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Fighting software piracy: which IPRs laws (treaties) matter in Africa?

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Fighting software piracy: which IPRs laws (treaties) matter in Africa?

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Abstract

With the proliferation of technology used to prate software, this paper answers some key questions in policy decision making. Dynamic panel Generalized Methods of Moments and Two Stage Least Squares are employed. IPRs laws (treaties) are instrumented with government quality dynamics to assess their incidence on software piracy. The following findings are established. (1) Government institutions are crucial in enforcing IPRs laws (treaties) in the fight against software piracy. (2) Main IP laws enacted by the legislature and Multilateral IP laws are most effective in combating piracy. (3) IPRs laws, WIPO Treaties and Bilateral Treaties do not have significant negative incidences on software piracy. Policy implications are discussed.

JEL Classification: F42; K42; O34; O38; O57
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1. Introduction

It is now an economic fact that for any country, region or continent to be actively engaged in the global economy, it must be competitive. Competition derives from intellectual

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property rights (IPRs) which protect intellectual capital. There has been a wide consensus on the key role IPRs protection play in promoting innovation processes and economic development. In recent history, technological progress has not only brought about an increased availability of information and technology related products, but also the proliferations of technology used to copy or pirate such commodities. Under the weight of these concerns, efforts are being placed on increasingly harmonizing the standards of IPRs protection worldwide. This harmonization is particularly important in developing countries, since the proliferation of pirated goods is more pronounced in low-income countries (Moores & Esichaikul, 2011, 2).

The debate that has centered on IPRs protection has been animated by two schools of thought. While some scholars postulate that increased protection of IPRs stimulate economic growth and development through a favorable impact on factor productivity (Gould & Gruben, 1996; Falvey et al., 2006), some skeptics are of the position that IPRs protection and adherence to international treaties (laws) may seriously limit the growth prospects of developing countries (Yang & Maskus, 2001). This second strand is of the stance that, less tight IPRs regimes are necessary (at least in the short-term) for developing countries to enable knowledge spillovers, crucial for growth and development. In line with their thinking, the existing technology in developing countries is more imitative and/or adaptive in nature and not suitable for the creation of new innovations[2].

In light of the above debate, there is a growing interest in the impact of IPRs protection on the promotion of innovation, technological advancements and economic development. Whereas, theoretical literature has focused on the concerns to some extent, little scholarly attention has been devoted to empirical research. The bulk of empirical studies have concentrated on the socio-economic determinants of piracy in several copyright industries

[2]This school of thought has gained prominence in the debate over if 'permission' should be granted to enable 'copying' of life-saving pharmaceuticals, especially those used in the management of HIV/AIDS in developing countries most affected and least likely to afford such treatments.

(Bezmen & Depken, 2004; Banerjee et al., 2005; Andrés, 2006; Bezmen & Depken, 2006; Peitz & Waelbroeck, 2006; Goel & Nelson, 2009; Andrés & Goel, 2012). However, with growing efforts currently being placed on harmonizing the standards of IPRs protection worldwide, policy makers should be eager to know which IPRs regimes are most effective in developing countries where the scourge of piracy is most acute[3].

Among developing nations, while regions like South America and Asia are responding in calculated steps that underscore IPRs in the current pursuit of national, regional and international initiatives, Africa appears to be lagging behind. In the current efforts towards harmonizing IPRs laws (treaties), policy makers in the continent are most likely to ask the following questions. (1) Which IPRs treaties (laws) are effective in fighting software piracy? (2) Are formal institutions really instrumental in upholding and enforcing IPRs treaties (laws)? (3) If so, for which IPRs laws (treaties) are government organs instrumental? (4) How are government institutions instrumental in the fight against piracy through IPRs laws (treaties)? The object of this study is to provide the much needed answers to these questions.

The rest of the paper is organized as follows. Section 2 examines existing literature. Data and methodology are discussed and outlined respectively in Section 3. Section 4 covers the empirical analysis and corresponding discussion. We conclude with Section 5.

2. Literature review

2.1 Institutional quality, software piracy and IPRs protection in Africa

There is mounting realization among international development experts that development requires above all, governance quality (Kaliannan et al., 2010; Rasiah, 2011; Katz & Iizuka, 2011). While the issue of institutional quality has been substantially documented in recent development literature (Asongu, 2011; Asongu, 2012abc), how it plays

[3]Many studies have concluded that nations with higher income and greater individualism have lower piracy rates (Maskus & Penubarti, 1995; Gould & Gruben, 1996; Park & Ginarte, 1997; Rushing & Thompson, 1996, 1999; Husted, 2000; Marron & Steel, 2000; Kranenberg & Hogenbirk, 2003; Kim, 2004; Depken & Simmons, 2004).

out in the fight against piracy (by upholding IPRs against software piracy) has received little or no scholarly attention. In fact, software piracy has reached an epidemic threshold in Africa (Hamade, 2006; El-Bialy, 2010). Consistent with the Business Software Alliance Global Software Piracy Study (BSA, 2010)[4], software piracy in Africa is double the global rate. According to the report of this alliance, the commercial value of unlicensed software installed on personal computers (PCs) in Eastern and Southern Africa (ESA), which excludes South Africa reached $109 million in 2010 as 83 % of software installed on PCs during the year was pirated. Having soared by 3.6 points on the previous five year average, this stands at almost double the global piracy rate for PC software (that is 42 %). In effect, the role of governance and formal institutions have been substantially documented as a means of effectively tackling the rising phenomenon (IDC, 2009; El-Bialy, 2010; Blakeney and Mengistie, 2011; Fripp, 2011; AFROL, 2012; Agabi, 2012). This section will be discussed in two strands. Whereas the first presents glaring evidence on software piracy from selected African countries in the dataset, the second focuses on institutional measures that are being implemented to combat the growing phenomenon.

With regard to the growing importance of piracy in Africa, Egypt, Kenya and Nigeria best illustrate the situation. Firstly, it is reported that software developers are losing millions of naira annually to software thefts and the phenomenon of software piracy is negatively affecting Nigeria's economy (Agabi, 2012). Agabi confirms from business experts that, the problem of illegal software usage in the country is a serious one and finding a solution is likely to become even more urgent with the usage rate expected to increase over the coming years. Secondly, the Kenya Copyright Board is currently increasing its efforts in the battle against the piracy of software. According to Fripp (2011), it was to battle it with vigor as of 2012 in order to increase investment potential and crackdown on illegal use of software. Fripp

[4]The BSA evaluates the state of software piracy around the world.

emphasizes that according to the board, there have been sustained raids on suspected resellers of counterfeit software, in order to reduce the Information and Communication Technology (ICT) sector's losses which is losing thousands of new jobs and millions of dollars as a result of the piracy. Consistent with the Executive Director of the Board, there are clear signs that the Board has resolved to uphold (and strengthen) Kenya's IPRs laws/treaties/regimes by firmly dealing with those that are engaged in software piracy[5]. Thirdly, a study by the International Data Corporation (IDC) Global Software Piracy has shown that Egypt is making substantial efforts to tackle the issue of piracy. It is also highlighted that, this is largely due to the improved collaboration between Egypt and the US on enforcement of IPRs cases (AFROL, 2012). Consistent with this AFROL report, Egypt is fully committed to further reducing its piracy rating and tackling the challenges facing the industry with a number of measures; among others, IPRs training for the Egyptian legal community and promotion of the copyright law (to improve awareness of IPRs and its role in sustaining economic growth and attracting foreign direct investment (FDI)).

We devote space in the second strand to discussing the role of institutions in IPRs protection and reduction of software piracy. Firstly, with regard to IPRs protection, the World Trade Organization (WTO) can be considered among the different multilateral organizations that are emphasizing on the importance of legal reforms in African countries. These organizations guide these countries in the granting and protection of IPRs by providing minimum requirement standards that should be fulfilled by each member country. However, a draw-back to this approach is that, their strategy is mainly based on promoting one-fits-all institutions. Therefore, they seem to neglect (or ignore) alternative institutional arrangements that could be used to reach efficient outcomes for the conflicting parties for a long time (El-Bialy, 2010) or how institutions matter in upholding IPRs (as the present paper seeks to

[5] "*The Board remains ready and willing to support software copyright owners by intensifying enforcement efforts to reduce software piracy in our country and ensure that legitimate businesses reap the fruits of their labor as per the Kenya Copyright Board mandate*" (Fripp, 2011).

address). Accordingly, El-Bialy goes further to assert that the phenomenon of inefficient IPRs institutions is more likely to be significant in developing countries. This is because they may need "appropriate" IPRs enforcement strategies and, their institutions differ considerably from those prevailing in wealthier countries. For example, Rodrik (2008) has qualified them as 'second-best institutions' and described the institutional reforms promoted by multilateral organizations (the World Bank (WB), International Monetary Fund (IMF) or WTO) as being heavily skewed towards a best-practice approach.

Secondly (with regard to the role of institutions in software piracy), during the end of the 20th century, the world began tilting toward new IPR strategies, with much emphasis placed on the need for cooperative policies to reduce software piracy. Governments, together with software companies (the International Intellectual Property Alliance (IIPA) and the BSA) started doing more to tackle piracy in Africa. The BSA started publishing an annual study (after the year 2000) to assess a detailed and diverse picture of global software piracy in order to analyze country- and regional-specific piracy trends (El-Bialy, 2010). It began to look for alternative ways of tackling piracy. In addition to conducting huge awareness campaigns to the public, agreements between the BSA and African governments were signed to provide price cut-offs of original software products. To this effect, some satisfactory results were observed[6]. Over the past few years however, reforming 'IPR enforcement organs' in developing countries has been the object of much attention. Accordingly, the efficiency of the enforcement authorities or the process of factual (de facto) enforcement is now acknowledged as an important orientation of modern IPRs policies (El-Bialy, 2010).

2.2 Intellectual Property Rights (IPRs) and development

According to Bezmen & Depken (2004), there are two principal avenues along which intellectual property (IP) and the strength of IPRs regimes are thought to affect the level of

[6] For instance, some considerable achievements were noticed as piracy trends started to decline in North Africa.

economic growth and development. The first strand provides analysis of the extent to which IPRs influence the creation of new knowledge and information within nations, as well as the diffusion of existing knowledge across countries. The second strand is concerned with the indirect effect of a nation's IPRs regime on international transactions that provide factors imperative to the growth process.

In the first strand on 'creation and dissemination of information', IPRs protection could be traced to the foundation of endogenous theories of economic growth whereby, investment in research and development (R&D) rewards individual investors with profit (returns) and also augment society's stock of knowledge. Lowering the cost of future innovation, improves the accumulation of knowledge for economic growth (Romer, 1990; Grossman & Helpman, 1991). The underlying wisdom of tighter and restrictive IPRs regimes is based on the notion that, protection of IPRs serves as a stimulus to growth by encouraging inventions and innovations. Recently, many newly industrialized countries have campaigned for stronger IPRs via bilateral, multilateral and regional arrangements. This difference in approach could be traced to the desire of developing countries to specialize in labor intensive production in agricultural industries. Until much recently, these industries have largely been supported by public expenditures on research and technology and have greatly benefited from shared knowledge spillovers.

In the second strand, IPRs may also influence a nation's growth and development process via their influence on the nation's ability to engage in international transactions such as trade, Foreign Direct Investment (FDI) flows and technology transfers (Bezmen & Depken, 2004). The endogenous growth theories have presented international trade as an important stimulus to economic prosperity, since access to world markets could stimulate greater utilization of human resources (Todaro & Smith, 2003), and ease the transmission of technology by providing contact with foreign counterparts and direction of domestic resources

towards more research intensive sectors. Nevertheless, these models do not necessarily predict that openness leads to economic growth for all countries and under all circumstances; principally because theoretical prediction is contingent on country-specific conditions. It has been substantially documented that a stronger IPRs regime is a crucial factor in attracting the inflows of FDI and technological transfers (Lee & Mansfield, 1996), stimulating exports (Maskus & Penubarti, 1995) and increasing the possibility of investment undertaken by multinational enterprises (Mansfield, 1994; Seyoum, 1996). From the other side of the coin, stronger IPRs protection could mitigate the need for FDI (Yang & Maskus, 2001).

2.3 The politics of piracy and intellectual property rights (IPRs) protection

Consistent with Shadlen et al. (2003), two of the main forms of IPRs are copyrights and patents. Copyright protects *form of expression* (e.g. written material and artistic works), whereas patents protect underlying ideas used for industrial products or processes. Where computer software receives protection, it is ordinary under copyright law, though in recent years software developers (particularly in the USA) have also been granted patent protection. When the government fails to enforce copyrights and patents, the processes of artistic creation and invention may take on a character of public goods and hence be subject to traditional collective action issues. IPRs are designed to solve a 'collective action concern' by offering inventors and authors temporary monopolies or in the jargon of public choice theory, *selective incentives* to pursue their vocations. Ultimately, patents and copyrights should be rewarding to producers of IP. In the same line of thinking, strengthened IPRs maybe unappealing to consumers who are likely to face exorbitant prices on protected commodities.

As concerns IPRs, managing the trade-offs between consumers and producers is particularly complex. The complexities are derived from the characteristics of expression and ideas as distinct types of goods and services. IPRs are different from *normal* property rights from the perspective that, they are different from tangible goods. Most importantly, ideas are

not rival-oriented in consumption and non-excludable, implying that an unlimited number of people can exploit the same idea simultaneously and repeated use does not deplete (diminish) the stock of the idea. Owing to these distinct characteristics, many of the standard rationales for giving property owners extensive rights to control the use of their commodities go by the wayside. Factually, without proper motivations to producers, ideas like *tangible goods* run the risk of being undersupplied. However, it is not necessary for example to endow owners with strong rights to control distribution and restrict use so as to prevent depletion of commodities that by their definition are non-excludable. Conversely, restricting-use could freeze ideas and stifle innovation. Indeed, a substantial body of the literature warns of the dangers of too much protection of IPRs (Yang & Maskus, 2001). For instance, stronger IPRs may stifle incentives to innovate and introduce new technologies (Helpman, 1993; Bessen & Maskin, 2000; Maskus, 2000; Shadlen et al., 2003). As sustained by Shadlen et al. (2003), with too much protection, the *tragedy of the commons* may be substituted by the *tragedy of the anti-commons* (Heller & Eisenberg, 1998), since diminished access to upstream ideas can stifle downstream innovation. Hence, the challenge for the management of IPRs is to create incentives for provision which do not unnecessarily deter the distribution.

To strike the delicate balance between provision and distribution, IPRs have been curtailed historically. For example, private rights over ideas are not conferred upon possession automatically. Nor are rights indefinite: copyrights and patents expire, after which what is private property enters into the public domain. Private property rights are also limited in the view of being subject to a range of automatic exceptions. That is, third parties also have rights to use ideas and commodities protected by IPRs. In the case of copyrights, these rights fall under the doctrine of *fair-use* which permits third parties to exploit copyrighted material regardless of the intent of the copyright owner. Before the 1980s, most governments throughout the world offered porous and weak copyright protection, precisely to motivate

diffusion and use (Lessig, 2001, p. 249). IPRs protection systems introduced in 1980s fundamental changes to overcome the limitations that traditionally distinguished the treatment of intellectual property from tangible property (May, 2000; Shadlen et al., 2003). From a software piracy standpoint, in addition to making copyrights easier to obtain by simplifying the process of registration, the current arrangement enables copyright owners with significantly greater control and exclusion rights; implying third parties' rights to *fair use* have been significantly reduced (Shadlen et al., 2003, p. 9). This represents a substantial challenge for government to enforce international treaties (laws) on IPRs protection in a bid to curb the growing phenomenon of piracy.

Shadlen et al. (2003) further postulate that, by granting extensive periods of protection to patents and copyrights, IPRs are made effectively permanent. By the time most operating systems or applications fall into the public domain, it is unlikely that any machine on earth will be able to use them (Lessig, 2001, p. 252). This implies, the sea of variations include introduction of software under copyright law, significantly greater scope of protection for copyright owners and longer protection periods. At the national level (beside the extraordinary trade-off between innovation and diminished diffusion of new commodities), a concern arises on how to enforce IPRs and fight piracy. This paper seeks to solve this puzzle by examining which IPRs treaties (laws) matter for the battle against piracy in Africa.

2.4 Scope and positioning of the paper

With recent developments in Information and Communication Technologies (ICTs), the concern over software piracy is increasingly relevant and, has retained scholarly attention. International organizations are currently advocating global convergence in IPRs as a prerequisite for successful innovation strategies. The difficulties of achieving such harmonization are however evident from the attempts of several nations to develop divergent IPRs systems. Standard-setting is increasingly important in tackling software piracy as a

means of reducing transaction cost. Standards also have a particularly important role of ensuring compatibility and interconnectivity of products and services.

A substantial part of the literature has examined the determinants of the ability to pirate software by investigating the socio-economic factors that affect piracy. Strong conclusions have been drawn that nations with higher income and greater individualism have lower piracy rates (Maskus & Penubarti, 1995; Gould & Gruben, 1996; Rushing & Thompson, 1996, 1999; Park & Ginarte, 1997; Husted, 2000; Marron & Steel, 2000; Kranenberg & Hogenbirk, 2003; Kim, 2004; Depken & Simmons, 2004). A vast empirical literature has also concentrated on the socio-economic determinants of piracy rates in several copyright industries (Andrés, 2006; Banerjee et al., 2005; Bezmen & Depken, 2006; Peitz & Waelbroeck, 2006; Goel & Nelson, 2009; Andrés & Goel, 2012). To a great extent, the above studies have concentrated on developed countries and the emerging economies of Latin America and East Asia. The focus of the present study on the sparsely represented African continent in the literature also draws from the debate on the 'East Asian Miracle'[7].

Europe and North America have mastered the dynamics of IP and inexorably driving developments in the global and international arena. Other regions like Asia and South America are responding in calculated steps that underscore the role of IP in the current pursuit of national, regional and international initiatives. Consequently, different nations have varying standards of protection of IPRs. The recent trend of globalization strengthened by several multilateral and regional treaties further creates some international minimum standard for

[7]Additional evidence for the possibility that the changing strength of IPRs regimes is based on a nation's level of development or current technological ability could be traced to the rapid growth witnessed by South-East Asia. Some evidence suggests that the 'East Asian Miracle' might have originated from weaker IPRs regimes at the early stages of these nations' development in addition to their accumulation of capital. These nations' capacity to absorb, replicate and duplicate foreign innovations might have contributed to their relatively high economic prosperity rates. Further evidence has suggested that, as these countries became significant producers of new technologies and innovations, their IPRs regimes tightened and became stricter. While Nelson & Pack (1999) have postulated that the productive assimilation of existing (foreign) production techniques and technologies 'was a critical component in the success of these countries', Maskus (2000) cautions that weaker protection of IPRs may not necessarily be beneficial for developing countries as it may cause them to remain subservient to older and less efficient outdated technologies.

IPRs protection. In Africa, IPRs issues are assuming central stage in discussions on development of the continent. Given the growing role of IPRs in software piracy protection, policy makers are more likely today to ask the questions we have discussed in the introduction of this paper. Hence, the empirical section will provide some answers.

3. Data and Methodology

3.1 Data

3.1.1 Measuring piracy

The proxy for piracy is the software piracy rate, which is defined as "the unauthorized copying of computer software which constitutes copyright infringement for either commercial or personal use" (SIIA, 2000). Software piracy is multidimensional and could potentially take many avenues – e.g., organized copiers, piracy by individuals and commercial or business piracy. Consistent with the Business Software Alliance (BSA), we can distinguish among three types of piracy: 1) end user copying; 2) downloading; and 3) counterfeiting. Hence, obtaining an accurate measure of the prevalence of software piracy remains a substantial challenge in the literature. The piracy level is computed as the difference in demand for new software applications (estimated from PC shipments) and the legal supply of software. In the present paper, the measure of piracy employed is the percentage of software (primarily business software) in a country that is illegally installed (without a license) on an annual basis and is taken to capture the level of software piracy. This variable is reported in percentages, scaling from 0 % (or no piracy) to 100 % (i.e., all software installed is of pirated origin). Piracy rates are gathered from the Business Software Alliance (BSA, 2007). Additional details on measurement can be obtained from BSA (2009)[8]. BSA is an industry group; nonetheless its data on software piracy is the best cross-country indicator currently used in the

[8] Data from the BSA primarily measures the piracy of commercial software. More discussion on the reliability of piracy data could be obtained from Png (2008) and Traphagan & Griffith (1998).

literature, though the object of some inherent upward bias[9]. From a broad perspective, the data on software piracy could be seen as proxying for the extent of digital piracy. The rate of software piracy is computed as: 'logarithm of (piracy/(100-piracy))' to ensure comparability of the variables.

3.1.2 Intellectual Property Rights (IPRs) variables

IPRs variables are gathered from the World Intellectual Property Organization (WIPO). The five exogenous variables gathered include: *Main IP laws, IPRs laws, WIPO Treaties, Multilateral Treaties* and *Bilateral Treaties*. *Main IP laws* and *IPRs laws* are IP laws that are enacted by the legislature and enforced by the institutions. WIPO administered treaties are defined from the day they enter into force for the contracting party. IP relevant Bilateral and Multilateral Treaties are also gathered with respect to the date they are enforced by the contracting parties. The primary purpose of these laws is to uphold IPRs. Hence, they are naturally exogenous to software piracy if properly instrumented with existing enforcement organs (formal institutions).

3.1.3 Instrumental variables

In this section, we devote space to providing justification for the empirical validity of the instrumental variables. This justification is essential for the relevance of the empirical analysis because a theoretical basis for the instruments is crucial for sound and consistent interpretation of estimated coefficients. In other words, while the object of this paper is to assess the effect of IPRs laws (treaties) on piracy, it also indirectly aims to examine how government institutions are instrumental in the incidence of IPRs laws (treaties) on piracy. The instrumental variable approach in the empirical section requires that the instruments be correlated with the main endogenous regressor. Logic and common-sense have it that,

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

government institutions and IPRs move hand in hand. Save in utopia, we cannot discuss one while ignoring the other. Hence, only formal institutions set by the governments in place enforce IPRs laws (treaties). Measures indicating the quality of formal institutions include: *the rule of law*, *regulation quality*, *corruption-control*, *government effectiveness*, *political stability* (*no violence*) and *voice & accountability*. We argue that, these good governance indicators are instruments for the upholding and enforcement of IPRs laws (treaties). Details on the definitions of these variables are provided in Appendix 3. Government quality indicators range from -2.5 to 2.5 and the negative values in Appendix 1 confirm the poor state of formal institutions in the sampled African countries.

Owing to constraints in data availability (for piracy), the dataset includes annual observations for 11 African countries for the years 2000-2010. Details about the variable definitions (with data sources), descriptive statistics (with presentation of countries) and correlation analysis (showing the basic correlations between key variables used in this paper) are reported in the appendices. The summary statistics (Appendix 1) of the variables used in the panel regressions show that, there is quite a degree of variation in the data utilized so that one should be confident that reasonable estimated relationships should emerge. The purpose of the correlation matrix (Appendix 2) is to mitigate issues resulting from overparametization and multicolinearity. Based on the correlation coefficients, there do not appear to be any serious issues in terms of the relationships to be estimated. The countries investigated are presented in Panel B of Appendix 1.

3.2 Methodology

3.2.1 Dynamic panel Generalized Methods of Moments (GMM)

Estimation with dynamic panel data has some important advantages and one disadvantage when compared to cross-country analysis (Demirgüç-Kunt & Levine, 2008). On the first positive note: (1) it makes use both of time-series and the cross sectional variations in

the data; (2) in cross-country regressions, the unobserved country-specific effect is part of the error term, so that correlation between the error term and the exogenous variables results in biased estimated coefficients. More so, in cross-country regressions, if the lagged dependent variable is included among the explanatory variables, the country-specific effect is certainly correlated with the regressors. A means of controlling for the presence of the unobserved country-specific effect is to first-difference the regression equation to eliminate the country-specific effect, and then employ instrumental variables to control for endogeneity. The endogeneity issue is the second edge of dynamic panel data analysis. Uncontrolled endogeneity can substantially bias estimates and lead to misleading inferences. Dynamic panel data analysis takes care of this endogeneity issue by using lagged values of exogenous variables as instruments.

The principal concern associated with dynamic panel data analysis is using data-averages over shorter time spans. This implies the estimated results reveal shorter-run impacts and not long-term effects, which should be kept in mind when interpreting and discussing results. In the context our paper, we shall overcome this issue by using both 'full data' and 'data averages'.

The dynamic panel regression model is expressed as follows:

$$P_{i,t} = \sigma_0 + \sigma_1 P_{i,t-1} + \sigma_2 MIP_{i,t} + \sigma_3 IPR_{i,t} + \sigma_4 WIPO_{i,t} + \sigma_5 Multi_{i,t} + \sigma_6 Bilat_{i,t} + \eta_i + \xi_t + \varepsilon_{i,t} \quad (1)$$

Where 't' stands for the period and 'i' represents a country. P is the piracy rate; MIP, Main Intellectual Property law; IPR, Intellectual Property Rights law; $WIPO$, World Intellectual Property Organization Treaties; $Multi$, Multilateral Treaties; $Bilat$, Bilateral Treaties, η_i is a country-specific effect, ξ_t is a time-specific constant and $\varepsilon_{i,t}$ an error term.

Estimates will be unbiased if and only if, the IPRs exogenous variables above are strictly exogenous. Unfortunately, this is not the case in the real world because: (1) while they

have a substantial incidence on piracy, the reverse effect cannot be ruled-out because the level of piracy could also affect the choice of IPRs regimes; (2) the regressors could be correlated with the error term ($\varepsilon_{i,t}$) and; (3) country- and time-specific effects could also be correlated with other variables in the model, which is often the case with lagged dependent variables included in the equations. Hence, an issue of endogeneity due to endogenous regressors. A way of dealing with the problem of the correlation between the individual specific-effect and the lagged endogenous variables involves eliminating the individual effect by first differencing. Thus, Eq. (1) becomes:

$$P_{i,t} - P_{i,t-1} = \sigma_1(P_{i,t-1} - P_{i,t-2}) + \sigma_2(MIP_{i,t} - MIP_{i,t-1}) + \sigma_3(IPR_{i,t} - IPR_{i,t-1}) + \sigma_4(WIPO_{i,t} - WIPO_{i,t-1}) + \sigma_5(Multi_{i,t} - Multi_{i,t-1}) + \sigma_6(Bilat_{i,t} - Bilat_{i,t-1}) + (\xi_t - \xi_{t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) \quad (2)$$

However Eq. (2) presents another issue; estimation by Ordinary Least Squares (OLS) is still bias because there remains a correlation between the lagged endogenous independent variable and the disturbance term. To address this concern, we estimate the regression in differences jointly with the regression in levels using the Generalized Method of Moments (GMM) estimation. The procedure uses lagged levels of the regressors as instruments in the difference equation, and lagged differences of the regressors as instruments in the levels equation, thus exploiting all the orthogonality conditions between the lagged dependent variables and the error term. Between the difference GMM estimator (Arellano & Bond, 1991) and system GMM estimator (Arellano & Bover, 1995; Blundell & Bond, 1998), we choose the latter in accordance with Bond et al. (2001, 3-4)[10].

[10] "*We also demonstrate that more plausible results can be achieved using a system GMM estimator suggested by Arellano & Bover (1995) and Blundell & Bond (1998). The system estimator exploits an assumption about the initial conditions to obtain moment conditions that remain informative even for persistent series, and it has been shown to perform well in simulations. The necessary restrictions on the initial conditions are potentially consistent with standard growth frameworks, and appear to be both valid and highly informative in our empirical application. Hence we recommend this system GMM estimator for consideration in subsequent empirical growth research*". Bond et al. (2001, pp.3-4).

In specifying the dynamic panel system estimation, we opt for the *two-step* GMM because it corrects the residuals for heteroscedasticity. In the *first-step*, the residuals are considered to be homoscedastic. The assumption of no auto-correlation in the residuals is crucial as past lagged variables are to be used as instruments for the endogenous variable. Also, the estimation depends on the hypothesis that the lagged values of the dependent variable and other independent variables are valid instruments in the regression. When the error terms of the level equation are not auto-correlated, the first-order auto-correlation of the differenced residuals should be significant while their second-order auto-correlation: *AR(2)* should not be. The validity of the instruments is assessed with the Sargan over-identifying restrictions (OIR) test. In summary, the main arguments for using the system GMM estimation are that: it does not eliminate cross-country variation, it mitigates potential biases of the difference estimator in small samples and, it can control for the potential endogeneity of all regressors.

3.2.2 Two-stage least squares

In accordance with recent piracy literature (Andrés & Goel, 2012), the paper adopts a Two-Stage Least Squares (2SLS) Instrumental Variable (IV) estimation technique. IV estimation solves the puzzle of endogeneity and hence, avoids the inconsistency of estimated coefficients by OLS when the exogenous variables are correlated with the error term in the main equation. The 2SLS estimation will entail the following steps:

First-stage regression:

$$IP_{it} = \gamma_0 + \gamma_{1i}(Instruments)_{it} + \upsilon_{it} \qquad (1)$$

Second-stage regression:

$$Piracy_{it} = \gamma_0 + \gamma_1(IP)_{it} + \mu_{it} \qquad (2)$$

In the first and second equations, υ_{it} and μ_{it} respectively represent the error terms. Instrumental variables are: *control of corruption*, *government effectiveness*, *voice & accountability*, *rule of law*, *regulation quality* and *political stability*. *IP* represents: *Main Intellectual Property Law*, *Intellectual Property Rights Law*, *WIPO Treaties*, *Multilateral Treaties* and *Bilateral Treaties*. *Piracy* is the software piracy rate.

We adopt the following steps in the IV analysis: (1) justify the choice of a 2SLS over an OLS estimation technique with the Hausman-test for endogeneity; (2) verify the instruments are exogenous to the endogenous components of the explaining variable (IPRs channels) and; (3) ensure the instruments are valid and not correlated with the error-term in the main equation with an Over-identifying Restrictions (OIR) test.

3.2.3 Further Robustness checks

Beside the control for endogeneity, further robustness of our models is ensured by the following: (1) use of 'full data' and 'average data' with non-overlapping intervals to capture both the long-term and short-run tendencies of estimated coefficients respectively; (2) employment of robust Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors; (3) use of both system and difference GMM estimation, and; (4) employment of both GMM instruments (for dynamic panel regressions) and 2SLS with 'government quality' instruments (based on common sense and discretion of the authors).

4. Empirical analysis

4.1 Presentation of results, discussion and policy implications

The section seeks to address the four main issues highlighted in the introductory section[11]. While the GMM estimations address the first issue, the 2SLS estimations assess all

[11] (1) Which IPRs treaties (laws) are effective in fighting software piracy? (2) Are formal institutions really instrumental in upholding and enforcing IPRs treaties (laws)? (3) If so, for which IPRs laws (treaties) are government organs instrumental? (4) How are government institutions instrumental in the fight against piracy through IPRs laws (treaties)?

four concerns. However, the GMM estimations are necessary (from a comparative standpoint), to enable the 2SLS approach address the second, third and fourth issues. This is because, the validity of the government quality instruments in the 2SLS approach need to be compared with other valid instruments.

From the results in Table 1, the difference GMM findings are substantially different from those of the system GMM. Hence, we shall give priority to system GMM estimators for reasons already outlined above in the methodology section (Bond et al., 2001). For both types of GMMs all the null hypotheses of the AR(2) and Sargan-OIR tests for no autocorrelation and validity of instruments respectively are not rejected. For the 2SLS, we perform a Hausman test prior to the IV estimations. The null hypothesis of the test is the position that, OLS estimates are consistent and efficient. Hence, a rejection of the null points to the issue of endogeneity and lends credit to the choice of an IV approach and corollarily justifies the GMM estimations. The null hypotheses of the Sargan-OIR tests are also rejected in all the 2SLS models, confirming the validity of the government quality instrumental variables. The absence of a significant initial piracy coefficient (*Pit-1*) in "full data" is not an issue because the two-Year NOI have been used to mitigate short-run disturbances looming in 'full data'[12]. Two years average data with NOI captures only the short-run tendencies. Full data captures the long-term tendencies. Two justifications could be provided to account for this difference: (1) it is standard GMM estimation inference (as discussed in the methodology section) and; (2) it is consistent with recent methodological innovations in the convergence literature (Asongu, 2012defgh). Moreover, when 'full data' is converted into two year averages, it is a means of mitigating short-term disturbances that may loom substantially large and bias the estimated coefficients.

[12] The absence of significant initial piracy coefficients (*Pit-1*) is simply an indication that the process of convergence cannot be fully appreciated with "full data" because short-term disturbances are looming substantially large (See, Islam, 1995, p. 14). This is the reason, the two-year NOI have been used to mitigate such short-term disturbances.

Based on the findings, the following could be established. (1) From GMM estimates, IPRs laws (treaties) mitigate piracy more in the long-term than in the short-run. While two-year non-overlapping interval results are interpreted as short-run effects, 'full data' results have long-term incidences. (2) On the first question of *which* IPRs treaties (laws) are effective in fighting software piracy, only *Main IP laws* and *Multilateral treaties* are found to have a significant negative effect. (3) On the second concern of assessing *if* formal institutions are instrumental in upholding and enforcing IPRs treaties, the answer is: *yes*, since government quality institutions are overwhelmingly valid by virtue of the Sargan-OIR test. In other words, failure to reject the null hypothesis of the Sargan-OIR test suggests that, the government quality instruments do not control piracy beyond IPRs laws (treaties) channels. Simply put, these IPRs mechanisms are the only channels via which government quality dynamics (of corruption-control, rule of law, regulation quality, government effectiveness, political stability (no violence), voice & accountability) fight piracy. (4) As regards the concern *for which* IPRs laws (treaties) are government organs instrumental, the answer is same as that to the first question. This is because; there are no additional significant IPRs channels estimates in the 2SLS, compared to the GMM. (5) On the question of *how* government institutions are instrumental, two interpretations are necessary. On the one hand, in short-term (two-year NOI) and long-run (full data), formal institutions increase the efficacy of *Main IP laws* and *Multilateral treaties*[13]. On the other hand, in the absence of formal institutions, the efficacy of *Main IP law* seems to be greater than that of *Multilateral treaties*[14]. (6) The remaining IPRs laws (treaties) overwhelmingly have the right signs but are not significant. In other words, WIPO and Bilateral treaties do not have significant negative signs. A possible explanation to these unexpected results could be the fact that, these IP treaties do not directly target software piracy because they are either too general (WIPO Treaties) or too specific (Bilateral Treaties).

[13] Note should be taken of the fact that, formal institutions are the instruments in the 2SLS approach.
[14]The efficacy of Main IP laws and Multilateral Treaties is almost equal in the 2SLS approach. However, this is not the case in the GMM.

Also, their variations in the summary statistics (in Appendix 1) that are significantly lower than those of other IP law variables could be the source of the insignificance. (7) A higher constant (autonomous) piracy rate in the 2SLS regressions (in comparison to GMM estimations) broadly indicates that other institutional organs need to be taken into account in the fight against piracy.

Table 1: GMM and 2SLS Regressions

	Dependent variable: Piracy rate							
	GMM Estimations				**Two-Stage Least Squares (2SLS)**			
	Full Data		Two Year NOI		Full Data		Two Year NOI	
	Dif. GMM	**Sys. GMM**	Dif. GMM	**Sys. GMM**	Not HAC	**HAC SE**	Not HAC	**HAC SE**
Constant	0.008	**0.791****	0.003	**0.432***	**1.88*****	**1.88****	**1.971****	**1.971***
	(0.529)	**(2.505)**	(0.089)	**(1.701)**	**(2.871)**	**(1.982)**	**(2.093)**	**(1.883)**
Initial Piracy	0.265	0.107	**0.324****	**0.491****	---	---	---	---
	(0.715)	(0.306)	**(1.977)**	**(2.195)**				
Main IP law	-0.035	**-0.080*****	**0.222****	**-0.045***	**-0.09*****	**-0.09*****	**-0.097****	**-0.097*****
	(-0.745)	**(-2.707)**	**(2.053)**	**(-1.959)**	**(-3.280)**	**(-3.044)**	**(-2.434)**	**(-2.694)**
IPRs law	-0.0004	0.020	-0.034	0.010	**-0.11***	-0.119	-0.124	-0.124
	(-0.011)	(1.453)	(-1.593)	(1.059)	**(-1.760)**	(-1.125)	(-1.187)	(-1.024)
WIPO Treaties	-0.041	-0.007	0.0004	0.014	-0.08	-0.089	-0.096	-0.096
	(-0.963)	(-0.145)	(0.005)	(0.448)	(-0.548)	(-0.422)	(-0.429)	(-0.429)
Multilat. Treaties	-0.014	**-0.022***	-0.015	**-0.017***	**-0.09*****	**-0.099***	**-0.107****	**-0.107***
	(-1.030)	**(-1.654)**	(-0.570)	**(-1.652)**	**(-3.01)**	**(-1.761)**	**(-2.179)**	**(-1.875)**
Bilateral Treaties	-0.063	-0.012	-0.057	0.017	**0.293***	0.293	0.313	0.313
	(-0.978)	(-0.200)	(-1.144)	(0.435)	**(1.777)**	(0.989)	(1.180)	(0.950)
Hausman test	---	---	---	---	**235.67*****	**235.67*****	**135.79*****	**135.79*****
AR(2)	**-0.941**	**-1.501**	**1.092**	**0.834**	---	---	---	---
	[0.346]	**[0.133]**	**[0.274]**	**[0.404]**				
Sargan OIR test	**6.257**	**5.576**	**7.125**	**4.863**	**0.880**	**0.880**	**0.603**	**0.603**
	[1.000]	**[1.000]**	**[0.624]**	**[0.978]**	**[0.348]**	**[0.348]**	**[0.437]**	**[0.437]**
Wald (joint) test	5.984	**724.01*****	**50.939*****	**499.2*****	---	---	---	---
Adjusted R^2	---	---	---	---	0.149	0.149	0.078	0.078
Fisher	---	---	---	---	**4.561*****	**3.174****	**2.236***	**2.947****
Countries	11	11	11	11	11	11	11	11
Observations	84	95	34	45	90	90	50	50
Instruments	51	60	16	20	Constant; CC; GE; RL; RQ; PolS; V&A			

*;**;***: significance levels of 10%, 5% and 1% respectively. Z-statistics in parentheses. [ ]:P-values. Initial piracy: estimated lagged endogenous variable (piracy rate). Dif: Difference. Sys: System. GMM: Generalized Methods of Moments. HAC: Heteroscedasticity and Autocorrelation Consistent. SE: Standard Errors. NOI: Non overlapping intervals. Main IP: Main Intellectual Property. IPRs: Intellectual Property Rights. WIPO: World Intellectual Property Organization. Multilat: Multilateral. OIR: Overidentifying restrictions. CC: Control of Corruption. GE: Government Effectiveness. RL: Rule of Law. RQ: Regulation Quality. PolS: Political Stability. V&A: Voice & Accountability.

We have observed that formal institutions are instrumental in upholding and enforcing IPRs treaties. Given the substantially documented evidence on poor institutions in most

countries making-up the sample, there is reason to believe that, improving good governance would: (1) mitigate the negative incidence of software piracy on the Nigerian economy and decrease the corresponding millions of naira in annual loses to software theft (Agabi, 2012); slow down the Kenyan ICT sector losses in thousands of new jobs and millions of dollars as well as improve on the country's investment potential and climate (Fripp, 2011) and; (3) sustain economic growth and attract FDI in Egypt (AFROL, 2012).

Another interesting finding worth laying emphasis on is the fact that based on GMM estimates; IPR laws (treaties) mitigate piracy more in the long-term than in the short-run. It points to the time advantage of IP laws. This implies governments of sampled countries should begin working toward balanced and appropriate IPRs protection at industrial and individual levels if they are to reap the time-oriented benefits of IPRs policies. Among others, it will be effective not only for governments to negotiate with one another, but also for interactions of government and organizations to be informed on the opinion of the software industry. The imperative for the inclusions of other organs is justified by the higher autonomous or constant piracy rate in the 2SLS regressions. We suggest the following points in order to facilitate this harmonization process. (1) The establishment of highly transparent international protection rules/regulations and greater efficiency in international rights acquisition among countries that are conducive to smooth trade, foreign investment and technology transfer. (2) Adequate and global protections for patents are imperative for the use of technological innovation geared toward a new society that takes African geographic universality of networks into consideration. (3) Development of an attractive international business environment that respects IPRs, with the global development of a business marketplace (among African countries as well as the rest of the world) that ensures the efficient use of IPRs, licensing contracts subject to 'African development oriented

regulations' and, fair competition will improve investment and technology transfer as well as contribute to a harmonious development of the African economy.

4.2 Caveats and future research direction

The principal caveat is on the measurement of software piracy from which three points are relevant. (1) 'Piracy rate is computed as the difference in demand for new software applications (computed from PC shipments) and the legal supply of software'. However, it should be noted that this metric defines piracy as the drop in demand of software products. Hence, all pirated copies constitute lost sales. (2) It has also been substantially documented that, those who buy pirate copies do not always have the money to buy the true commodity. Hence, to consider the use of pirated products as diminishing demand for originals could be some kind of overstatement. (3) Knowledge of the elasticity of demand for the original product is necessary before the use of the metric. Otherwise, there will be a comparison of pirated commodities that constitute loss in sales with ones that do not. Hence, there is some upward bias in the software piracy estimate.

An interesting future research direction could be assessing why some IPRs laws are not so significant in the battle against software piracy.

5. Conclusion

It is now an economic fact that for any country, region or continent to be actively involved in the global economy, it must be competitive. Competition derives from intellectual property rights (IPRs) which protect intellectual capital. In the current efforts towards harmonizing IPRs laws (treaties) in Africa, this paper has answered four key questions policy makers need to know. On the first question of *which* IPRs treaties (laws) are effective in fighting software piracy, only *Main IP laws* and *Multilateral treaties* are found to have a significant negative effect. Concerning the second issue of assessing *if* formal institutions are

instrumental in upholding and enforcing IPRs treaties, the answer is: *yes.* As regards to third concern of, *for which* IPRs laws (treaties) are government organs instrumental, the answer is same as that to the first question. On the fourth question of *how* are government institutions instrumental, two interpretations are necessary. On the one hand, in both short-term (two-year non-overlapping intervals) and long-run (full data), formal institutions increase the efficacy of *Main IP laws* and *Multilateral treaties*. On the other hand, in the absence of formal institutions, the efficacy of *Main IP laws* seems to be greater than that of *Multilateral treaties*. Policy implications, caveats and a future research direction have been discussed.

Appendices

Appendix 1: Summary statistics and presentation of countries

Panel A: Summary Statistics

		Mean	S.D	Min	Max	Obser.
Dependent Variable	Piracy rate	2.745	1.857	0.000	5.250	121
Independent Variables	Main IP law	2.256	2.835	0.000	11.000	121
	IPRs law	1.438	1.944	0.000	7.000	121
	WIPO Treaties	2.735	0.793	2.000	4.000	121
	Multilateral Treaties	9.628	3.304	4.000	17.00	121
	Bilateral Treaties	0.322	0.535	0.000	2.000	121
Instrumental Variables	Control of Corruption	-0.309	0.641	-1.236	1.086	110
	Rule of Law	-0.302	0.687	-1.657	1.053	110
	Regulation Quality	-0.180	0.547	-1.305	0.905	110
	Government Effectiveness	-0.164	0.583	-1.038	0.807	100
	Voice & Accountability	-0.277	0.69	-1.256	1.047	110
	Political Stability (No violence)	-0.393	0.842	-2.094	0.996	110

Panel B: Presentation of Countries

Algeria, Botswana, Cameroon, Egypt, Kenya, Mauritius, Morocco, Nigeria, Senegal, South Africa, Zambia.

S.D: Standard Deviation. Min: Minimum. Max: Maximum. Obser: Observations.

Appendix 2: Correlation matrix

Piracy rate	IP Independent variables					Government Quality Instrumental variables						
	MIPL	IPRL	WIPO	Multi	Bilat	CC	RL	RQ	GE	VA	PolS	
1.000	-0.715	-0.017	0.320	0.026	0.015	-0.432	-0.508	-0.602	-0.609	-0.420	-0.291	Piracy
	1.000	0.103	-0.273	-0.221	-0.071	0.232	0.100	0.293	0.438	0.294	0.014	MIPL
		1.000	0.308	0.443	0.143	0.196	0.121	0.087	0.285	-0.025	0.016	IPRL
			1.000	0.311	-0.052	-0.094	-0.128	-0.094	-0.101	-0.098	-0.222	WIPO
				1.000	0.261	-0.263	-0.069	-0.154	-0.129	-0.201	-0.149	Multi
					1.000	-0.242	-0.145	-0.284	-0.328	-0.612	-0.180	Bilat
						1.000	0.902	0.867	0.942	0.796	0.779	CC
							1.000	0.871	0.886	0.727	0.828	RL
								1.000	0.931	0.846	0.764	RQ
									1.000	0.833	0.712	GE
										1.000	0.722	VA
											1.000	PolS

MIPL: Main Intellectual Property Rights. IPRL: Intellectual Property Rights Law. WIPO: WIPO Treaties. Multi: Multilateral Treaties. Bilat: Bilateral Treaties. CC: Control of Corruption. RL: Rule of Law. RQ: Regulation Quality. GE: Government Effectiveness. VA: Voice & Accountability. PolS: Political Stability.

Appendix 3: Variable definitions

Variables	Signs	Variable definitions	Sources
Piracy	Piracy	Logarithm Piracy rate (annual %)	BSA
Main IP law	MIPL	Main Intellectual Property Law	WIPO
IPRs law	IPRL	Intellectual Property Rights Law	WIPO
WIPO Treaties	WIPO	World Intellectual Property Organization Treaties	WIPO
Multilateral Treaties	Multi	Multilateral IP Treaties	WIPO
Bilateral Treaties	Bilat	Bilateral IP Treaties	WIPO
Control of Corruption	CC	Control of Corruption (estimate):Captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests.	WDI (World Bank)
Rule of Law	RL	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.	WDI (World Bank)
Regulation Quality	RQ	Regulation Quality (estimate): Measured as the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.	WDI (World Bank)
Government Effectiveness	GE	Government Effectiveness(estimate): Measures the quality of public services, the quality and degree of independence from political pressures of the civil service, the quality of policy formulation and implementation, and the credibility of governments commitments to such policies	WDI (World Bank)
Voice & Accountability	VA	Voice and Accountability (estimate): Measures the extent to which a country's citizens are able to participate in selecting their government and to enjoy freedom of expression, freedom of association, and a free media.	WDI (World Bank)
Political Stability	PolS	Political Stability/ No Violence (estimate): Measured as the perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional and violent means, including domestic violence and terrorism.	WDI (World Bank)

WDI: World Bank Development Indicators. BSA: Business Software Alliance. Log: Logarithm. WIPO: World Intellectual Property Organization. IP: Intellectual Property.

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