** **	**0.028** **	-0.0007	**0.086*** **	**0.087** **
	(0.010)	(0.177)	**(0.000)**	**(0.042)**	**(0.000)**	**(0.021)**	(0.383)	**(0.000)**	**(0.048)**	(0.970)	**(0.000)**	**(0.018)**
R^2/Pseudo R^2	0.6667	0.4592	0.4856	0.4565	0.4571	0.4473	0.6914	0.4651	0.5012	0.4762	0.4781	0.4719
Fisher	**276.72*** **						**317.11*** **					
Observations	729	729	729	729	729	729	743	743	743	743	743	743

Panel B: Internet Penetration and WIPO treaties

	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	**2.823*** **	**2.263*** **	**2.107*** **	**3.146*** **	**3.639*** **	**4.833*** **	**3.157*** **	**2.674*** **	**2.409*** **	**3.269*** **	**3.826*** **	**4.847*** **
	(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 (Internet)	**-0.080** **	**-0.112*** **	**-0.062*** **	-0.027	**-0.140*** **	**-0.114** **	-0.040	**-0.030** **	-0.017	0.047	**-0.109*** **	**-0.104*** **
	(0.012)	**(0.000)**	**(0.000)**	(0.338)	**(0.000)**	**(0.021)**	(0.194)	**(0.040)**	(0.216)	(0.142)	**(0.006)**	**(0.007)**
WIPO treaties	-0.013	**-0.039*** **	-0.001	0.001	-0.046	-0.040	-0.017	-0.009	0.009	0.032	**-0.055***	**-0.056***
	(0.572)	**(0.001)**	(0.928)	(0.949)	(0.136)	(0.296)	(0.440)	(0.299)	(0.384)	(0.172)	**(0.058)**	**(0.064)**
WIPO treaties ×Internet	-0.004	**0.012*** **	-0.005	-0.009	0.003	-0.002	-0.003	0.004	**-0.007** **	**-0.016** **	0.006	0.003
	(0.482)	**(0.000)**	(0.108)	(0.140)	(0.716)	(0.847)	(0.639)	(0.112)	**(0.016)**	**(0.023)**	(0.473)	(0.712)
Gross Domestic Product	**-0.612*** **	**-0.477*** **	**-0.492*** **	**-0.687*** **	**-0.783*** **	**-0.941*** **	**-0.665*** **	**-0.560*** **	**-0.542*** **	**-0.734*** **	**-0.787*** **	**-0.945*** **
	(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 & Development	**-0.094*** **	**-0.097*** **	**-0.104*** **	**-0.096*** **	**-0.091*** **	**-0.116*** **	**-0.099*** **	**-0.094*** **	**-0.105*** **	**-0.101*** **	**-0.099*** **	**-0.125*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Population	**0.046***	0.008	**0.041*** **	0.018	**0.080*** **	0.028	0.008	**-0.041*** **	0.003	-0.013	0.039	0.019
	(0.051)	(0.594)	**(0.001)**	(0.387)	**(0.005)**	(0.251)	(0.728)	**(0.007)**	(0.778)	(0.578)	(0.133)	(0.412)
R^2/Pseudo R^2	0.6804	0.4541	0.4887	0.4669	0.4763	0.4851	0.7024	0.4633	0.5052	0.4837	0.4944	0.5052
Fisher	**300.47*** **						**342.94*** **					
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 so because the combinations between software piracy and regressors are more apparent in non-contemporary regressions.

Table 6: Internet Penetration, Bilateral and Multilateral treaties

Panel A: Internet Penetration and Bilateral treaties

	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	**2.341*** **	**2.120*** **	**2.395*** **	**2.636*** **	**2.109*** **	**3.931*** **	**2.683*** **	3.004*** **	**2.588*** **	**2.866*** **	**2.542*** **	**3.600*** **
	(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 (Internet)	**-0.111*** **	**-0.064*** **	**-0.069*** **	**-0.063*** **	**-0.169*** **	**-0.167*** **	**-0.062*** **	0.013	**-0.044*** **	-0.021	**-0.097*** **	**-0.153*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.001)**	**(0.000)**	**(0.000)**	**(0.003)**	(0.187)	**(0.000)**	(0.122)	**(0.000)**	**(0.000)**
Bilateral treaties	**0.102*** **	**0.053*** **	**0.076*** **	**0.083*** **	**0.113*** **	0.053	**0.103*** **	**0.073*** **	**0.085*** **	**0.107*** **	**0.114*** **	**0.057***
	(0.000)	**(0.003)**	**(0.000)**	**(0.000)**	**(0.000)**	(0.110)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.060)**
Bilateral treaties×Internet	**-0.021*** **	**-0.009*** **	**-0.014*** **	**-0.017*** **	**-0.023*** **	**-0.012***	**-0.021*** **	**-0.013*** **	**-0.016*** **	**-0.021*** **	**-0.024*** **	**-0.012** **
	(0.000)	**(0.007)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.064)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.033)**
Gross Domestic Product	**-0.564*** **	**-0.463*** **	**-0.546*** **	**-0.605*** **	**-0.583*** **	**-0.865*** **	**-0.619*** **	**-0.615*** **	**-0.579*** **	**-0.645*** **	**-0.656*** **	**-0.824*** **
	(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 & Development	**-0.097*** **	**-0.094*** **	**-0.085*** **	**-0.106*** **	**-0.103*** **	**-0.080*** **	**-0.102*** **	**-0.087*** **	**-0.088*** **	**-0.111*** **	**-0.104*** **	**-0.097*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.001)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Population	**0.081*** **	-0.001	0.020	**0.040***	**0.170*** **	**0.100** **	0.040	**-0.075*** **	-0.001	**0.009**	**0.114*** **	**0.112*** **
	(0.001)	(0.898)	(0.254)	**(0.070)**	**(0.000)**	**(0.011)**	(0.109)	**(0.000)**	(0.885)	**(0.550)**	**(0.000)**	**(0.004)**
R^2/Pseudo R^2	0.6824	0.4629	0.4924	0.4676	0.4665	0.4547	0.7088	0.4783	0.5129	0.4927	0.4881	0.4805
Fisher	**338.07*** **						**417.83*** **					
Observations	729	729	729	729	729	729	743	743	743	743	743	743

Panel B: Internet Penetration and Multilateral treaties

	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	**2.505*** **	**1.744*** **	**2.223*** **	**2.850*** **	**3.222*** **	**3.604*** **	**2.905*** **	**2.592*** **	**2.597*** **	**3.315*** **	**3.493*** **	**4.001*** **
	(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 (Internet)	**-0.073** **	**0.061*** **	-0.024	**-0.088*** **	**-0.184*** **	-0.098	-0.045	**0.060*** **	**0.047** **	**-0.047***	**-0.147*** **	**-0.146*** **
	(0.021)	**(0.000)**	(0.182)	**(0.000)**	**(0.000)**	(0.107)	(0.132)	**(0.000)**	**(0.016)**	**(0.083)**	**(0.000)**	**(0.005)**
Multilateral treaties	-0.007	**0.017*** **	0.001	**-0.014** **	**-0.026*** **	-0.013	**-0.013***	0.005	0.006	**-0.020*** **	**-0.025*** **	**-0.030** **
	(0.346)	**(0.000)**	(0.716)	**(0.019)**	**(0.000)**	(0.386)	**(0.060)**	(0.217)	(0.236)	**(0.002)**	**(0.000)**	**(0.027)**
Multilateral treaties×Internet	-0.002	**-0.008*** **	**-0.004*** **	-0.0002	**0.003***	-0.001	-0.0008	**-0.004*** **	**-0.005*** **	0.001	**0.003***	0.003
	(0.234)	**(0.000)**	**(0.002)**	(0.901)	**(0.076)**	(0.808)	(0.664)	**(0.000)**	**(0.000)**	(0.502)	**(0.090)**	(0.360)
Gross Domestic Product	**-0.547*** **	**-0.437*** **	**-0.510*** **	**-0.567*** **	**-0.668*** **	**-0.726*** **	**-0.601*** **	**-0.566*** **	**-0.579*** **	**-0.645*** **	**-0.716*** **	**-0.765*** **
	(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 & Development	**-0.079*** **	**-0.074*** **	**-0.063*** **	**-0.081*** **	**-0.088*** **	**-0.117*** **	**-0.084*** **	**-0.065*** **	**-0.082*** **	**-0.084*** **	**-0.091*** **	**-0.114*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Population	**0.058*** **	-0.003	**0.026***	0.024	**0.098*** **	**0.070** **	0.018	**-0.051*** **	-0.019	-0.015	**0.065*** **	**0.054***
	(0.009)	(0.812)	**(0.082)**	(0.181)	**(0.000)**	**(0.045)**	(0.399)	**(0.000)**	(0.200)	(0.443)	**(0.000)**	**(0.081)**
R^2/Pseudo R^2	0.7046	0.4611	0.5075	0.4969	0.4996	0.4944	0.7278	0.4714	0.5248	0.5157	0.5158	0.5187
Fisher	**349.65*** **						**400.19*** **					
Observations	729	729	729	729	729	729	743	743	743	743	743	743

***,**,*: significance levels of 1%, 5% and 10% respectively. 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 so because the combinations between software piracy and regressors are more apparent in non-contemporary regressions.

Further discussion and policy implications

The findings are discussed in three main strands. They comprise : (i) differences in the effects of IPRs measurements (positive versus negative and significant versus insignificant effects); (ii) variations across the conditional distributions (where the magnitude of the effects are explained) and (iii) differences in observed impacts from the interaction of IPR channels with technology dynamics.

First, on differences in the correlation of IPRs channels with technology, we have observed that main IP law interacts with PCs to raise the prevalence of pirated software in the 90^{th} quantile and bottom quantiles whereas IP law has a similar increasing effect exclusively in the bottom quantiles. The corresponding interaction of internet penetration displays a similar increasing marginal effects on software piracy, although these are not for the most part consistent across contemporary and non-contemporary specifications, notably at the: (i) 90^{th} quantile with main IP law in non-contemporary regressions; (ii) IP law in the 50^{th} (bottom) quantile(s) for non-contemporary (contemporary) specifications; (iii) WIPO treaties in the 10^{th} quantile of contemporary specifications and (iv) multilateral treaties in the 75^{th} quantile. Evidently, the findings show that with a few exceptions, the property rights institutions effectively interact with technology to reduce software piracy. The exceptions justify the relevance of our decision to employ an estimation model which accounts for the initial levels of software piracy.

The insignificant effect of some of the IPR indicators implies that a mere inclusion of the IP law and/or implementation of an IPR treaty without a corresponding improvement in the quality of the technology network with which IPRs interact, is necessary but not sufficient to fighting the corresponding software piracy. As a policy implication, the adoption of one IPR law

and treaty should continually be complemented with more modern and innovative IPRs laws and treaties in order to deter software piracy. The underlying insignificance may also infer that the institutions currently in place are not effective in upholding IPRs to drive KE (see Andres *et al*., 2015).

Overall, the increasing impact on piracy of the IP law channel and overwhelming diminishing piracy effects of our other measures of IPRs is broadly consistent with Asongu (2015)[10]. Nevertheless, some subtle differences between the results of this study and those established by Asongu (2015) are noteworthy. For example, (i) multilateral treaties, main IP law and WIPO treaties interact with technology to produce decreasing marginal effects which have different magnitudes throughout the software piracy conditional distributions; (ii) bilateral treaties lessen the use of pirated software with the moderating effect rising throughout the software piracy distribution and (iii) the increasing piracy effect of IP laws is contingent on the initial software piracy levels and the sophistication of technology embodied in the pirated software.

Second, positive threshold effects are apparent when bilateral treaties are combined with both PC users and internet penetration. A similar positive threshold effect was calculated with respect to the Constitution and WIPO treaties in three successive streams of quantiles when they are interacted with PC users. The notion of positive threshold should be understood in the perspective that the effectiveness of the underlying IPRs channels rises with increasing levels of software piracy. This is primarily because the magnitude of the estimated moderating effects increases from lower levels of software piracy to higher levels of software piracy. As a policy implication, some IPRs institutions are can be adopted by sampled countries in relation to their

[10] The term 'broad' is employed to emphasis the fact that this study cannot be directly compared with Asongu (2015) because the latter is: (i) focused exclusively on Africa: (ii) based on mean values of software piracy and (iii) is modelled with non-interactive interactive specifications.

existing levels of software piracy. Moreover, the fact that their effectiveness increases with the level of software piracy is an advantage over other IPRs mechanisms. This is essentially because in order to for policy makers to reduce software piracy by a higher magnitude in countries with high levels of software piracy vis-à-vis their counterparts with low levels of software piracy, a bilateral IP treaty of the same magnitude can be implemented in all countries concerned. For instance, if Nigeria and the United Kingdom sign a bilateral agreement on IPR protection with regards to software piracy that is linked to PC and internet penetration, it is expected that the implementation of the bilateral agreement will significantly discourage piracy in Nigeria (a country with a high initial level of software piracy) more than the corresponding reduction in the United Kingdom (a country with a low initial level of software piracy).

Third, there are obvious differences in the relevance of IPRs institutions in fighting software piracy. It follows from the fact that their effectiveness is not only contingent on existing levels of software piracy, but also on the technology embodied in the pirated software. To be sure, some IPR regimes are more conducive with specific technological settings. For instance whereas IP laws are not successful when pirated software is physically installed in PCs, it is effective in some quantiles when pirated software is downloaded over the internet. As a policy implication when adopting IPRs mechanisms in the fight against software piracy, the nature of the technology with which the pirated software is deployed should be considered. In other words, the implementation of IP laws should be preceded by individual-country studies aimed at investigating the effectiveness of such policies at varying initial levels of software piracy and sophistication of technology network.

Conclusion and future research directions

This study has extended the literature on fighting software piracy by examining how Intellectual Property Rights (IPRs) regimes interact with technology to mitigate software piracy when existing levels of software piracy are considered. Two technology (internet penetration and PC users) and six IPRs measurements (constitution, IPR laws, main IP laws, WIPO Treaties, bilateral treaties and multilateral treaties) are used in the analysis. The empirical evidence is based on: (i) a panel of 99 countries for the period 1994-2010 and (ii) interactive contemporary and non-contemporary Quantile regressions. The decision to use interactive Quantile regressions as opposed to the OLS method employed in previous studies centres on two main reasons. *First*, interactive QR modeling allows us to demonstrate more clearly the policy implications of the supposition that IPR regimes may perform differently depending on the nature of the technologies embodied in the pirated software. *Second*, interactive QR approach helps to control for the influence of initial levels of software piracy differentiated across countries with high-, intermediate- and low-values.

The following findings are confirmed. *First*, with regard to the effect on software piracy of the interaction between PC users and IPRs measurements, we reported that: (i) the Constitution and WIPO treaties have moderating effects of increasing magnitude respectively between 25^{th} and the 75^{th} quantiles and between 10^{th} and 75^{th} quantiles; (ii) main intellectual property (IP) law and IP law do not significantly reduce PC-related software piracy and; (iii) the modulating interactive effect with bilateral treaties is noticeable throughout the conditional distribution of software piracy, with an increasing magnitude in bottom quantiles while the mitigating role of multilateral treaties is only evident in the bottom quantiles and 75^{th} quantile.

Second, with respect to the impact on software piracy of the interaction between PC users and IPRs regimes: (i) the Constitution indicator has a modulating effect in the 50th quantile and top quantiles whereas there are no noticeable piracy reducing impact from the Main IP laws; (ii) while there are piracy increasing and diminishing marginal effects from IP law in the bottom and top quantiles respectively, there is a (are some) sparse evidence of an piracy increasing(negative) marginal effect in the 10th quantile (25th and 50th quantiles) of contemporary and non-contemporary regressions and; (iii) while the moderating effects from bilateral treaties are visible throughout the conditional distribution of software piracy with an increasing magnitude from the 10th quantile to the 75th quantile, the rising (reducing) influence of multilateral treaties on software piracy is observable in the 75th (bottom) quantile (quantiles).

Generally, our findings indicate that modulating effect of IP laws is greater in countries with high levels of software piracy. Policy implications have been discussed in the light of *inter alia*: (i) differences in the effects of IPRs regimes (increasing versus decreasing and significant versus insignificant effects); (ii) variations across the conditional distributions (in terms of the magnitude of the established effects) and (iii) differences in the piracy moderating effects of the interaction of IPR channels with technology dynamics. It is apparent from the above discussion that the adoption of blanket policies in the fight against software piracy is unlikely to succeed unless they are contingent on the existing levels of technologies and software piracy in the country concerned. Future research could improve on the extant literature by interacting IPRs metrics among themselves. This potential line of inquiry would clarify whether or not IPRs are complementary or substitutes.

Appendices

Appendix 1: Variable Definitions

Variables	Abbreviation	Variable Definitions (Measurement)	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)
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.

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
Technology and control variables	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
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.

Appendix 3: Correlation matrix

Piracy	GDP	R & D	Internet	PC	Pop.	Const.	MIPlaw	IPrlaw	WIPO	Multi.	Bilat.	
1.000	-0.766	-0.703	-0.503	-0.551	0.009	0.108	-0.405	-0.109	-0.215	-0.534	-0.180	Piracy
	1.000	0.653	0.386	0.482	-0.206	-0.173	0.285	0.067	0.077	0.376	0.160	GDP
		1.000	0.424	0.530	0.044	-0.161	0.221	-0.042	0.035	0.414	0.248	R & D
			1.000	0.897	0.609	0.145	0.284	0.196	0.119	0.316	0.299	Internet
				1.000	0.688	0.123	0.286	0.197	0.036	0.319	0.340	PCs
					1.000	0.269	0.068	0.179	-0.087	0.031	0.231	Pop.
						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. Const: Constitution. MIPlaw: Main Intellectual Property Law. IPrlaw: Intellectual Property Rights Law. WIPO: World Intellectual Property Organization Treaties. Multi: Multilateral Treaties. Bilat: Bilateral Treaties.

Compliance with Ethical Standards

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