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Software piracy, inequality and the poor: evidence from Africa

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A G D I Working Paper

WP/12/035

Software piracy, inequality and the poor: evidence from Africa

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AGDI Working Paper

Research Department

Software piracy, inequality and the poor: evidence from Africa

Simplice A. Asongu[1]

September 2012

Abstract

Purpose – Poverty and inequality undoubtedly remain substantial challenges to economic and human developments amid growing emphasis on IPRs (with recent advances in ICTs) and good governance. In the first empirical study on the incidence of piracy on inequality in Africa, we examine how a plethora of factors (IPRs laws, education & ICTs and government quality) are instrumental in the piracy-inequality nexus.

Design/methodology/approach – Two-Stage-Least Squares estimation approaches are applied in which piracy is instrumented with IPRs regimes (treaties), education & ICTs and government quality dynamics.

Findings – The main finding suggests that, software piracy is good for the poor as it has a positive income-redistributive effect; consistent with economic and cultural considerations from recent literature**.** ICTs & education (dissemination of knowledge) are instrumental in this positive redistributive effect, while good governance mitigates inequality beyond the piracy channel.

Practical implications – As a policy implication, in the adoption IPRs, sampled countries should take account of the role less stringent IPRs regimes play on income-redistribution through software piracy. Collateral benefits include among others, the cheap dissemination of knowledge through ICTs which African countries badly need in their quest to become 'knowledge economies'. A caveat however is that, too much piracy may decrease incentives to innovate. Hence, the need to adopt tighter IPRs regimes in tandem with increasing income-equality.

Originality/value – It is the first empirical assessment of the incidence of piracy on inequality in Africa: a continent with stubbornly high poverty and inequality rates.

JEL Classification: F42; K42; O34; O15; O55

Keywords: Inequality; Piracy; Intellectual property rights; Africa

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1. Introduction

Poverty and inequality undoubtedly remain substantial challenges to African economic and human developments (Asongu, 2012a). It has also become abundantly clear that, for any country, region or continent to be actively involved in the global economy, it must adopt competition as a benchmark to progress. Competition derives from intellectual capital, which is protected by intellectual property rights (IPRs) laws (treaties). In recent economic history, there has been a wide consensus on the key role that IPRs protection play in promoting innovation processes and economic growth. Much recently however, technological progress has not only brought about an increased availability of information and technology products, but also the proliferation of technology used to copy, unlawfully download or counterfeit such commodities. Given present efforts being placed on harmonizing the standard and enforcement of IPRs protection worldwide (Asongu, 2012b), whereas much has been debated about the incidence of IPRs on economic development in developing countries, the income-redistributive role of piracy has remained unexplored in the literature.

Hitherto, much of the debate has centered on IPRs protection. While some scholars have postulated that increased IPRs stimulates growth and economic development through the rewarding impact on factor productivity (Gould & Gruben, 1996; Falvey et al., 2006), others 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 skeptical 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 their thesis, the existing technology in developing countries is more imitative and/or adaptive in nature and not suitable for the creation of new innovations.

The debate on HIV/AID drugs best illustrates this second stance and adds motivation to the current paper[2].

In light of the above debate, there is increasing relevance of the impact of IPRs protection on promotion of innovation, technological advancements and economic development. Still, whereas theoretical literature has addressed the issue to some extent, little scholarly attention has been devoted to empirical literature. The existing bulk of empirical studies has examined the socio-economic determinants of piracy in several copyright industries (Bezmen & Depken, 2004; Banerjee et al., 2005; Andrés, 2006a,b; Bezmen & Depken, 2006; Peitz & Waelbroeck, 2006; Goel & Nelson, 2009). As far as we know, there is very scanty evidence on the piracy-inequality nexus. Andrés (2006a), a study closest to the present paper in the literature, has assessed the incidence of inequality on piracy in a 'developed-countries' focused framework. The present study steers clear of Andrés (2006a) from a number of dimensions (as will be discussed subsequently) and aims to examine the incidence of piracy on inequality in Africa. Results could provide the much needed policy guidance, given the growing concerns on IPRs, governance and poverty in the continent.

This paper's contribution to the existing quantitative literature is threefold. Firstly, as far as we have reviewed, it is the first empirical study to assess the incidence of piracy on inequality in Africa. Secondly, the piracy-inequality nexus is contingent on the upholding of IPRs. In other words, it examines how IPRs laws (treaties) are instrumental in the income-inequality nexus. Thirdly, given current efforts that have been devoted to fighting piracy in the continent, the study also assesses how governance mechanisms are instrumental in the effect of piracy on inequality. The rest of the paper is organized in the following manner. Section 2 examines existing literature. Data and methodology are discussed and outlined

[2]This strand 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.

respectively in Section 3. Section 4 covers the empirical analysis. We conclude with Section 5.

2. Literature review

2.1 Intellectual property rights (IPRs) and development

There are two main avenues along which intellectual property and the strength of IPRs regimes are thought to influence the level of economic growth and development (Bezmen & Depken, 2004). The first strand captures the extent to which IPRs affect 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 necessary for the growth process.

In the first strand on 'creation and dissemination of information', IPRs protection draws from 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 prosperity (Romer, 1990; Grossman & Helpman, 1991). The underlying wisdom of tighter IPRs regimes (with stricter adherence to IPRs) is based on the notion that, protection of IPRs serves as a stimulus to growth by motivating innovations and inventions. The recent tendency by many newly industrialized countries pushing for stronger IPRs through bilateral, multilateral and regional arrangements, point to the interest of developing countries to specialize in labor intensive production in agricultural industries. Until very recently, these industries have largely been supported by public expenditures on R & D and technology, and have greatly benefited from shared knowledge spillovers.

The second strand looks at how IPRs can affect a nation's growth and development process through their influence on a nation's ability to engage in international transactions

such as Foreign Direct Investment (FDI) flows, trade and technology transfers (Bezmen & Depken, 2004). International trade has been presented by endogenous growth theories 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 has contributed to economic growth in all countries under all circumstances; principally because, theoretical prediction depends on country-specific conditions. It has been substantially documented that stronger IPRs regimes are crucial in attracting the inflows of FDI and technology 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).

2.2 Piracy and inequality in Africa

As presented in Table 1 below, in addition to being one of the poorest regions in the world, Africa is also the world's most inequitable region after Latin America. Inequalities have not substantially diminished overtime. Accordingly, in 2010, six out of ten most unequal countries worldwide were in Sub-Saharan African and more specifically in Southern Africa (African Development Bank: AfDB, 2012). The continent accounts for a substantial portion of the world's people living in absolute poverty. Its share of the world's poor rose from below 20% to the neighborhood of 25% and nearly 50% of the population in Sub-Saharan Africa lives on less than one US$ a day today: the world's highest rate of extreme poverty. According to the AfDB, with the richest capturing the largest share of income, when measured by share of income that goes to the poorest, inequalities are striking; especially with geographic disparities between urban and rural areas where the poor are concentrated.

Table 1: Regional inequalities and software piracy

	LAC	ECA	Asia	Europe	Africa
			Gini Index		
1980-1989	52.1	22.8	36.7	23.9	41.1
1990-1999	51.2	31.6	38.7	30.5	45.9
2000-2009	52.2	33.4	37.5	32.5	43.9
			Levels of software piracy (per 100 computers)		
2008	65%	66%	61%	35%	75%
2009	63%	64%	59%	35%	74%
			Software piracy levels in Africa		
	2005	2006	2007	2008	2009
Algeria	84%	84%	84%	84%	83%
Botswana	82%	81%	82%	80%	79%
Cameroon	84%	84%	84%	83%	83%
Egypt	64%	63%	60%	59%	59%
Ivory Coast	82%	82%	81%	80%	79%
Kenya	81%	80%	81%	80%	79%
Libya	---	---	88%	87%	88%
Mauritius	60%	59%	57%	57%	56%
Morocco	68%	66%	67%	66%	66%
Nigeria	82%	82%	82%	83%	83%
Senegal	82%	81%	80%	79%	78%
South Africa	36%	35%	34%	35%	35%
Tunisia	81%	79%	76%	73%	72%
Zambia	83%	82%	82%	82%	82%
Zimbabwe	90%	91%	91%	92%	92%

LAC: Latin America & the Caribbean. ECA: Europe and Central Asia. Data sources: the AfDB (2012) for inequality data and the BSA (2010) for piracy levels.

The global piracy rate increased from 41% in 2008 to 43% in 2009 (BSA, 2010). As shown in Table 1, Africa has the highest level of software piracy with 74% of all software installed from pirated origins. With the exceptions of Egypt, Mauritius, Morocco and South Africa, the level of piracy is averagely in the neighborhood of 80%. Indeed, software piracy in Africa has reached an epidemic level (Andrés & Asongu, 2013; Asongu, 2012bc). Consistent with the BSA (2010**),** software piracy in Africa is double the global rate. For instance, 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. This stands at almost twofold the

global piracy level for PC software (that is 42 %), having soared by 3.6 points on the previous five year average. In light of the above, recent African oriented studies have focused on best governance tools that could be used to fight piracy (Andrés & Asongu, 2013), intellectual property rights (IPRs) protections channels that matter in the battle (Asongu, 2012c) and, feasible timeframes for the harmonization of IPRs against the scourge (Asongu, 2012b). With growing levels in African income inequality, it is of policy relevance to assess whether current efforts in the fight against piracy are pro-poor or not.

2.3 Piracy, IPRs protection and quality of institutions in Africa

In light of the staggering statistics presented in Table 1 above, substantial efforts are being devoted to effectively tackle the rising phenomenon (IDC, 2009; El-Bialy, 2010; Fripp, 2011; Blakeney and Mengistie, 2011; AFROL, 2012; Agabi, 2012). This section will be discussed in two main strands. The first will complement the statistics in Table 1 with glaring stylized facts on software piracy in selected African countries while the second will focus on the role of institutional measures in combating the growing phenomenon.

In order to better understand the growing importance of piracy in Africa, we shall present stylized facts from selected African countries that best illustrate the situation, notably: Nigeria, Kenya and Egypt. Firstly, consistent with Agabi (2012), software developers are losing millions of naira annually to software thefts. The phenomenon is negatively affecting Nigeria's economy and business experts are consistent with the position that, the issue of illegal software in the country is a serious one and an urgent solution is necessary because software usage is expected to increase over the coming years. Secondly, the Kenya Copyright Board is currently beefing-up its efforts in the fight against piracy. Accordingly, it is reported that, the board planned to battle it with vigor in 2012 in order to increase investment potential and crackdown on illegal use of software (Fripp, 2011). Fripp elucidates that according to the board, there were to be 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. With regard to 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 engaging in software piracy[3]. Thirdly, a study by the International Data Corporation (IDC) on Global Software Piracy has shown that Egypt is making considerable strides in tackling the issue. It is reported that, this is largely due to the improved collaboration between Egypt and the US on enforcement for IPRs cases (AFROL, 2012). According to the report, Egypt is fully committed to further reducing its piracy rating and tackling the challenges facing the industry with a number of initiatives; among others, IPRs training for the Egyptian legal community and promotion of the copyright law (to increase awareness of IPRs and its role in sustaining economic growth and attracting foreign direct investment (FDI)).

In the second strand, we allocate space to discussing the role of institutions in IPRs protection. The World Trade Organization (WTO) can be counted among the different multilateral organizations that are laying emphasis on the importance of legal reforms in African countries. Hence, it guards African countries on the granting and protection of IPRs by given minimum requirement standards that should be fulfilled by each member country. A downside of this approach is that, its strategy is mainly based on promoting one-fits-all institutions. Therefore, it seems to ignore (or neglect) alternative institutional arrangements that could be used to reach efficient outcomes for the conflicting parties in a long-run (El-Bialy, 2010) or how institutions and IPRs matter in the effect of piracy on poverty and inequality (as the present paper seeks to address). Accordingly, El-Bialy postulates that the phenomenon of inefficient IPRs institutions is more likely to be significant in developing countries because they may need "appropriate" IPRs enforcement strategies and, their

[3] "*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).

institutions differ significantly from those prevailing in rich countries. For example, Rodrik (2008) has qualified them as 'second-best institutions' and described the institutional reforms promoted by multilateral organizations as being heavily biased towards a best-practice approach.

The existing bulk of empirical studies has examined the socio-economic determinants of piracy in several copyright industries (Bezmen & Depken, 2004; Banerjee et al., 2005; Andrés, 2006a,b; Bezmen & Depken, 2006; Peitz & Waelbroeck, 2006; Goel & Nelson, 2009). As far as we know, there is very scanty evidence on the piracy-inequality nexus. Andrés (2006a), a study closest to the present paper in the literature, has assessed the incidence of inequality on piracy. The results show that economic inequality has a negative incidence on national rates of piracy. The present study steers clear of Andrés (2006a) from three standpoints: (1) it is focused exclusively on Africa instead of developed-world oriented; (2) IPRs, education & ICTs and good governance instruments are used to control for endogeneity in the piracy-inequality nexus with an Instrumental Variable (IV) estimation approach, contrary to the Ordinary Least Squares (OLS) employed by Andrés and; (3) the incidence of piracy on inequality is assessed and not the other way round.

3. Data and methodology

3.1 Data

3.1.1 Dependent and independent variables

The proxy for inequality is the GINI coefficient which appreciates disparity among values of the frequency income-distribution. A value of zero expresses perfect equality while a coefficient of one represents maximal inequality. As recently documented (Senadza, 2012; De Silva, 2013), the GINI coefficient which is commonly used as a measure of inequality in income or wealth has found application in diverse disciplines investigating inequality: sociology, economics, health science, agriculture…etc.

The measure 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 may potentially take many avenues – e.g., organized copiers, piracy by individuals and commercial or business piracy. Hence, obtaining an accurate measure of the prevalence of software piracy remains a challenge in the literature. There are many types of piracy. 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 difference in demand for new software applications (estimated from PC shipments) and the legal supply of software. In the present, 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 % (no piracy) to 100 % (i.e., all software installed is of pirated origin). Piracy rates source from the Business Software Alliance (BSA, 2010). Additional information on measurement could be obtained from BSA (2009)[4]. BSA is an industry group; nevertheless its data on software piracy is the best cross-country measure currently used in the literature, though object of some inherent upward bias.[5] From a broad perspective, the data on software piracy could be viewed as proxying for the extent of digital piracy.

3.1.2 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 imperative for sound and consistent

[4] Data from the BSA primarily measures the piracy of commercial software. See Png (2008) and Traphagan & Griffith (1998) for a discussion on the reliability of piracy data.

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

interpretation of estimated coefficients. In other words, while the object of this article is to assess the income-redistributive effect of piracy, it also indirectly aims to examine how IPRs laws, ICTs & education and good governance are instrumental in the incidence of piracy on income-inequality. 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, piracy and the instruments (IPRs laws, education, ICTs and government quality) move hand in hand. Save in utopia, we cannot discuss piracy while ignoring these instruments. Firstly, only with the recognition and upholding of IPRs can a government put in place tools for the fight against piracy (that hypothetically affect income-distribution). The most widely known IPRs instruments in the battle against piracy are: main IP law, IPRs law, World Intellectual Property Organization (WIPO) treaties and Multilateral (Bilateral) treaties. Software piracy has been instrumented in recent empirical literature with these IPRs laws instruments (Andrés & Asongu, 2013). Secondly, theoretical underpinnings of good governance as instruments in the fight against software piracy have already been covered in the form of stylized facts presented in Section 2.3. Asongu (2012c) has recently employed these government quality instruments in the African piracy literature. They include: corruption, government effectiveness, voice & accountability, corruption-control, rule of law, regulation quality and political stability. Thirdly, ICTs and education are also important determinants of software piracy because advancements in ICTs have rendered the dissemination of information and knowledge less object of *real sector* scrutiny in comparison to past decades. From intuition we: (1) use internet penetration and the number of personal computer (PC) users as ICT instruments and; (2) adopt the literacy rate and research & development (R&D) expenditure as education instruments.

3.1.3 Control variables

Owing constraints in degrees of freedom necessary for the overidentifying restrictions tests, we are unable to control for more than three variables[6]: economic prosperity (GDP growth), inflation and trade. (1) GDP growth may reduce inequality conditional on even-distribution of the fruits of economic prosperity (Dao, 2009). The absence of any significant nexus between GDP growth and income-inequality could confirm growing fears that the relative high growth rates enjoyed by African countries (4.36% in the mean) do not trickle down from the macroeconomic to the microeconomic level. (2) The inflation rate (Bashir, 2002) included to control for the macroeconomic environment could either have a positive or negative sign depending on whether it is high or low. Though inflation has been generally seen to fuel inequality (Albanesi, 2007) owing to decreased purchasing power, low inflation however has a negative incidence on inequality (Bulir, 1998; Lopez, 2004). (3) Trade can either increase or decrease inequality depending on the proportion of the poor relying on agricultural exports. On the other hand, cheap imports could increase savings and hence improve the income-distribution of the poor. In the same vein, too much imports of 'substitution goods' produced by domestic industries could fuel income-inequality if a great chunk of the population in the lower-income bracket depends on the affected industries for subsistence income. Moreover, imports reduce racial earning inequality by significantly decreasing the wage of low- and medium-skill non-whites (Agesa et al., 2011).

Owing to constraints in data availability (for piracy rates), the data include annual observations for 11 African countries for the years 2000-2010. Details about the 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)

[6]An OIR test is only employable in the presence of over-identification. That is, the instruments must be higher than the endogenous explaining variables by at least one degree of freedom. In the cases of exact-identification (instruments equal to endogenous explaining variables) and under-identifications (instruments less than endogenous explaining variables) an OIR test is by definition not possible.

are presented 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 3) 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. Variable definitions and corresponding sources are presented in Appendix 2.

3.2 Methodology

3.2.1 Endogeneity

While inequality could be endogenous to piracy, the reverse effect cannot be ruled-out, since inequality can also be exogenous to piracy (Andrés, 2006a). We are therefore confronted here with an issue of endogeneity owing to reverse-causality since the piracy indicators are correlated with the error term in the equation of interest. Moreover, the definition and appreciation of piracy could be plagued by substantial issues of omitted variables (see Section 4.3.2 below on caveats). To tackle this endogeneity concern, we shall assess its presence with the Hausman test before employing an estimation technique relevant to the outcome of the test.

3.2.2 Estimation technique

The paper adopts a Two-Stage Least Squares (2SLS) Instrumental Variable (IV) estimation technique. IV estimation addresses the puzzle of endogeneity and hence avoids the inconsistency of estimated coefficients by Ordinary Least Squares (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:

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

Second-stage regression:

$$Inequality_{it} = \gamma_0 + \gamma_1(Piracy)_{it} + \beta_i X_{it} + \mu_{it} \qquad (2)$$

In Equation 2, *X* is a set of control variables (trade, GDP growth and inflation). In the first and second equations, υ_{it} and μ_{it} respectively represent the error terms. Instrumental variables are: IPRs laws (Main Intellectual Property Law, Intellectual Property Rights Law, WIPO Treaties, Multilateral Treaties and Bilateral Treaties), ICTs (internet penetration and number of PC users), education (literacy rate and R & D expenditure), and government quality dynamics (corruption, government effectiveness, voice & accountability, corruption-control, rule of law, regulation quality and political stability). *Inequality* represents the GINI index while *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 (piracy channel) 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. Further robustness checks will be ensured with; (1) robust Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors and; (2) restricted modeling.

4. Empirical analysis

This section aims to examine three main issues: (1) the ability of the instruments to explain the endogenous components of the piracy channel; (2) the capacity of the exogenous components of the piracy channel to explain inequality and; (3) the ability of instruments to explain inequality beyond the piracy channel. While the first issue is addressed with first-stage regressions, the second and third concerns are assessed with the 2SLS regressions.

4.1 First stage regressions

Table 2 below summarizes first-stage regressions in which the piracy rate and other second-stage control variables are regressed on the instrumental variables. This is the first condition for the 2SLS-IV estimation in which the potential instruments must be correlated with the piracy channel under consideration. Hence, the table reports an 'essential first-stage regression' which is crucial for the initial strength of the instruments and a 'supplementary first-stage regression' (for the 2SLS control variables) to confirm that the selected instruments are correlated with the endogenous explaining variable of interest (piracy rate). Models with an asterisk (*) are OLS with HAC standard errors. Panel A, Panel B and Panel C entail regressions with IPRs laws, education & ICTs and, government quality instruments respectively. Broadly across panels, the findings for the piracy channel overwhelmingly demonstrate that, the instruments jointly (taken together) enter significantly at the 1% significance level (Fisher statistics). Hence the instruments are strong, indicating that, distinguishing sampled African countries by IPRs laws (treaties), education & ICTs and government quality levels helps explain cross-country differences in software piracy levels**.** From Panel A**,** on a specific note, but for the IPRs laws that have a positive incidence on the piracy rate (contrary to expectation), the other IP laws (treaties) have a negative effect on piracy. The effects of WIPO and bilateral treaties are not significant. In Panel B and Panel C respectively, ICTs and good governance should intuitively increase and mitigate piracy respectively. Differences in signs are traceable to the high correlation between ICTs measures (internet penetration and PC users) and government quality dynamics respectively in Panel B and Panel C. The findings in Table 2 have no policy implications, as the regressions are simply meant to demonstrate that the instruments are correlated with the endogenous explaining variable of interest. Hence, discussing these to elaborate detail will be space consuming and out of scope. However, it is worth emphasizing that the insignificance of IPRs

laws (treaties) on economic prosperity could be due to the documented U-shaped relationship (Briggs, 2010).

Table 2: First-stage (FS) regressions with (without) HAC standard errors

	Essential FS regression		Supplementary FS regressions					
	Panel A: IPR laws (treaties) instruments							
	Piracy		Inflation		Trade		Economic Prosperity	
	Model 1	**Model 1***	Model 2	**Model 2***	Model 3	**Model 3***	Model 4	**Model 4***
Constant	**0.814*** **	**0.814*** **	**7.553*** **	7.553	**89.65*** **	**89.656*** **	**5.022*** **	**5.022*** **
	(6.960)	**(3.653)**	**(2.929)**	(1.199)	**(11.38)**	**(6.215)**	**(5.110)**	**(5.688)**
Main IP law	**-0.083*** **	**-0.083*** **	-0.015	-0.015	**-1.923*** **	**-1.923** **	-0.064	-0.064
	(-10.46)	**(-7.339)**	(-0.076)	(-0.049)	**(-3.135)**	**(-2.289)**	(-0.837)	(-1.089)
IPRs law	**0.028** **	0.028	-0.370	-0.370	**1.980** **	1.980	0.182	**0.182* **
	(2.258)	(1.580)	(-1.166)	(-1.057)	**(2.039)**	(1.311)	(1.507)	**(1.864)**
WIPO Treaties	0.018	0.018	0.462	0.462	**-9.236*** **	-9.236	-0.451	-0.451
	(0.623)	(0.273)	(0.623)	(0.335)	**(-4.067)**	(-1.483)	(-1.600)	(-1.535)
Multilateral Treaties	**-0.029*** **	**-0.029* **	-0.069	-0.069	**1.230** **	1.230	0.056	0.056
	(-3.803)	**(-1.807)**	(-0.366)	(-0.253)	**(2.116)**	(0.790)	(0.783)	(1.020)
Bilateral Treaties	-0.009	-0.009	**-1.920* **	-1.920	**-15.06*** **	-15.068	-0.276	-0.276
	(-0.250)	(-0.104)	**(-1.889)**	(-0.703)	**(-4.794)**	(-1.643)	(-0.713)	(-0.422)
Adjusted R^2	0.559	0.559	0.022	0.022	0.227	0.227	0.003	0.003
Fisher	**27.655*** **	**27.655*** **	1.548	1.548	**8.010*** **	**8.010*** **	1.079	1.079
Observations	106	106	121	121	120	120	121	121
	Panel B: Information & Communication Technologies (ICTs) and Education instruments							
	Piracy		Inflation		Trade		Economic Prosperity	
	Model 5	**Model 5***	Model 6	**Model 6***	Model 7	**Model 7***	Model 8	**Model 8***
Constant	**1.935*** **	**1.935*** **	-13.897	-13.897	-76.625	-76.625	**14.079* **	**14.079*** **
	(3.856)	**(6.337)**	(-0.626)	(-0.823)	(-1.004)	(-0.954)	**(1.912)**	**(7.182)**
Internet Penetration	**0.404**** **	**0.404*** **	-3.808	-3.808	8.301	8.301	2.104	**2.104*** **
	(4.342)	**(5.343)**	(-0.986)	(-0.807)	(0.625)	(0.634)	(1.643)	**(5.326)**
PC Users	**-0.752*** **	**-0.752*** **	4.956	4.956	**-40.566** **	**-40.566** **	-1.901	**-1.901*** **
	(-5.799)	**(-7.044)**	(0.906)	(0.836)	**(-2.157)**	**(-2.482)**	(-1.048)	**(-2.915)**
Literacy rate	-0.365	-0.365	12.404	12.404	**123.20*** **	**123.20** **	-5.614	**-5.614*** **
	(-1.354)	(-1.629)	(1.035)	(1.155)	**(2.990**	**(2.291)**	(-1.412)	**(-4.658)**
Research & Dev.	**-0.268** **	**-0.268*** **	**-13.151** **	**-13.151** **	22.102	22.102	0.698	0.698
	(-2.221)	**(-2.879)**	**(-2.564)**	**(-2.148)**	(1.253)	(1.629)	(0.410)	(0.866)
Adjusted R^2	0.877	0.877	0.196	0.196	0.458	0.458	0.148	0.148
Fisher	**51.187*** **	**51.187*** **	**2.894** **	**2.894** **	**7.551*** **	**7.551*** **	**2.347* **	**2.347* **
Observations	29	29	32	32	32	32	32	32
	Panel C: Good Governance instruments							
	Piracy		Inflation		Trade		Economic Prosperity	
	Model 9	**Model 9***	Model 10	**Model 10***	Model 11	**Model 11***	Model 12	**Model 12***
Constant	**0.747*** **	**0.747*** **	**-10.101* **	**-10.101* **	**93.535*** **	**93.535*** **	**5.601** **	**5.601* **
	(3.006)	**(3.728)**	**(-1.873)**	**(-1.771)**	**(6.098)**	**(6.688)**	**(2.324)**	**(1.934)**
Corruption	-0.082	-0.082	**4.216*** **	**4.216*** **	-4.885	-4.885	-0.344	-0.344
	(-1.289)	(-1.330)	**(3.050)**	**(2.795)**	(-1.239)	(-1.306)	(-0.557)	(-0.471)
Rule of Law	**-0.168* **	-0.168	**3.776* **	3.776	**34.112*** **	**34.112*** **	0.921	0.921
	(-1.971)	(-1.050)	**(1.851)**	(1.133)	**(5.941)**	**(2.767)**	(1.010)	(1.277)
Regulation Quality	-0.144	-0.144	**6.844** **	**6.844* **	-0.153	-0.153	1.584	1.584
	(-1.118)	(-1.038)	**(2.164)**	**(1.720)**	(-0.015)	(-0.010)	(1.121)	(1.182)
Gov. Effectiveness	**-0.957*** **	**-0.957*** **	**-13.92*** **	**-13.92*** **	-13.994	-13.994	**-2.742* **	**-2.742** **
	(-6.267)	**(-2.843)**	**(-3.885)**	**(-2.763)**	(-1.372)	(-1.035)	**(-1.711)**	**(-2.440)**
Corruption-Control	**0.863*** **	**0.863*** **	**-7.906** **	**-7.906* **	-7.123	-7.123	0.984	0.984
	(6.297)	**(3.629)**	**(-2.427)**	**(-1.944)**	(-0.777)	(-0.459)	(0.676)	(0.920)
Political Stability	0.067	0.067	-0.209	-0.209	3.615	3.615	0.268	0.268
	(1.206)	(0.816)	(-0.156)	(-0.116)	(0.944)	(0.529)	(0.448)	(0.433)
Voice & Account.	**0.124* **	0.124	**3.597** **	3.597	**13.304*** **	**13.304* **	-0.028	-0.028
	(1.844)	(1.357)	**(2.236)**	(1.114)	**(2.881)**	**(1.862)**	(-0.039)	(-0.037)
Adjusted R^2	0.660	0.660	0.296	0.296	0.573	0.573	-0.012	-0.012
Fisher	**25.758*** **	**25.758*** **	**6.828*** **	**6.828*** **	**19.461*** **	**19.461*** **	0.833	0.833
Observations	90	90	98	98	97	97	98	98

*;**;***: significance levels of 10%, 5% and 1% respectively. t-statistics in brackets. IP: Intellectual Property. HAC: Heteroscedasticity and Autocorrelation Consistent. Model ()*: with HAC standard errors. PC: Personal Computer. Dev: Development. Gov: Government.

4.2 Two-stage least squares

This section discusses the second and third issues: the ability of the exogenous components of the piracy channel to explain inequality and, the capacity of the instruments to explain inequality beyond the piracy channel. To inspect these issues, we employ a 2SLS with IPRs laws, education & ICTs and government quality dynamics as instrumental variables.

Whereas the second issue is addressed by the significance and signs of estimated coefficients, the third is solved with the Sargan-OIR test. The null hypothesis of this test is the position that, the instruments explain inequality only through the piracy mechanism, conditional on other covariates (control variables). Hence, a rejection of this null hypothesis is a rejection of the view that the instruments do not explain inequality beyond the piracy channels. A Hausman test is performed prior to the 2SLS-IV approach. The null hypothesis of this test is the stance that, estimated coefficients by OLS are efficient and consistent. Therefore, a rejection of this null hypothesis points to the concern of endogeneity due to inconsistent estimates and hence, lends credit to the choice of the IV estimation technique. For almost all models under consideration, we find overwhelming evidence of endogeneity (at the 1% significance level) and proceed with the IV estimation.

4.2.1 2SLS with IPRs laws (treaties) instruments

While Panel A of Table 3 presents restricted 2SLS regressions, Panel B reports their unrestricted counterparts (with a constant). The first halves of both panels contain regressions without HAC standard errors while the second halves report estimates robust to HAC standard errors. Like in Table 2, the asterisk sign (*) denotes regressions with robust HAC standard errors.

Table 3: Restricted and Unrestricted 2SLS with IPRs laws (treaties) instruments

Dependent variable: Income Inequality

Panel A: Restricted 2SLS

	2SLS without HAC SE				**2SLS with robust HAC SE**			
	Model 13	Model 14	Model 15	Model 16	**Model 13***	**Model 14***	**Model 15***	**Model 16***
Constant	---	---	---	---	---	---	---	---
Piracy	**72.22*** **	-18.206	**-35.56*** **	**-36.73*** **	**72.22*** **	-18.206	**-35.56*** **	**-36.73*** **
	(8.692)	(-1.084)	**(-3.604)**	**(-3.773)**	**(5.060)**	(-0.771)	**(-3.495)**	**(-3.263)**
Inflation	---	**7.120*** **	**2.975*** **	**2.673** **	---	**7.120*** **	**2.975*** **	**2.673*** **
		(6.606)	**(2.904)**	**(2.359)**		**(4.787)**	**(3.120)**	**(3.115)**
Trade	---	---	**0.556*** **	**0.453** **	---	---	**0.556*** **	0.453
			(4.956)	**(2.070)**			**(6.569)**	(1.060)
GDPg	---	---	---	2.100	---	---	---	2.100
				(0.539)				(0.268)
Hausman	**7.322*** **	**271.87*** **	**814.12*** **	**862.53*** **	**7.322*** **	**271.87*** **	**814.12*** **	**862.53*** **
Sargan OIR	67.746***	**7.453**	**0.935**	**0.722**	67.746***	**7.453**	**0.935**	**0.722**
	[0.000]	**[0.113]**	**[0.816]**	**[0.696]**	[0.000]	**[0.113]**	**[0.816]**	**[0.696]**
Adjusted R^2	0.183	0.026	0.062	0.048	0.183	0.026	0.062	0.048
Fisher	---	---	**117.22*** **	**95.146*** **	---	---	**90.672*** **	**64.434*** **
Chi^2	---	**98.673*** **	---	---	---	**37.436*** **	---	---
Observations	80	80	80	80	80	80	80	80

Panel B: Unrestricted 2SLS

	2SLS without HAC SE				**2SLS with robust HAC SE**			
	Model 17	Model 18	Model 19	Model 20	**Model 17***	**Model 18***	**Model 19***	**Model 20***
Constant	**53.274*** **	**44.271*** **	13.398	11.238	**53.274*** **	**44.271*** **	13.398	11.238
	(30.21)	**(9.507)**	(0.728)	(0.353)	**(16.71)**	**(9.145)**	(0.282)	(0.190)
Piracy	**-24.34*** **	**-26.31*** **	**-33.41*** **	**-34.03*** **	**-24.34*** **	**-26.31*** **	**-33.41*** **	**-34.030** **
	(-6.200)	**(-5.601)**	**(-3.908)**	**(-2.982)**	**(-4.333)**	**(-3.980)**	**(-3.043)**	**(-2.270)**
Inflation	---	**1.439** **	**2.354** **	**2.385* **	---	**1.439*** **	2.354	2.385
		(2.158)	**(1.975)**	**(1.866)**		**(3.382)**	(1.308)	(1.163)
Trade	---	---	**0.408* **	**0.408* **	---	---	0.408	0.408
			(1.842)	**(1.793)**			(0.727)	(0.715)
GDPg	---	---	---	0.481	---	---	---	0.481
				(0.084)				(0.077)
Hausman	**67.384*** **	**92.127*** **	**221.65*** **	**223.74*** **	**67.384*** **	**92.127*** **	**221.65*** **	**223.74*** **
Sargan OIR	22.339***	11.591***	**0.879**	**0.835**	22.339***	11.591***	**0.879**	**0.835**
	[0.000]	[0.000]	**[0.644]**	**[0.360]**	[0.000]	[0.008]	**[0.644]**	**[0.360]**
Adjusted R^2	0.173	0.168	0.073	0.056	0.173	0.168	0.073	0.056
Fisher	---	**16.283*** **	**5.244*** **	**3.726*** **	---	**10.164*** **	**4.422*** **	**4.738*** **
Chi^2	**38.435*** **	---	---	---	**18.772*** **	---	---	---
Observations	80	80	80	80	80	80	80	80
Instruments	Constant; Main IP_Law; IPR_Law; WIPO Treaties; Multilateral Treaties; Bilateral Treaties							

*;**;***: significance levels of 10%, 5% and 1% respectively. z-statistics in brackets. [ ]: p-values. 2SLS: Two-Stage-Least Squares. HAC: Heteroscedasticity and Autocorrelation Consistent. SE: Standard Errors. OIR: Overidentifying Restrictions test. Model ()*: with HAC standard errors. IP: Intellectual Property. IPR: Intellectual Property Right. WIPO: World Intellectual Property Organization.

The significant difference between estimates without HAC standard errors and those with HAC standard errors indicate, issues of heteroscedasticity and autocorrelation represent

significant noises that could seriously bias estimated coefficients. Hence, we base our conclusions on the second halves of the panels.

Concerning the second issue of the empirical analysis, it could be established that: piracy has a positive income-redistributive effect. But for Model 13* (with invalid instruments) this finding is consistent for Models 14*, 15*, 16*, 17*, 18*, 19* and 20*. The third issue is only addressed by Models 15*, 16*, 19* and 20* because their null hypotheses of the Sargan-OIR test are not rejected. This implies, the IPRs instruments are valid and not correlated with the error term in the equation of interest (Eq. 2). In other words, the IPRs instrumental variables explain income-inequality through no other channels beside the piracy mechanism, conditional on the control variables. For the remaining models, while some suffer from endogeneity (13*, 17*, 18*), Model 14* has valid instruments with an insignificant piracy estimate.

With regard to the control variables, the following conclusions could be drawn: (1) *economic prosperity* has no significant redistributive effect on inequality; (2) *trade openness* has an income disequalizing effect and; (3) *inflation* has a negative income redistributive effect.

4.2.2 2SLS with Education and ICTs instruments

While Panel A of Table 4 below presents restricted 2SLS regressions, Panel B reports their unrestricted counterparts (with a constant). The first halves of both panels contain regressions without HAC standard errors whereas the second halves report estimates robust to HAC standard errors. Like in Tables 2-3, the asterisk sign (*) denotes regressions with robust HAC standard errors. Restricted regressions (Panel A) address the second issue but not the third issue because: (1) the null hypothesis of the Sargan OIR is rejected for the most part and; (2) where the null of the Sargan test is not rejected (Model 24(24*)), the adjusted coefficient of determination (R^2) has a negative explanatory power. With a thin exception (Model 27*)

in unrestricted regressions (Panel B), both the second and third issues are addressed. Hence, the findings from Table 3 on the pro-poor character of software piracy are confirmed with a different set of instrumental variables in Table 4.

Table 4: Restricted and Unrestricted 2SLS with ICTs & Education instruments

Dependent variable: Income Inequality

Panel A: Restricted 2SLS

	2SLS without HAC SE				**2SLS with robust HAC SE**			
	Model 21	Model 22	Model 23	Model 24	**Model 21***	**Model 22***	**Model 23***	**Model 24***
Constant	---	---	---	---	---	---	---	---
Piracy	**50.045***	**-53.871***	**-38.382****	**-42.42*****	50.045	-53.871	**-38.382***	**-42.42*****
	(1.931)	**(-1.895)**	**(-2.078)**	**(-2.850)**	(1.071)	(-1.210)	**(-1.651)**	**(-3.009)**
Inflation	---	**6.630*****	-0.166	-0.052	---	**6.630*****	-0.166	-0.052
		(5.069)	(-0.105)	(-0.041)		**(4.107)**	(-0.188)	(-0.047)
Trade	---	---	**0.679*****	**0.295***	---	---	**0.679*****	0.295
			(5.110)	**(1.769)**			**(3.739)**	(1.194)
GDPg	---	---	---	**6.025*****	---	---	---	6.025
				(2.980)				(2.221)
Hausman	0.005	**9.928*****	**19.707*****	**96.486*****	0.005	**9.928*****	**19.707*****	**96.486*****
Sargan OIR	22.088***	12.750***	6.316**	**0.184**	22.088***	12.750***	6.316**	**0.184**
	[0.000]	[0.005]	[0.042]	**[0.667]**	[0.000]	[0.005]	[0.042]	**[0.667]**
Adjusted R^2	0.337	0.059	-0.069	-0.060	0.337	0.059	-0.069	-0.060
Fisher	---	---	**34.811*****	**42.740*****	---	---	**7.495*****	**45.31*****
Chi^2	---	**32.148*****	---	---	---	**43.527*****	---	---
Observations	24	24	24	24	24	24	24	24

Panel B: Unrestricted 2SLS

	2SLS without HAC SE				**2SLS with robust HAC SE**			
	Model 25	Model 26	Model 27	Model 28	**Model 25***	**Model 26***	**Model 27***	**Model 28***
Constant	**49.871*****	**50.099*****	**39.219*****	**14.436*****	**49.871*****	**50.099*****	**39.219****	14.436
	(21.12)	**(11.77)**	**(3.819)**	**(0.417)**	**(12.74)**	**(13.75)**	**(2.485)**	(0.629)
Piracy	**-26.46*****	**-26.10*****	**-27.75*****	**-38.44*****	**-26.46*****	**-26.10*****	**-27.75****	**-38.44*****
	(-3.875)	**(-2.916)**	**(-2.344)**	**(-2.606)**	**(-3.001)**	**(-2.676)**	**(-2.324)**	**(-2.742)**
Inflation	---	-0.0452	-0.517	---	---	-0.045	-0.517	---
		(-0.065)	(-0.526)			(-0.073)	(-0.639)	
Trade	---	---	0.192	0.234	---	---	0.192	0.234
			(1.263)	(1.304)			(0.712)	(1.024)
GDPg	---	---	---	3.926	---	---	---	3.926
				(0.739)				(1.203)
Hausman	**10.941*****	**13.924*****	**32.417*****	**43.086*****	**10.941*****	**13.924*****	**32.417*****	**43.086*****
Sargan OIR	**4.042**	**3.957**	**0.491**	**0.063**	**4.042**	**3.957**	**0.491**	**0.063**
	[0.256]	**[0.138]**	**[0.483]**	**[0.801]**	**[0.256]**	**[0.138]**	**[0.491]**	**[0.801]**
Adjusted R^2	0.307	0.262	0.006	0.004	0.307	0.262	0.006	0.004
Fisher	---	**7.025*****	**3.243****	**2.934***	---	**4.437****	2.175	**2.536***
Chi^2	15.012***	---	---	---	9.004***	---	---	---
Observations	24	24	24	24	24	24	24	24
Instruments	Constant; Internet penetration; PC Users; Literacy; Research & Development							

*;**;***: significance levels of 10%, 5% and 1% respectively. z-statistics in brackets. [ ]: p-values. 2SLS: Two-Stage-Least Squares. HAC: Heteroscedasticity and Autocorrelation Consistent. SE: Standard Errors. OIR: Overidentifying Restrictions test. Model ()*: with HAC standard errors. PC: Personal Computer.

4.2.3 2SLS with Good Governance instruments

While Panel A of Table 5 below presents restricted 2SLS regressions, Panel B reports their unrestricted counterparts (with a constant). The first halves of both panels contain regressions without HAC standard errors whereas the second halves report estimates robust to HAC standard errors. Like in Tables 2-4, the asterisk sign (*) denotes regressions with robust HAC standard errors.

Table 5: Restricted and Unrestricted 2SLS with Good governance instruments

	Dependent variable: Income Inequality							
	Panel A: Restricted 2SLS							
	2SLS without HAC SE				**2SLS with robust HAC SE**			
	Model 29	Model 30	Model 31	Model 32	**Model 29***	**Model 30***	**Model 31***	**Model 32***
Constant	---	---	---	---	---	---	---	---
Piracy	**74.338*** **	12.883	0.666	1.580	**74.338*** **	12.883	0.666	1.580
	(8.381)	(0.988)	(0.102)	(0.119)	**(11.72)**	(0.546)	(0.038)	(0.098)
Inflation	---	4.931	0.434	0.378	---	**4.931*** **	0.434	0.378
		(5.912)	(0.697)	(0.403)		**(3.211)**	(1.586)	(0.278)
Trade	---	---	**0.605*** **	0.638	---	---	**0.605*** **	0.638
			(0.000)	(1.520)			**(4.063)**	(0.749)
GDPg	---	---	---	-0.494	---	---	---	-0.494
				(-0.079)				(-0.045)
Hausman	**17.710*** **	**46.370*** **	**29.634*** **	**27.321*** **	**17.710*** **	**46.370*** **	**29.634*** **	**27.321*** **
Sargan OIR	48.069***	30.556***	43.773***	42.457***	48.069***	30.556***	43.773***	42.457***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Adjusted R^2	0.193	-0.008	-0.029	-0.044	0.193	-0.008	-0.029	-0.044
Fisher	---	---	**202.87*** **	**145.46*** **	---	---	**414.88*** **	**360.85*** **
Chi^2	---	**124.41*** **	---	---	---	**54.263*** **	---	---
Observations	70	70	70	70	70	70	70	70
	Panel B: Unrestricted 2SLS							
	2SLS without HAC SE				**2SLS with robust HAC SE**			
	Model 33	Model 34	Model 35	Model 36	**Model 33***	**Model 34***	**Model 35***	**Model 36***
Constant	**48.211*** **	**46.478*** **	**48.030*** **	**56.792*** **	**48.211*** **	**46.478*** **	**48.030*** **	**56.792* **
	(27.63)	**(18.80)**	**(8.578)**	**(2.602)**	**(8.244)**	**(8.262)**	**(5.614)**	**(1.882)**
Piracy	**-9.870*** **	**-10.95*** **	**-11.23*** **	12.767	-9.870	-10.954	-11.238	12.767
	(-2.602)	**(-2.818)**	**(-2.802)**	(0.469)	(-0.981)	(-1.115)	(-1.129)	(0.477)
Inflation	---	0.329	0.364	-1.230	---	0.329	0.364	-1.230
		(0.971)	(1.015)	(-0.613)		(1.472)	(1.180)	(-0.711)
Trade	---	---	-0.025	0.809	---	---	-0.025	0.809
			(-0.309)	(0.946)			(-0.303)	(1.059)
GDPg	---	---	---	-14.155	---	---	---	-14.155
				(-1.040)				(-1.087)
Hausman	**2.727***	2.093	1.917	**22.284*** **	**2.727***	2.093	1.917	**22.284*** **
Sargan OIR	54.256***	56.151***	56.394***	**3.262**	54.256***	56.151***	56.394***	**3.262**
	[0.000]	[0.000]	[0.000]	**[0.352]**	[0.000]	[0.000]	[0.000]	**[0.352]**
Adjusted R^2	0.181	0.207	0.198	-0.059	0.181	0.207	0.198	-0.059
Fisher	---	**3.985** **	**2.665** **	0.425	---	1.465	1.317	0.620
Chi^2	**6.772*** **	---	---	---	0.963	---	---	---
Observations	70	70	70	70	70	70	70	70
Instruments	Constant; RL; RQ; Gov. E; PolSta; CPI; V&A; CC							

*;**;***: significance levels of 10%, 5% and 1% respectively. z-statistics in brackets. [ ]: p-values. 2SLS: Two-Stage-Least Squares. HAC: Heteroscedasticity and Autocorrelation Consistent. SE: Standard Errors. OIR: Overidentifying Restrictions test. Model ()*: with HAC standard errors. RL: Rule of Law. RQ: Regulation Quality. Gov. E: Government Effectiveness. PolSta: Political Stability. CPI: Corruption Perception Index. V&A: Voice & Accountability. CC: Corruption Control.

Restricted and unrestricted regressions (Panel A and Panel B respectively) address the second issue but not the third issue because: (1) the null hypothesis of the Sargan OIR is rejected for the most part and; (2) where the null of the Sargan test is not rejected (Model 36(36*)), the adjusted coefficient of determination (R^2) has a negative explanatory power. Though the estimated piracy coefficients have the rights signs in Panel B, rejection of the null hypothesis of the Sargan test indicates that, government quality instruments do not mitigate inequality only through the piracy channel (conditional on the control variables). In other words, other instruments beside formal institutions are necessary for a pro-poor piracy effect. These instruments include among others; IPRs laws, education & ICTs used above.

4.3 Discussion, policy implications and caveats

4.3.1 Discussion and policy implications

The findings have shown a positive income-redistributive effect for software piracy. In other words, piracy maybe good for the poor. The income equalizing effect of software piracy is a fairly simple phenomenon to understand. Given the high cost of computer software, a great chunk of the population from the lowest income strata cannot afford to buy original software packages. Hence illegal copying, unauthorized downloading and counterfeiting become the only alternative means to obtaining the desired software packages. By purchasing cheap pirated software, computer literates in the lower income strata can save money for other utilities. Hence, an indirect increase in their purchasing power. This interpretation is consistent with the relevance of the hypothesis that, the poor are more prone to using pirated software (Moores & Esichaikul, 2011, 1-2). Moores & Esichaikul have found a strong negative relationship between economic wealth and the level of software piracy, such that poorer countries tend to have higher levels of software piracy. The high cost of software is

often cited as a motivating factor for pirating software. At a micro economic level, this explanation lends credit to our findings.

Beside economic considerations, another factor that could elucidate the income-equalizing effect of piracy in Africa is cultural. It has been firmly established that countries with a more collectivist society also tend to have higher levels of software piracy (Moores & Esichaikul, 2011, 2). High collectivist income groups are usually those at the bottom of the income distribution because, people become more individualistic as they grow richer. Hence, the natural conclusion that sharing and commercialization of cheap pirated software is among the faction of the population making-up the lower income strata. The findings are consistent with a great bulk of the literature that has examined the determinants of the willingness to pirate software (by assessing the socio-economic factors that affect piracy). The conclusion drawn from these studies is 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). Our findings concur with the above studies from a microeconomic standpoint.

Our finding has also shed some light on the current debate over IPRs protection. While some are postulating increased protection of IPRs as means of stimulating economic growth and development through the appealing impact on factor productivity (Gould & Gruben, 1996; Falvey et al., 2006), others are skeptical and 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 latter school of thought is of the view that, less tight IPRs regimes are necessary (at least in the short-run) for developing countries, to enable knowledge spillovers, imperative for growth and development. The findings of this paper have reconciled this debate with the bridge that, less tight IPRs regimes in the short-run

are good for the poor as they enhance the benefits of knowledge spillovers. However, as income-inequality decreases, the adoption of tighter IPRs regimes will facilitate inflows of FDI and technological transfers (Lee & Mansfield, 1996), stimulate exports (Maskus & Penubarti, 1995) and increase the likelihood of investment undertaken by multinational enterprises (Mansfield, 1994; Seyoum, 1996).

The following discussion concerns the control variables in Table 3. (1) A negative or positive sign was expected from the estimated coefficient of economic prosperity. The absence of any significant nexus between GDP growth and income-inequality confirms growing fears that the relative high growth rates enjoyed by African countries (4.36% in the mean) do not trickle down from the macroeconomic to the microeconomic level. (2) Inflation was also included to control for the macroeconomic environment and was expected to either have a positive or negative sign depending on its rate. Though inflation has been generally seen to fuel inequality (Albanesi, 2007) owing to decreased purchasing power, low inflation however has a negative incidence on inequality (Bulir, 1998; Lopez, 2004). The relative high inflation rate (6.96% in the mean) confirms the disequalizing income-distribution inflationary effect in the results. (3) The positive incidence of trade openness on inequality has two possible interpretations: on the one hand, the proportion of exports originating from the poor is quite low; on the other hand, cheap imports are stifling the domestic industries on which the poor substantially depend for income.

It is also interesting to discuss some ethical implications of software piracy in Africa. Inequality could be further mitigated owing to software piracy from four main ethical standpoints: (1) the seller of pirated software thinks (S)he is right to continue her (his) business because the company may incur more expenses taking the matter to court; (2) users of pirated software think it is right to use pirated commodities because they are poor; (3) illegal copying might be based on interpersonal trust as those who either copy or share

software with others must trust that the software contains no viruses and; (4) moreover, individuals distributing illegal copies to others must trust these persons not to report to the police.

4.3.2 Caveats

Two main caveats have been retained: limitations in the measurement of software piracy and, the perception based good governance measures that may be subject to substantial bias due to media propaganda.

Firstly, on the measurement of software piracy, three points are relevant (Asongu, 2012c). (1) Accordingly, the 'piracy level is computed as the difference in demand for new software applications (computed from PC shipments) and the legal supply of software'. It is worth noting 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 pirated 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) The employment of the metric presupposes knowledge of the elasticity of demand for the original product. Otherwise, there will be a comparison of pirated products that constitute loss in sales with ones that do not. Therefore, there is some upward bias in the software piracy estimate.

Secondly, good governance indicators are perception based measures that may be subject to a considerable degree of media propaganda. This downside has been mitigated with: (1) the use of a broad range of government quality indicators; (2) the use of other IPRs and ICTs (and education) alternative instrumental variables and; (3) the adoption of an endogeneity based estimation approach that accounts for measurement errors and variable collection errors. Ultimately, as far as we have reviewed, there are no better government quality indicators than those available in the World Bank Development Indicators.

5. Conclusion

Poverty and inequality undoubtedly remain substantial challenges to economic and human developments. There is also a growing role of IPRs protection, especially with advances in ICTs. While existing piracy literature has focused on the socio-economic determinants of piracy, but for Andrés (2006a), the piracy-inequality nexus has remained unexplored. The current paper which steers clear of Andrés (2006a) from three standpoints[7] has had a threefold contribution to the literature. Firstly, as far as we have reviewed, it is the first empirical study to assess the incidence of piracy on inequality in Africa. Secondly, the piracy-inequality nexus is contingent on the upholding of IPRs. In other words, it has examined how IPRs laws (treaties) are instrumental in the effect of piracy on income-inequality. Thirdly, given current efforts that have been devoted to fighting piracy in the continent, the study has also assessed how governance mechanisms are instrumental in the effect of piracy on inequality. The main finding suggests that, software piracy is good for the poor as it has a positive income-redistributive effect. This finding is consistent with recent piracy literature (Moores & Esichaikul, 2011) from both economic and cultural considerations. ICTs & education (dissemination of knowledge) are instrumental in this positive redistributive effect, while good governance mitigates inequality beyond the piracy channel.

As a policy implication, in the adoption tight IPRs regimes, sampled countries should take account of the role less stringent IPRs regimes play on income-redistribution through software piracy. Collateral benefits include among others, the cheap dissemination of knowledge through ICTs which African countries badly need in their quest to become

[7] The present paper has steered clear of Andrés (2006a) from three standpoints: (1) it has focused exclusively on Africa instead of developed-world oriented; (2) IPRs, education & ICTs and good governance instruments have been used to control for endogeneity in the piracy-inequality nexus using an Instrumental Variable (IV) estimation approach, contrary to the Ordinary Least Squares (OLS) employed by Andrés (2006a) and; (3) the incidence of piracy on inequality has been assessed and not the other way round.

‘knowledge economies’. A caveat however is that, too much piracy may decrease incentives to innovate. Hence, the need to adopt tighter IPRs regimes in tandem with increasing income-equality.

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Appendices

Appendix 1: Summary statistics and presentation of countries

Panel A: Summary Statistics

		Mean	S.D	Min	Max	Obser.
Dependent Variable	Inequality (GINI)	44.216	8.574	32.140	67.400	92
Independent Variable	Piracy rate	2.745	1.857	0.000	5.250	121
	Inflation	6.963	5.736	-1.050	26.240	121
Control Variables	Trade Openness	70.03	19.711	39.01	134.52	120
	Economic Prosperity (GDPg)	4.360	2.165	-3.653	10.600	121
	Main IP law	2.256	2.835	0.000	11.000	121
IPRs laws (treaties)	IPRs law	1.438	1.944	0.000	7.000	121
Instrumental Variables	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
	Internet Penetration	2.888	0.799	1.301	4.727	121
ICTs & Education	Personal Computer Users	2.633	0.527	1.699	3.758	121
Instrumental Variables	Literacy	1.826	0.097	1.572	1.956	110
	Research and Development	0.395	0.290	0.006	0.946	32
	Rule of Law	-0.302	0.687	-1.657	1.053	110
	Regulation Quality	-0.180	0.547	-1.305	0.905	110
Good Governance	Corruption	3.369	1.266	1.000	6.400	117
Instrumental Variables	Government Effectiveness	5.058	11.362	-34.882	80.449	103
	Voice & Accountability	-0.277	0.696	-1.256	1.047	110
	Control of Corruption	-0.309	0.641	-1.236	1.086	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: Variable definitions

Variables	Signs	Variable definitions	Sources
		Panel A: Dependent and Independent Variables	
Inequality	GINI	Income Inequality Index	World Bank (WDI)
Piracy	Piracy	Logarithm Piracy rate (annual %)	BSA
		Panel B: Control Variables	
Inflation	Inflation	Consumer Price Index (annual %)	World Bank (WDI)
Trade Openness	Trade	Import plus Exports of Commodities (% of GDP)	World Bank (WDI)
Economic Prosperity	GDPg	GDP Growth Rate (annual %)	World Bank (WDI)
		Panel C: IPRs laws (treaties) Instrumental Variables	
Main IP law	MIPlaw	Main Intellectual Property Law	WIPO
IPRs law	IPlaw	Intellectual Property Rights Law	WIPO
WIPO Treaties	WIPO	World Intellectual Property Organization Treaties	WIPO
Multilateral Treaties	Multilat	Multilateral IP Treaties	WIPO
Bilateral Treaties	Bilat	Bilateral IP Treaties	WIPO
		Panel D: ICTs and Education Instrumental Variables	
Internet Penetration	Internet	Logarithm of Internet Users per 1000	GMID
Personal Computer Users	PC	Logarithm of Personal Computer Users per Capita	GMID
Literacy	Literacy	Logarithm of Adult Literacy Rate (% of population aged above 15)	GMID
Research & Development	R & D	Research & Development Expenditures (% of GDP)	World Bank (WDI)
		Panel E: Good Governance Instrumental Variables	
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.	World Bank (WDI)
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.	World Bank (WDI)
Corruption	CPI	Corruption Perception Index or perceived levels of corruption (the misuse of public power for private benefit) as determined by expert assessments and opinion surveys.	World Bank (WDI)
Government Effectiveness	Gov. E	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.	World Bank (WDI)
Voice & Accountability	V&A	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.	World Bank (WDI)
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	World Bank (WDI)

		grand forms of corruption, as well as 'capture' of the state by elites and private interests.	
Political Stability (No Violence)	PolSta	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.	World Bank (WDI)

WDI: World Bank Development Indicators. BSA: Business Software Alliance. GDP: Gross Domestic Product. WIPO: World Intellectual Property Organization. IP: Intellectual Property. GMID: Global Market Information Database.

Appendix 3: Correlation Analysis

Panel A: Correlation Analysis with IPRs laws (treaties) Instrumental Variables

Inequality (GINI)	Piracy rate	Control variables			IPRs laws (treaties) Instrumental variables					
		Inflation	Trade	GDPg	MIPlaw	IPlaw	WIPO	Multilat	Bilat	
1.000	-0.428	0.098	-0.058	-0.070	0.764	-0.137	-0.318	-0.491	-0.454	GINI
	1.000	0.146	-0.050	0.174	-0.715	-0.017	0.320	0.026	0.015	Piracy
		1.000	0.151	0.176	-0.016	-0.150	0.024	-0.120	-0.210	Inflation
			1.000	0.095	-0.173	0.079	-0.148	0.126	-0.281	Trade
				1.000	-0.036	0.132	-0.061	0.108	-0.007	GDPg
					1.000	0.103	-0.273	-0.221	-0.071	MIPlaw
						1.000	0.308	0.443	0.143	IPlaw
							1.000	0.311	-0.052	WIPO
								1.000	0.261	Multilat
									1.000	Bilat

Panel B: Correlation Analysis with ICTs & Education Instrumental Variables

Inequality (GINI)	Piracy rate	Control variables			ICTs & Education Instrumental Variables				
		Inflation	Trade	GDPg	Internet	PC	Literacy	R& D	
1.000	-0.428	0.099	-0.058	-0.070	0.090	0.260	0.491	0.684	GINI
	1.000	0.146	-0.050	0.174	-0.184	-0.625	-0.348	-0.821	Piracy
		1.000	0.151	0.176	-0.040	-0.047	0.161	-0.464	Inflation
			1.000	0.095	-0.235	-0.266	0.262	-0.176	Trade
				1.000	0.140	0.035	-0.130	-0.032	GDPg
					1.000	0.840	-0.105	0.409	Internet
						1.000	-0.003	0.658	PC
							1.000	0.265	Literacy
								1.000	R&D

Panel C: Correlation Analysis with Good Governance Instrumental Variables

Inequality (GINI)	Piracy rate	Control variables			Good Governance Instrumental Variables							
		Inflation	Trade	GDPg	RL	RQ	CPI	Gov. E	V&A	CC	PolSta	
1.000	-0.428	0.099	-0.058	-0.070	0.044	0.420	0.304	0.441	0.597	0.305	0.235	GINI
	1.000	0.146	-0.050	0.174	-0.508	-0.602	-0.480	-0.609	-0.420	-0.432	-0.291	Piracy
		1.000	0.151	0.176	-0.136	-0.073	-0.143	-0.108	0.041	-0.184	-0.042	Inflation
			1.000	0.095	0.578	0.470	0.430	0.532	0.579	0.505	0.491	Trade
				1.000	-0.073	-0.095	-0.095	0.013	-0.003	-0.058	-0.073	GDPg
					1.000	0.871	0.887	0.886	0.727	0.902	0.828	RL
						1.000	0.884	0.931	0.846	0.867	0.764	RQ
							1.000	0.916	0.759	0.940	0.779	CPI
								1.000	0.833	0.942	0.712	Gov. E
									1.000	0.796	0.722	V&A
										1.000	0.779	CC
											1.000	PolSta

MIPlaw: Main Intellectual Property Law. IPlaw: Intellectual Property Rights Law. WIPO: World Intellectual Property Organization Treaties. Multilat: Multilateral IP Treaties. Bilat: Bilateral IP Treaties. PC: Personal Computer Users. R&D: Research & Development. RL: Rule of Law. RQ: Regulation Quality. CPI: Corruption Perception Index. Gov. E: Government Effectiveness. V&A: Voice & Accountability. CC: Control of Corruption. PolSta: Political Stability.

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