Harmonizing IPRs on Software Piracy: Empirics of Trajectories in Africa

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27 July 2012

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Abstract

In the current efforts of harmonizing the standards and enforcement of IPRs protection worldwide, this paper explores software piracy trajectories and dynamics in Africa. Using a battery of estimation techniques that ignore as well as integrate short-run disturbances in time-dynamic fashion, we answer the big questions policy makers are most likely to ask before harmonizing IPRs regimes in the battle against software piracy. Three main findings are established. (1) African countries with low software piracy rates are catching-up their counterparts with higher rates; implying despite existing divergent IPRs systems, convergence in piracy rate could be a genuine standard-setting platform. (2) Legal origins do not play a very significant role in the convergence process. (3) A genuine timeframe for standardizing IPRs laws in the fight against piracy is most likely between a horizon of 4 to 8 years. In other words, full (100%) convergence within the specified horizon will mean the enforcements of IPRs regimes without distinction of nationality and locality.

JEL Classification: F42; K42; O34; O38; O57

Keywords: Software piracy; Intellectual property rights; Panel data; Convergence

1. Introduction

It has become abundantly clear that, for any country, region or continent to be actively involved in the global economy, it must be competitive. Competition derives from intellectual capital, which is protected by intellectual property laws. In recent history, there has been a wide consensus on the key role that intellectual property rights (IPRs) protection play in promoting innovation processes and economic growth. Much recently, technological progress has not only brought about an increased availability of information and technology related products, but also the proliferation of technology used to copy or pirate such commodities. In the light of these concerns, efforts are being placed on increasing and harmonizing the standard and enforcement of IPRs protection worldwide. However, the issue of consolidating and harmonizing laws to curtail the proliferation of pirated goods is particularly pronounced in developing countries. In this paper, we assess the trajectories and dynamics of software piracy in Africa using a battery of estimation approaches. Based on the results, we are able to provide the much needed policy recommendations on the feasibility of IPRs law harmonization across the continent, as well a genuine timeframe for the standard-setting process.

The debate has centered around IPRs protection, with some scholars postulating that increased protection of IPRs stimulates economic growth and development through the appealing impact on factor productivity (Gould & Gruben, 1996; Falvey et al., 2006). On the other hand, 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 strand is of the view that, less tight IPRs regimes are necessary (at least in the short-term) for developing countries, to enable knowledge spillovers, imperative for growth and development. According to them, the existing technology in developing countries is more imitative and/or adaptive in nature and not suitable for the creation of new innovations[1].

In the light of the debate, there is a growing importance in the impact of IPRs protection on promotion of innovation, technological advancements and economic development. Yet, while theoretical literature has addressed the concern to some degree, little scholarly attention has been devoted to empirical literature. The bulk of empirical studies has examined the socio-economic determinants of piracy in several copyright industries (Bezmen & Depken, 2004; Banerjee et al., 2005; Andrés, 2006; Bezmen & Depken, 2006; Peitz & Waelbroeck, 2006; Goel & Nelson, 2009; Andrés & Goel, 2012). To the best of our knowledge, no study has yet addressed current efforts placed on harmonizing the standard and enforcement of IPRs protection in Africa. Upholding blanket IPRs regimes for software piracy through bilateral and multilateral treaties may not be effective unless they are contingent on the prevail trajectories and dynamics of software piracy in the continent. Hence, policy makers are most likely to ask the following questions before considering harmonizing IPRs regimes in the fight against piracy. (1) Is software piracy converging within Africa? (2) If so, what is the degree and timing of convergence? While the answer to the first question will guide on the feasibility of harmonizing blanket IPRs regimes, the answer to the second will determine the timing of the blanket IPRs regimes through multilateral and bilateral treaties.

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 empirical analysis. We conclude with Section 5.

[1]This stance 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.

2. Intuition, literature and scope

2.1 Intuition

The intuition motivating this paper typically follows the evidence of income convergence across countries which has been investigated in the context of neoclassical growth models, originally developed by the pioneering works of Baumol (1986), Barro & Sala-i-Martin (1992, 1995) and Mankiw et al. (1992). The theoretical underpinnings of income convergence are abundant in the empirical growth literature (Solow, 1956; Swan, 1956) and have recently been applied in other fields of development. While there is a theory and vast empirical work on per capita income convergence, there is yet not a theory on convergence in other development branches, e.g financial systems. However, there is growing importance of empirical convergence application to financial markets (Bruno et al., 2011; Narayan et al., 2011; Asongu, 2012). In the light of these developments, aware of the risks of 'doing measurement without theory'; we argue that, reporting facts even in the absence of a formal theoretical model maybe a useful scientific activity. Hence, we concur with Costantini & Lupi (2005) in the assertion that applied econometrics has other tasks than merely validating or refuting economic theories.

The intuition underlying the linkage between software piracy and harmonization of IPRs is twofold; (1) convergence in software piracy rate will imply, the adoption of multilateral treaties on IPRs is feasible and; (2) full (100%) convergence will mean, the enforcements of particular IPRs regimes without distinction of nationality and locality. Since it is unlikely to find convergence (in laws emphasizing IPRs) within a very heterogeneous set of countries, the sample is sub-divided into two homogenous panels, based on legal-origins. The premise of this distinction is the emphasis legal origins place on private property rights vis-à-vis those of the state (La Porta et al., 1998). While English common-law countries place more emphasis on private property rights (or IPRs), French civil-law focuses more on state power. In summary, the underlying logic for this segmentation is that, the institutional web of informal norms, formal rules and enforcement characteristics affect software piracy and IPRs (La Porta et al., 1988; North, 1990, 1994).

2. 2 Intellectual Property Rights (IPRs) and development

Borrowing from Bezmen & Depken (2004), there are two main avenues along which intellectual property (IP) and the strength of IPRs regimes are thought to influence the level of economic growth and development. The first strand captures 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 focused on 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 increase society's stock of knowledge. Lowering the cost of future innovation, fosters the accumulation of knowledge for economic growth (Romer, 1990; Grossman & Helpman, 1991). The underlying wisdom of tighter and restrictive IPRs is based on the notion that, protection of IPRs serves as a stimulus to growth by encouraging innovations and inventions. Recently, many newly industrialized countries have pushed for stronger IPRs via bilateral, multilateral and regional arrangements. This difference in approach could be attributed to the interest of developing countries to specialize in labor intensive production in agricultural industries. These industries, until much recently 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 affect a nation's growth and development process through their influence on a 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, as access to world markets could spur greater utilization of human resources (Todaro & Smith, 2003), and facilitate 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 depends on country-specific conditions. It has been well 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 likelihood of investment undertaken by multinational enterprises (Mansfield, 1994; Seyoum, 1996). On the other hand, stronger IPRs protection could mitigate the need for FDI (Yang & Maskus, 2001).

2.3 Scope and positioning of the paper

A great bulk of the literature has examined the determinants of the willingness to pirate software by assessing the socio-economic factors that affect piracy. Strong conclusions have been established 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). A vast empirical literature has also focused 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). For the most part, the above studies have concentrated on developed countries and the emerging economies of Latin America and East Asia. The focus of this paper on the sparsely represented African continent in the literature also draws from the debate over the 'East Asian Miracle'[2].

Europe and North America have fully understood the dynamics of IP and inexorably driving developments in the global and international arena. Other regions like South America and Asia are responding in calculated steps that underscores the role of IP in the current pursuit of national, regional and international initiatives. Consequently, different nations have standards of protection of IP. The recent trend of globalization strengthened by several multilateral and regional treaties further creates some international minimum standard for IP protection. In Africa, IP issues are assuming central stage in discussions on development of the continent.

With recent developments in ICTs, the concern over software piracy has retained scholarly attention. International organizations are currently advocating global convergence in IP 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 IP systems. Hence, IPRs are growingly implicated in standard-setting activities. Standard-setting is increasingly important in software piracy as a means of reducing transaction cost. Standards also have a particular important role in ensuring compatibility and interconnectivity of products and services.

[2] Additional support 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 in the rapid growth witnessed by South-East Asia. Some evidence suggest that the 'East Asian Miracle' could 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 growth rates. Further evidence has suggested that, as these countries became significant producers of new technologies and innovations, their IPRs regimes tightened. While Nelson & Pack (1999) have postulated that the productive assimilation of existing (foreign) productive techniques and technologies 'was a critical component of the success of these countries', Maskus (2000) cautions that weaker protection of IPRs will not necessarily be beneficial for developing countries as it may cause them to remain dependent on older and less efficient outdated technologies.

Given the growing role of IPRs in software piracy protection, policy makers are more likely today to ask the following questions. Is the rate of software piracy converging within homogenous sets of countries (clubs)? If so, then at what momentum are countries with low piracy rates catching-up their counterparts with higher rates? What is the timing of full (100%) convergence in the rate of piracy? Answers to these questions could provide relevant answers to timing, enforcement and standardization of IPRs regimes in the fight against piracy. To the best of our knowledge, there is yet no model for standard-setting in the promotion of IPRs and fight against piracy. The manner in which standards are set and harmonized have important consequences for the cost of products, economic efficiency and innovation. Upholding blanket IPRs regimes (against software piracy) through bilateral and multilateral treaties may not be effective unless they are contingent on the prevailing trajectories and dynamics of software piracy in Africa. The empirical section will throw the much needed light into the pressing policy questions outlined above.

3. Data and Methodology

3.1 Data

3.1.1 Measuring piracy

Borrowing from SIIA (2000), software piracy is defined as "the unauthorized copying of computer software which constitutes copyright infringement for either commercial or personal use". Due to software piracy potentially taking place in many avenues – e.g., organized copiers, piracy by individuals and commercial or business piracy, obtaining an accurate measure of the prevalence of software piracy remains a challenge in the literature. There are many types of piracy and according to the Business Software Alliance (BSA), we can distinguish among: 1) end user copying; 2) downloading; and 3) counterfeiting. The level of piracy is computed as the variation in demand for new software applications (estimated from PC shipments) and the legal supply of software. In the current work, the measure of piracy employed is the percentage of software (primarily business software) in a country that is illegally installed (without a license) annually and is taken to capture the level of software piracy. This variable is reported in percentages, scaling from 0 % (no piracy) to 100 % (i.e., all software installed is pirated). Piracy rates are obtained from the Business Software Alliance (BSA, 2007). More details on measurement could be obtained from BSA (2009)[3]. BSA is an industry group; nevertheless its data on software piracy, is the best cross-country measure currently available, though object of some inherent upward bias.[4] The data on software piracy could be viewed more broadly as proxying for the extent of digital piracy.

Owing to constraints in piracy data availability, the data include annual observations for 11 African countries for the years 2000-2010. Details about variable definitions (and data sources), descriptive statistics (with presentation of countries) and correlation analysis (showing the basic correlations between key variables used in this paper) are presented in Appendix 2, Appendix 1 and Appendix 3 respectively. The summary statistics 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. Both the standard deviations and minimum/maximum values validate this assertion and further lend credit to the inappropriateness of an estimation model that assumes a particular functional distribution. The purpose of the correlation matrix is to mitigate issues resulting from overparametization and multicolinearity. Based on the correlation coefficients, there do not appear to be any serious concerns in terms of the relationships to be estimated.

[3]The BSA data primarily measures the piracy of commercial software. We are unaware of any publicly available cross-national data on end-user software piracy. See Png (2008) for a discussion on the reliability of piracy data. Also see Traphagan & Griffith (1998).

[4]Among the many researchers that have used this data are: Marron & Steel (2000); Banerjee et al. (2005); Andrés (2006); and Goel & Nelson (2009).

3.1.2 Control variables

In the regressions we shall control for institutional quality (rule of law), economic prosperity (GDP growth rate), financial depth (money supply), trade openness (trade), literacy in computing (number of Personal Computer (PC) users) and financial openness (FDI). While the first variable is an estimate, the last three are in ratios of GDP. We expect the 'rule of law' and 'economic prosperity' to decrease and increase the piracy rate respectively. Money supply (which reflects an extensive use of currency) and globalization (trade and FDI) may either have a positive or negative incidence on piracy, depending to the country's tendency towards IPRs. From common-sense, the number of PC users should have a positive effect on software piracy.

3.2 Methodology

The estimation approach will be based on β-convergence due to constraints in the data set. The use of cointegration and unit roots are not convenient because of limited degrees of freedom in homogenous panels or convergence clubs. More so, the alternative view of convergence (σ-convergence) which is of the position that a group of economies converge when the cross-section variance of the variable under consideration declines, is also inappropriate because our data structure is panel. Our estimation procedure typically follows the evidence of income convergence across countries which has been investigated in the context of pioneering works in neoclassical growth models (Baumol, 1986; Barro & Sala-i-Martin, 1992, 1995; Mankiw et al., 1992). The theoretical underpinnings of income convergence are well documented in the empirical growth literature (Solow, 1956; Swan, 1956).

Borrowing from the convergence literature (Fung, 2009, 3), the two equations below are the standard approaches in the literature for investigating conditional convergence if $W_{i,t}$ is taken as strictly exogenous.

$$\ln(Y_{i,t}) - \ln(Y_{i,t-\tau}) = \beta \ln(Y_{i,t-\tau}) + \delta W_{i,t-\tau} + \eta_i + \xi_t + \varepsilon_{i,t} \quad (1)$$

$$\ln(Y_{i,t}) = \sigma \ln(Y_{i,t-\tau}) + \delta W_{i,t-\tau} + \eta_i + \xi_t + \varepsilon_{i,t} \quad (2)$$

Where σ = 1+ β, $Y_{i,t}$ is the proxy for the rate of piracy in country *i* at period *t*. $W_{i,t}$ is a vector of determinants of piracy, η_i is a country-specific effect, ξ_t is a time-specific constant and $\varepsilon_{i,t}$ an error term. Consistent with the neo-classical growth model, a statistically significant negative coefficient on β in Eq. (1) suggests that, countries relatively close to their steady state in 'piracy-rate growth' will experience a slowdown in the growth of piracy, known as conditional convergence (Narayan et al., 2011, 2). In the same vein, according to Fung (2009, 3) and recent African convergence literature (Asongu, 2012), if $0 < |\sigma| < 1$ in Eq. (2) , then $Y_{i,t}$ is dynamically stable around the path with a trend piracy rate the same as that of W_t, and with a height relative to the level of W_t. The variables contained in $W_{i,t-\tau}$ and the individual effect η_i are measures of the long-term level the software market is converging to. Therefore, the country-specific effect η_i emphasizes other determinants of a country's steady state not captured by $W_{i,t-\tau}$.

Conditions for convergence elucidated above are valid if and only if, $W_{i,t}$ exhibits strict exogeneity. Unfortunately, this is not the case in the real world because, while the institutional quality, economic prosperity, globalization, financial development and literacy in computing (components of $W_{i,t}$) influence piracy rate, the reverse effect is also true. Thus, we are confronted here with the issue of endogeneity where control variables ($W_{i,t}$) are correlated with the error term ($\varepsilon_{i,t}$). Also, country and time specific effects could be correlated with other variables in the model, which is very probable with lagged dependent variables included in the equations. This concern for endogeneity has been substantially documented in the piracy literature (Ginarte & Park, 1997; Bezmen & Depken, 2004)[5]. A way of dealing with the problem of the correlation between the individual specific-effect and the lagged dependent variables consists of eliminating the individual effect by first differencing. Therefore Eq. (2) becomes:

$$\ln(Y_{i,t}) - \ln(Y_{i,t-\tau}) = \sigma \ln(Y_{i,t-\tau} - Y_{i,t-2\tau}) + \delta(W_{i,t-\tau} - W_{i,t-2\tau}) + (\varepsilon_{i,t} - \varepsilon_{i,t-\tau}) \quad (3)$$

However Eq. (3) presents another issue; estimation by Ordinary Least Square (OLS) is still biased because there remains a correlation between the lagged endogenous independent variable and the disturbance term. To solve this issue, we estimate the regression in differences jointly with the regression in levels using the Generalized Method of Moments (GMM) estimation. Arellano & Bond (1991) suggested an application of the Generalized Method of Moments (GMM) exploiting all the orthogonality conditions between the lagged dependent variables and the error term. The procedure employs lagged levels of the regressors as instruments in the difference equation, and lagged differences of the regressors as instruments in the levels equation, therefore 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), in a bid for robustness, we shall use both in the empirical analysis. However, in event of conflict of interest in the results, those of the system GMM will be given priority; in line with Bond et al. (2001, 3-4)[6].

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[5]As emphasized by Bezmen & Depken (2004), studies assessing the piracy-development nexus are subject to potential endogeneity problems, because it is likely that a nation's level of development is a crucial factor in its choice of or adherence to a particular IPRs regime. This confirms an earlier position by Ginarte & Park (1997) who found strong evidence that the level of economic development explains the strength of patent protection provided by individual countries.

[6] "*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).

The GMM estimation approach has been extensively applied in the convergence literature. In contrast to Narayan et al. (2011), we shall adopt Fung (2009) owing to software specificities[7]. In model specification, we opt for the second-step GMM because it corrects the residuals for heteroscedasticity[8]. The assumption of no auto-correlation in the residuals is crucial as lagged variables are to be used as instruments for the dependent variables. Moreover, the estimation depends on the assumption 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 should not be. The validity of the instruments is examined with the Sargan over-identifying restrictions (OIR) test.

According to Islam (1995, 14), yearly time spans are too short to be appropriate for studying convergence, as short-run disturbances may loom substantially in such brief time spans. Therefore, considering the data span of 10 years, we use both two-year and three-year non-overlapping intervals[9]. This implies in our analysis, τ is set to 2 and 3 respectively. We also assess the incidence of short-term disturbances by setting τ to 1 under the hypothesis of 'no intervals'. Hence, we compute the implied rate of convergence by calculating $\sigma/3$, $\sigma/2$, $\sigma/1$ for three-year, two-year and 'no intervals' respectively. For example, with $\sigma/3$, we divide the estimated coefficient of the lagged differenced endogenous variable by 3 because we have used a three year interval to absorb the short-term disturbances. When the absolute value of the estimated autoregressive coefficient is greater than zero but less than one ($0 < |\sigma| < 1$), we

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[7] While Narayan et al. (2011) have used Eq. (1) in the absence of fixed effects, this paper applies Eqs. (2) and (3) instead; in line with Fung (2009). The Fung (2009) approach has been used in recent African convergence literature (Asongu, 2012).

[8] In the *first-step*, the residuals are assumed to be homoscedastic.

[9] We have 6 two-year non-overlapping intervals: 2000; 2001-2002; 2003-2004; 2005-2006; 2007-2008; 2009-2010. There are also four three-year non-overlapping intervals: 2000-2001; 2002-2004; 2005-2007; 2008-2010. For both types of non-overlapping intervals, owing to data and periodical constraints, the first interval is short of one year.

conclude the existence of convergence. The broader interpretation suggests, past differences have less proportionate impact on future differences, denoting the variation on the left hand side of Eq. (3) is decreasing overtime as the country is converging to a steady state (Asongu, 2012).

4. Empirical analysis

4.1 Presentation of results

This section investigates three principal issues: (1) assessment of the presence of convergence; (2) computation of the speed of convergence and; (3) determination of the time needed for full (100%) convergence. The summary of overall results is presented in Table 1 where-in the three issues are addressed. Results for absolute (unconditional) and conditional convergence are presented in Table 2 and Table 3 respectively.

Absolute convergence is estimated with just the lagged difference of the endogenous variable as independent variable whereas, conditional convergence is with respect to Eqs. (2) and (3) in the presence of control variables. Thus, unconditional convergence is estimated in the absence of $W_{i,t}$: vector of determinants (rule of law, GDP growth, money supply, PC users, trade and FDI) of software piracy. To examine the validity of the model and indeed the convergence hypothesis, we perform two tests, notably the Sargan-test which examines the over-identification restrictions and the Arellano and Bond test for autocorrelation which assesses the null hypothesis of no autocorrelation. The Sargan-test examines if the instruments are uncorrelated with the error term in the equation of interest. The null hypothesis is the position that the instruments as a group are strictly exogenous (do not suffer from endogeneity), which is required for the validity of the GMM estimates. The p-values of estimated coefficients are presented in brackets in the line following the reported values of the estimated coefficients. We notice that the Sargan-test statistics often appear with a p-value greater than 0.10, hence its null hypothesis is not rejected in all the regressions. We only report the second order autocorrelation: AR(2) test in first difference because it is more relevant than AR(1) as it detects autocorrelation in levels. However, owing to constraints in degrees of freedom for the three-year NOI specifications, we report only AR(1)[10] for this particular type of NOI. For most estimated models, we are unable to reject the AR(2) null hypothesis for the absence of autocorrelation, especially for conditional convergence specifications. Therefore, there is robust evidence that most of the models are deficient of autocorrelation at the 1% significance level.

A summary of the results from Tables 2-3 is presented in Table 1. This includes findings for Absolute Convergence (AC), Conditional Convergence (CC), the Speed of Absolute Convergence (SAC), the Speed of Conditional Convergence (SCC) and the rate required to achieve full (100%) convergence in both types of convergences.

From a general standpoint, the following conclusions could be drawn. (1) The choice of the GMM approach affects the nature of the results substantially. (2) Full data (without mitigation of short-run disturbances) does not provide significant results for the most part (See AR(2) tests results for AC). This confirms the position of Islam (1995, 14) on the inappropriateness of assessing convergence with annual data, owing to short-run disturbances. (3) The convergence rate (years to convergence) decreases (increase) as the number of non-overlapping intervals increase. (4) The two-year NOI has significant results in both AC and CC for the system GMM specification. (5) Also, in the system GMM, but for the findings on AC in 'Full data' for Africa, results in terms of significance are alike across panels.

Given the heterogeneous nature of the findings, our interpretation will be based on system GMM results of the two-year NOI for the following reasons. (1) The edge of system GMM estimators over difference GMM estimators has already been outlined in the methodology section. (2) The choice of the two-year NOI has two premises: on the one hand,

[10] This poses no issue because overall, interpretations will not be based on the three-year NOI results. Their use enriches the analysis in providing trajectories and dynamics hitherto unexplored in convergence empirics.

‘Full data’ is not used in mainstream literature because it is inherent of short-run disturbances; on the other hand, the variability in the data (suggesting short-run disturbances) is not quite great (see Appendix 1) and hence, does not give much justification for the three-year NOI.

Based on the two-year NOI and system GMM, the following findings could be established. (1) Legal-origin is not a very significant factor in determining convergence in the rate of software piracy. This is true for both AC and CC. (2) The rate of AC is higher than that of CC. In Africa, AC (time required for full convergence) is 47.85% per annum (4.17 years) while for CC it is: 29.60% per annum (6.75 years). For common-law countries, AC (CC) is 48.20 (26.38) % per annum and achievement of 100% convergence is in 4.14 (7.58) years. Regarding civil-law countries, AC (CC) is 48.39 (25.70) % per annum and achievement of 100% convergence is in 4.13 (7.78) years.

Table 1: Summary of results on Absolute and Conditional Convergences

	Panel A: Difference GMM								
	Africa			English			French		
	Full Data	2 Yr NOI	3Yr NOI	Full Data	2 Yr NOI	3Yr NOI	Full Data	2 Yr NOI	3Yr NOI
Absolute C (AC)	Yes	Yes	No	Yes	Yes	No	No	No	Yes
% of A.C	31.80%	11.14%	n.a	30.54%	12.55%	n.a	n.a	n.a	7.76%
Years to A.C	3.14 Yrs	17.95 Yrs	n.a	3.27 Yrs	15.93 Yrs	n.a	n.a	n.a	38.65 Yrs
Conditional C (CC)	No	No	Yes	No	Yes	Yes	No	No	Yes
% of CC	n.a	n.a	10.06%	n.a	25.20%	21.36%	n.a	n.a	12.90%
Years to CC	n.a	n.a	29.82 Yrs	n.a	7.93 Yrs	14.04 Yrs	n.a	n.a	23.25 Yrs
	Panel B: System GMM								
	Africa			English			French		
	Full Data	2 Yr NOI	3Yr NOI	Full Data	2 Yr NOI	3Yr NOI	Full Data	2 Yr NOI	3Yr NOI
Absolute C (AC)	Yes	Yes	No	No	Yes	No	No	Yes	No
% of AC	98.60%	47.85%	n.a	n.a	48.20%	n.a	n.a	48.39%	n.a
Years to AC	1.01 Yrs	4.17 Yrs	n.a	n.a	4.14 Yrs	n.a	n.a	4.13 Yrs	n.a
Conditional C (CC)	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
% of CC	n.a	29.60%	17.06%	n.a	26.38%	14.63%	n.a	25.70%	9.56%
Years to CC	n.a	6 .75 Yrs	17.58 Yrs	n.a	7.58 Yrs	20.50 Yrs	n.a	7.78 Yrs	31.38 Yrs

AC: Absolute Convergence. CC: Conditional Convergence. English : English Common Law countries. French: French Civil Law countries. Yr: Year. NOI: Non overlapping intervals.

Table 2: Absolute convergence

Panel A: Difference GMM

	Africa			English			French		
	Full Data	2 Yr NOI	3Yr NOI	Full Data	2 Yr NOI	3Yr NOI	Full Data	2 Yr NOI	3Yr NOI
Initial	**0.318*** **	**0.222*** **	-0.188	**0.305*** **	**0.251*** **	0.017	-0.383	0.126	**-0.233** **
	(0.000)	**(0.000)**	(0.116)	**(0.000)**	**(0.002)**	(0.958)	(0.581)	(0.600)	**(0.041)**
AR(1)	---	---	-0.286	---	---	-0.733	---	---	0.180
			(0.774)			(0.463)			(0.856)
AR(2)	-2.308**	**-0.304**	---	-1.913*	**0.809**	---	**-0.399**	**-0.864**	---
	(0.021)	**(0.760)**		(0.055)	**(0.418)**		**(0.689)**	**(0.387)**	
Sargan OIR	**10.154**	**9.287**	**2.377**	**5.104**	**5.217**	**2.557**	**3.425**	**4.492**	**2.004**
	(1.000)	**(0.411)**	**(0.304)**	**(1.000)**	**(0.814)**	**(0.278)**	**(1.000)**	**(0.876)**	**(0.367)**
Wald	**56.16*** **	**10.98*** **	2.463	**38.30*** **	**9.302*** **	0.002	0.304	0.275	**4.157** **
	(0.000)	**(0.000)**	(0.116)	**(0.000)**	**(0.002)**	(0.958)	(0.581)	(0.600)	**(0.041)**
Countries	11	11	11	6	6	6	5	5	5
Observations	99	44	22	54	24	12	45	20	10

Panel B: System GMM

	Africa			English			French		
	Full Data	2 Yr NOI	3Yr NOI	Full Data	2 Yr NOI	3Yr NOI	Full Data	2 Yr NOI	3Yr NOI
Initial	**0.986*** **	**0.957*** **	**1.057*** **	**1.037*** **	**0.964*** **	**1.043*** **	**1.010*** **	**0.967*** **	**1.062*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
AR(1)	---	---	**2.306** **	---	---	1.533	---	---	---
			(0.021)			(0.125)			
AR(2)	-2.189**	**0.735**	---	-1.743*	**1.248**	---	**-1.292**	**-0.262**	1.722*
	(0.028)	**(0.462)**		(0.081)	**(0.211)**		**(0.196)**	**(0.792)**	(0.085)
Sargan OIR	**10.604**	**10.835**	**7.743**	**3.940**	**4.784**	**3.788**	**4.988**	**3.540**	**4.998**
	(1.000)	**(0.624)**	**(0.101)**	**(1.000)**	**(0.979)**	**(0.435)**	**(1.000)**	**(0.995)**	**(0.287)**
Wald	**1788.3*** **	**881.3*** **	**872.9*** **	**128.6*** **	**12410*** **	**907.5*** **	**46.20*** **	**690.6*** **	**454.5*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Countries	11	11	11	6	6	6	5	5	5
Observations	110	55	33	60	30	18	50	25	15

***,**,*: significance levels of 1%, 5% and 10% respectively. AR(2): Second Order Autocorrelation test. OIR: Overidentifying Restrictions test. Initial: lagged endogenous estimated coefficient. Yr: Year. NOI: Non overlapping intervals. Wald: test for the joint significance of estimated coefficients.

Table 3: Conditional convergence

Panel A: Difference GMM

	Africa			English			French		
	Full Data	2 Yr NOI	3Yr NOI	Full Data	2 Yr NOI	3Yr NOI	Full Data	2 Yr NOI	3Yr NOI
Initial	0.175	**1.159****	**0.302*****	0.101	**0.504***	**0.641*****	-11.25	4.929	**0.387*****
	(0.631)	**(0.025)**	**(0.002)**	(0.882)	**(0.059)**	**(0.000)**	(0.398)	(0.527)	**(0.000)**
Constant	-0.271	-0.167	-0.063	0.399	0.172	-0.730	0.141	13.81	-0.092
	(0.526)	(0.866)	(0.925)	(0.377)	(0.110)	(0.257)	(0.969)	(0.505)	(0.508)
Rule of Law	**-6.066***	**-7.80***	-0.121	-7.152	-3.633	**-1.71****	88.61	57.84	**3.155*****
	(0.080)	**(0.082)**	(0.895)	(0.624)	(0.447)	**(0.010)**	(0.468)	(0.344)	**(0.006)**
GDP growth	**0.120****	**0.437***	0.063	0.012	**0.251****	0.012	0.266	3.177	0.094
	(0.017)	**(0.067)**	(0.120)	(0.741)	**(0.010)**	(0.773)	(0.210)	(0.391)	(0.348)
Money Supply	---	7.017	-0.736	---	---	**-7.00*****	---	---	---
		(0.503)	(0.773)			**(0.007)**			
PC Users	4.795	-2.250	-0.061	-10.78	---	4.772	38.52	-94.79	---
	(0.615)	(0.874)	(0.989)	(0.760)		(0.296)	(0.108)	(0.535)	
FDI	-0.201	0.132	-0.014	---	---	---	---	---	---
	(0.132)	(0.313)	(0.832)						
Trade	-0.011	-0.053	-0.001	---	---	---	---	---	---
	(0.185)	(0.122)	(0.963)						
AR(1)	---	---	**-1.590**	---	---	**0.501**	---	---	**-1.187**
			(0.111)			**(0.615)**			**(0.234)**
AR(2)	**-0.898**	**-0.348**	---	**-0.240**	**0.288**	---	**-0.290**	**-0.648**	---
	(0.369)	**(0.727)**		**(0.809)**	**(0.772)**		**(0.771)**	**(0.516)**	
Sargan OIR	**2.404**	**1.841**	**4.758**	**0.706**	**1.284**	**0.000**	**0.000**	**0.000**	**2.466**
	(1.000)	**(0.993)**	**(0.092)**	**(1.000)**	**(0.998)**	**(1.000)**	**(1.000)**	**(1.000)**	**(0.291)**
Wald	**11.132***	**87.21*****	**29.81*****	6.935	**28.64*****	**66.92*****	7.583	**16.00*****	**26.13*****
	(0.084)	**(0.000)**	**(0.000)**	(0.139)	**(0.000)**	**(0.000)**	(0.108)	**(0.003)**	**(0.000)**
Countries	11	11	11	6	6	6	5	5	5
Observations	79	41	21	48	24	12	40	20	10

Panel B: System GMM

	Africa			English			French		
	Full Data	2 Yr NOI	3Yr NOI	Full Data	2 Yr NOI	3Yr NOI	Full Data	2 Yr NOI	3Yr NOI
Initial	-0.179	**0.592*****	**0.512*****	-0.832	**0.527****	**0.439*****	1.093	**0.514****	**0.286*****
	(0.784)	**(0.000)**	**(0.000)**	(0.376)	**(0.020)**	**(0.000)**	(0.114)	**(0.041)**	**(0.003)**
Constant	**8.953****	**3.790*****	**5.686*****	-1.409	0.001	**5.228*****	1.670	2.861	3.297
	(0.039)	**(0.001)**	**(0.000)**	(0.573)	(0.998)	**(0.000)**	(0.419)	(0.480)	(0.168)
Rule of Law	**-1.931***	-0.470	**-0.66****	**-4.341***	-0.410	0.531	1.457	1.574	-1.478
	(0.098)	(0.398)	**(0.015)**	**(0.050)**	(0.611)	(0.498)	(0.468)	(0.724)	(0.342)
GDP growth	**0.142****	**0.358****	0.099	0.034	**0.331****	**0.089***	-0.125	0.0009	-0.359
	(0.049)	**(0.031)**	(0.199)	(0.583)	**(0.015)**	**(0.056)**	(0.526)	(0.998)	(0.424)
Money Supply	0.904	0.422	-0.666	---	---	**-5.974****	---	---	---
	(0.734)	(0.781)	(0.179)			**(0.032)**			
PC Users	**-2.387****	**-1.09*****	**-1.31*****	---	---	-0.416	---	---	---
	(0.018)	**(0.003)**	**(0.000)**			(0.452)			
FDI	**-0.166***	0.008	0.016	---	---	---	---	---	---
	(0.090)	(0.923)	(0.704)						
Trade	-0.0001	-0.018	-0.009	0.075	---	---	---	---	---
	(0.994)	(0.120)	(0.155)	(0.118)					
AR(1)	---	---	**-0.823**	---	---	**-1.061**	---	---	**-1.222**
			(0.410)			**(0.288)**			**(0.221)**
AR(2)	**0.0207**	**-0.002**	---	**-0.595**	**0.175**	---	**-0.923**	**-0.242**	---
	(0.983)	**(0.997)**		**(0.551)**	**(0.860)**		**(0.355)**	**(0.808)**	
Sargan OIR	**3.169**	**3.940**	**5.748**	**0.685**	**4.176**	**0.000**	**0.144**	**2.912**	**3.926**
	(1.000)	**(0.991)**	**(0.218)**	**(1.000)**	**(0.989)**	**(1.000)**	**(1.000)**	**(0.998)**	**(0.416)**
Wald	**25.95*****	**307.5*****	**270.5*****	**92.05*****	**47.44*****	**526.3*****	**8.569****	**8.998****	**50.52*****
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.035)**	**(0.029)**	**(0.000)**
Countries	11	11	11	6	6	6	5	5	5
Observations	84	52	32	54	30	18	45	25	15

***,**,*: significance levels of 1%, 5% and 10% respectively. AR(2): Second Order Autocorrelation test. OIR: Overidentifying Restrictions test. Initial: lagged endogenous estimated coefficient. Yr: Year. NOI: Non overlapping intervals. Wald: test for the joint significance of estimated coefficients. PC: Personal Computer. FDI: Foreign Direct Investment.

4.2 Discussion of results

4.2.1 Discussion and policy implications

Before we dive into the discussion of results, it is important at the outset to understand the economic intuition motivating absolute and conditional convergence of software piracy rate in the African continent. Absolute convergence in software piracy occurs when countries share similar fundamental characteristics with regard to the laws governing private IP such that, only variations across countries in initial levels of software piracy exist. Absolute convergence therefore results from factors such as the formulation of laws protecting IPRs against software piracy within a legal system (e.g common-law countries, civil-law countries …etc) or through multilateral IPRs treaties, among others. Absolute convergence also occurs because of adjustments common to many countries with the same legal origin in the fight against piracy. Fundamentally, contrary to civil-law countries, common-law systems place more emphasis on IPRs vis-à-vis the power of the state. Thus, enforcements of laws governing IPRs against software piracy should influence the convergence in common-law countries faster than in their civil-law counterparts. Conversely, owing to regional corporations, multilateral agreements, globalization and the diffusion of laws overtime, common-law and civil law countries could also converge in software piracy at the same. This will empirically depend on the difference between their respective convergence rates.

On the other hand, conditional convergence is that which is contingent on structural and institutional characteristics of countries. Consistent with the economic growth literature (Barro, 1991), conditional convergence depicts the kind of convergence whereby, one's own long-term steady state (equilibrium) is contingent on structural characteristics and fundamentals of its economy in general and ICT sector in particular. For instance common-law countries may differ substantially in the level of openness, economic prosperity, development of the ICT sector, internet penetration…etc. To this end, our model for conditional convergence is contingent on institutional quality (rule of law), economic prosperity (GDP growth and money supply), ICT sector development (PC Users) and globalization (FDI and Trade for respectively financial and trade openness). Hence, findings are contingent on the macro economic variables we empirically test. Owing to constraints in data availability and degrees of freedom required for the Sargan-OIR test, we could not condition the analysis beyond six macroeconomic variables. This position on conditionality is more solid than in mainstream literature where, specification of this form of convergence analysis is not conditioned beyond two macroeconomic variables (Bruno et al., 2011; Asongu, 2012).

Our findings have shown that in both absolute and conditional terms, software piracy is converging within Africa. This rate of convergence almost doubles in the absence of structural and institutional characteristics (absolute convergence). Implying, a genuine platform for standardizing IPRs laws in the fight against piracy is most likely between a horizon of 4 to 8 years. Put in other words, full (100%) convergence within the specified horizon means, feasibility of standard IPRs regimes without distinction of nationality and locality. Based the two-year NOI, legal-origin does seem to be a factor in determining the rate of piracy. Surprisingly, contrary to mainstream literature (La Porta et al., 1998; North, 1990, 1994), we do not find evidence of overwhelming dominance of English common-law countries from a software piracy standpoint. This could be due to regional corporations which have diluted legal-origin oriented IPRs laws over time. This finding was not predicted, as we expected convergence within common-law countries not to be the same as in civil-law countries because of the emphasis common-law places on IPRs protection. Hence, the argument that the institutional web of informal norms, formal rules and enforcement characteristics affect the quality of IPRs protection is not visible from a software piracy perspective.

International organizations are currently advocating global convergence in IP as a prerequisite for successful innovation strategies. The interrelationships among IPRs, standard-setting and software piracy is a complex one. With advances in ICTs, standard-setting against the growing phenomenon of piracy is increasingly important as standardization has a particular important role of ensuring computability and interconnectivity of products and services. The difficulties of achieving such harmonization are however, evident from the attempts of several nations to develop divergent IP systems. Our results have shown that, countries with low software piracy rates are catching-up counterparts with higher rates; implying, despite existing divergent IP systems, convergence in piracy rate could be a genuine standard-setting platform. Standard-setting in software piracy will reduce transaction cost, enhance the value of IP, promote welfare by enhancing IPR holders' incentive to innovate.

4.2.2 Caveats

Two main caveats have been retained: the absence of a theoretical basis and, draw-backs in the methodology. Firstly, using econometrics to accomplish more than just testing theory is not without risks. The intuition basis of the work implies, results should be interpreted with caution as the model is conditioned on the variables we choose and empirically test, which may not directly reflect all macroeconomic conditions on which 'piracy convergence' is endogenous. Secondly, as we have already outlined in the first paragraph of Section 4.1, the choice of the converge approach (which is based on constraints in data structure) also has its draw-backs. Consistent with Apergis et al. (2008), critics of β-convergence argue that, if countries converge to a common equilibrium with identical internal structures, then the dispersion of the variable under consideration should disappear in the long-run as all countries converge to the same long-run path. If, however, states converge to 'convergence clubs' or to their own unique equilibrium, the dispersion of this measure will not approach zero (Miller & Upadhyay, 2002). Moreover, in the latter case of country-specific equilibrium, the movements of the dispersion will depend on the initial distribution of the variable under investigation with regard to their final long-run outcomes. Overall, as argued by Caporale et al. (2009), the approach suffers from specific estimation deficiencies associated with the data structure. Indeed, piracy data is scarce and these issues can only be overcome with time.

5. Conclusion

In the current efforts of harmonizing the standards and enforcement of IPRs protection worldwide, this paper has explored software piracy trajectories and dynamics in Africa. To the best of our knowledge, no study has yet modeled current efforts placed on harmonizing the standard and enforcement of IPRs protection in the continent. The manner in which standards are set and harmonized have important consequences on the cost of products, economic efficiency and innovation. We have answered two questions that policy makers are most likely to ask before considering harmonizing IPRs regimes in the fight against piracy. (1) Is software piracy converging within Africa? (2) If so, what is the degree and timing of convergence?

Three main findings have been established. (1) African countries with low software piracy rates are catching-up counterparts with higher rates; implying, despite existing divergent IP systems, convergence in piracy rate could be a genuine standard-setting platform. (2) Legal origins do not play a very significant role in the convergence process. (3) A genuine timeframe for standardizing IPRs laws in the fight against piracy is most likely between a horizon of 4 to 8 years. In other words, full (100%) convergence within the specified horizon means, enforcements of IPRs regimes without distinction of nationality and locality.

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
	Rule of Law	-0.302	0.687	-1.657	1.053	110
	Economic Prosperity (GDPg)	4.360	2.165	-3.653	10.600	121
Control Variables	Financial depth (M2)	0.470	0.274	0.139	1.141	110
	Personal Computer (PC) Users	2.633	0.527	1.699	3.758	121
	Foreign Direct Investment (FDI)	2.527	2.902	-7.646	11.603	110
	Trade Openness	70.03	19.711	39.01	134.52	120

Panel B: Presentation of Countries

Algeria (F), Botswana (E), Cameroon (F), Egypt (F), Kenya (E), Mauritius (E), Morocco (F), Nigeria (E), Senegal (F), South Africa (E), Zambia (E).

S.D: Standard Deviation. Min: Minimum. Max: Maximum. Obser: Observations. E: English Common Law countries. F: French Civil Law countries.

Appendix 2: Variable definitions

Variables	Signs	Variable definitions	Sources
Piracy	Piracy	Logarithm of Piracy rate (annual %)	BSA
Rule of Law	RL	Rule of Law (Estimate)	World Bank (WDI)
Economic Prosperity	GDPg	GDP Growth Rate (annual %)	World Bank (WDI)
Financial Depth	M2	Monetary base plus demand, savings and time deposits (% of GDP)	World Bank (FDSD)
Personal Computer Users	PC Users	Logarithm of Personal Computer Users	World Bank (WDI)
Foreign Direct Investment	FDI	Foreign Direct Investment (% of GDP)	World Bank (WDI)
Trade Openness	Trade	Import plus Exports of Commodities (% of GDP)	World Bank (WDI)

WDI: World Bank Development Indicators. FDSD: Financial Development and Structure Database. BSA: Business Software Alliance. GDP: Gross Domestic Product. Log: Logarithm.

Table 3: Correlation matrix

Piracy	RL	GDPg	M2	PC Users	FDI	Trade	
1.000	-0.434	0.169	-0.305	-0.156	0.066	-0.049	Piracy
	1.000	-0.073	0.566	-0.095	0.129	0.578	RL
		1.000	-0.036	0.035	0.378	0.095	GDPg
			1.000	0.362	-0.041	0.356	M2
				1.000	-0.122	-0.266	PC Users
					1.000	0.100	FDI
						1.000	Trade

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