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Boosting scientific publications in Africa: which IPRs protection channels matter?

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Boosting scientific publications in Africa: which IPRs protection channels matter?

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Abstract

This paper examines how Africa's share in the contribution to global scientific knowledge can be boosted with existing Intellectual Property Rights (IPRs) mechanisms. The findings which broadly indicate that tight IPRs are correlated with knowledge contribution can be summarized in two main points. First, the enshrinement of IPRs laws in a country's Constitution is a good condition for knowledge economy. Secondly, while Main IP laws, WIPO treaties and Bilateral treaties are positively correlated with scientific publications, the IPRs law channel have a negative correlation. Whereas the study remains expositional, it does however offer interesting insights into the need for IPRs in the promotion of knowledge contribution within sampled countries of the continent. Other policy implications are discussed.

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1. Introduction

The 2013 Shanghai Academic Rankings of World Universities (ARWU, 2013)[2] present a dominant picture of developed countries vis-à-vis their developing counterparts. It highlights the dominance of North America, Western Europe, Australia, Japan and China; the catch-up struggle of Latin America and miserable representation of the Middle East, South East Asia, Africa, and Eastern Europe & Central Asia[3].

As countries that have mastered knowledge economy (KE) continue to steer development in the global arena, the relevance of KE as a root axis of 21st century development is no longer an issue of moderate consensus (Albuquerque, 2000; Esler & Nelson 1998; Murray & Stern, 2005; Mowery & Sampat 2005; World Bank, 2007; Mazzoleni & Nelson, 2007; Amavilah, 2009; Mazzoleni, 2008; Chandra & Yokoyama, 2011; Weber, 2011; Asongu, 2013a; Nyarko, 2013a). Against this background, the mission of universities and public research organizations in facilitating the transition from product-based economies to knowledge-based economies is crucial. As demonstrated in the early experiences of Germany in the 19th century and late experiences of Asian countries (Japan, South Korea, Taiwan, Singapore and China), beside education, universities by undertaking basic and applied research contribute to a country's development.

The prospect for intellectual property rights (IPRs) to stimulate the diffusion of scientific knowledge is core to several contemporary policy debates. A key issue in this debate has been to know how IPRs over a given piece of knowledge affects the propensity of future researchers to build upon that knowledge in their own scientific research activities (Murray & Stern, 2005). This article frames the debate in the continent that is substantially

[2] The 2013 ARWU release by the Center for World-Class Universities at Shanghai Jiao Tong University which began about 10 years ago has been annually reporting the Top 500 World universities from reliable data and a transparent methodology. Moreover the Shanghai ARWU is acknowledged as the most trustworthy and precursor in the rankings of world universities.

[3] Please see http://www.shanghairanking.com/.

lagging behind in terms of scientific publications, by attempting to provide policy makers with the much needed guidance on IPRs that matter in boosting 'contribution to knowledge' in the scientific world.

The last decades have been marked with a substantial debate on the imperative role that IPRs protection play on the promotion of innovation processes, economic growth and development. While the debate has tilted towards a consensus on the importance of tight IPRs in developed countries, the nexus between the strength of IPRs and knowledge spillovers has been hotly debated in developing countries. Whereas some scholars have emphasized that, tight protection of IPRs stimulate economic growth and development via the appealing effect on factor productivity (Gould & Gruben, 1996; Ginarte & Park, 1997; Falvey et al., 2006), a skeptical standpoint is of the view that strong IPRs protection and adherence to international IPRs regimes (treaties) may stifle, rather than stimulate economic prosperity in developing countries (Yang & Maskus, 2001). The school of thought on less stringent IPRs disputes that, since the existing technology in developing countries is more imitative and/or adaptive in nature, instead of being suitable for the creation of new innovation, developing countries will be detrimentally affected by tight IPRs law regimes. Additionally, it is vehemently disputed that, weaker IPRs are necessary at least on a temporal basis for emerging countries to obtain the knowledge spillovers imperative for growth and development. This skeptical school has gained prominence in the debate over if 'permission' should be accorded to enable the 'copying' of life-saving pharmaceuticals, especially those used in less developed nations that are most affected and least likely to afford treatment for the management of HIV/AIDS.

Cognizant of the above, with increasing emphasis on the relevance of IPRs protection on economic development, promotion of innovation and technological advancement; while theoretical literature has tackled the concerns to a certain degree, the empirical literature has been subject to scanty scholarly attention. Accordingly, a considerable bulk of empirical

studies has investigated the socio-economic determinants of violating IPRs in several copyright industries (Andrés, 2006ab; Banerjee et al., 2005; Bezmen & Depken, 2006; Peitz & Waelbroeck, 2006; Goel & Nelson, 2009). Conversely, very few empirical studies have assessed the breaching of IPRs (e.g piracy) on economic prosperity (Bezmen & Depken, 2004; Andrés & Goel, 2012) in general and knowledge economy (KE) in particular.

In fact, the growing relevance of IPRs has come with increasing emphasis on KE. Since the 1990s, the phenomenon has been central in the reports of most influential organizations, with strong emphasis on the imperative dimension of knowledge (via technological progress and innovation) as the engine for long-term economic prosperity (World Bank, 2007; Weber, 2007; Tchamyou, 2014). Complementarily, the appealing literature has consistently been of the perspective that, Europe and North America have mastered the lofty dynamics of IPRs in KE and have inexorably steered developments at the global arena. Other regions like East Asia and Latin America have responded in calculated steps that underpin the imperatives of KE and IPRs in their current pursuits of national, regional and international initiatives. Accordingly, the pattern of Japan has set the course for governments of the Newly Industrialized Asian Economies (China, Korea, Hong Kong, Singapore, Malaysia and Taiwan) which are marching respectfully towards 'knowledge-based' economies from the 'product-based' economies (Chandra & Yokoyama, 2011). In Africa, KE and IPRs items have recently been occupying a substantial portion on the agenda of development discussions (Asongu, 2014ab).

To the best of our knowledge and as far as we have reviewed, very little is currently known on the dynamics of IPRs and KE in Africa. Whereas the growth-KE nexus is quite relevant, the debate has recently been tilted towards how African economies can replicate the 'East Asian Miracle'. This new strand of studies has been motivated by abundance in clarity of the fact that, for African economies to be actively involved in the global economy, they

must be competitive. Competition is a fruit of KE and intellectual capital that are protected by IPRs laws. These phenomena have recently witnessed special interest in Africa: either through the fight against software piracy (Andrés & Asongu, 2013ab), via dynamics in KE (Amavilah et al., 2014; Asongu, 2013bc, 2014c), production value of doctoral dissertations (Amavilah, 2009) or pro-poor nexuses (Asongu, 2014d).

The interesting African KE literature has focused on amongst others: broad views on the phenomenon (Rooney, 2005; Anyanwu, 2012; Lin, 2006); education (Wantchekon et al., 2014; Ford, 2007; Amavilah, 2009; Weber, 2011; Chavula, 2010); information & communication technologies (Chavula, 2010; African Partnership Forum, 2008 ; Butcher, 2011); innovation (Oyelaran-Oyeyinka & Gehl Sampath, 2007; Carisle et al., 2013; Anyanwu, 2012); economic incentives & institutional regime (Andrés & Asongu, 2013a; Cogburn, 2003; Saxegaard, 2006; Letiche, 2006; Nguena & Tsafack, 2014; Andrés et al., 2014); intellectual capital & economic development (Preece, 2013; Wagiciengo & Belal, 2012); indigenous knowledge systems (Raseroka, 2008; Lwoga et al., 2010); research & development (German & Stroud, 2007; African Development Bank, 2007; Sumberg, 2005); intellectual property rights (Lor & Britz, 2005; Zerbe, 2005; Myburgh, 2011; Andrés et al., 2014; Asongu, 2013a; Andrés & Asongu, 2013ab, 2014b); spatiality in the production of knowledge (Bidwell et al., 2011; Neimark, 2012) and; KE space transformation (Maswera et al., 2008; Moodley, 2003).

With the above solid and interesting backgrounds, the present paper complements existing African literature by exploring the correlations between IPRs and contribution to knowledge by means of scientific publications. It broadly extends the debate on the relationship between the strength of IPRs and prospects for KE by investigating the correlation among IPRs protection mechanisms and scientific publications in African countries for which data is available. Specifically, the paper's contribution to the literature is twofold.

First, recent evidence has demonstrated that, not all IPRs protection channels matter in the fight against software piracy in the African continent (Asongu, 2014e) irrespective of legal origins (Asongu, 2014b). Moreover, Andrés et al. (2014) have also established that the enforcement of IPRs through governance mechanisms is not a necessary condition for KE in the continent. Therefore extending these findings to the dimension of knowledge spillovers in scientific publications could be of interesting policy relevance. Second, beside the highlighted works of Asongu, Andrés and Amavilah on KE in Africa, the study also substantially steers clear of mainstream literature (Dahlman, 2007; AfDB, 2007; Bizri, 2009; Aubert, 2005; Britz et al., 2006[4]; Makinda, 2007; Lightfoot, 2011)[5].

By investigating the correlations between IPRs and knowledge contributions, the paper also extends a growing strand of the literature on '*achieving development success: strategies and lessons from the developing world*' (Fosu, 2013a; Jomo & Wee, 2013; Lee, 2013; Thoburn, 2013; Warr, 2013; Khan, 2013; Yao, 2013; Singh, 2013; Santos-Paulino, 2013; Robinson, 2013; Lundahl & Petersson, 2013; Subramanian, 2013; Fosu, 2013b; De Mello, 2013; Naudé, 2013; Solimano, 2013; Trejos, 2013; Cardoso, 2013; Pozo et al., 2013; Looney, 2013; Drine, 2013; Nyarko, 2013b & Baliamoune-Lutz, 2013). The rest of the paper is organized as follows. Data and methodology issues are discussed in Section 2. The empirical analysis is covered in Section 3. Section 4 concludes.

[4]For instance, consistent with Asongu (2013a), the African Development Bank (AfDB, 2007) has examined the incidence of public expenditure on the education dimension of KE and found the following: firstly, in the short-term, there is a positive nexus between public expenditure on education and economic growth in Africa, as well as on knowledge generation and human capital development, that have a potential to positively affect aggregate labor productivity and; secondly, in the long-run however, public expenditure is negatively related to economic growth due to the often lack of capacity to retrain human capital and subsequent brain drain.

[5]Britz et al. (2006) have assessed the question of whether Africa is moving towards a KE and found that, Africa still has a far way to go down the road and the journey could be quickened with certain preconditions, amongst others: investment in human capital, effective stopping of brain drain, as well as effective development and maintenance of a physical infrastructure. In accordance with Makinda, in order to rectify the gap between SSA and the Western World, African policy makers need to: firstly, define the type of knowledge their countries require; secondly, establish conditions for nurturing strategic leaders who will in turn, seek right forms of knowledge to tackle Africa's problems; thirdly, build political and legal frameworks that encourage the absorption and application of scientific innovation and; fourthly, revamp universities, establish regional research centers and take capacity building more seriously (Makinda, 2007). This need for policy reforms draws from the Lightfoot (2011) conclusion that emphasizes the need for in-depth reforms as means to fulfilling the policy aspirations rather than speculating over progress through technology enriched futures.

2. Data and Methodology

We assess a panel of 10 African countries with data from African Development Indicators (ADI) of the World Bank (WB) for the period 1996-2010. Limitations to the time span and number of countries are constrained by IPRs and 'scientific publications' data availability. The sampled countries are presented in Panel B of Appendix 1.

The dependent variable is the number of scientific and technical journal articles published on a yearly basis. Consistent with Asongu (2014e), the main independent variables are IPRs variables gathered from the World Intellectual Property Organization (WIPO). The six exogenous variables gathered include: *Constitution*, *Main IP laws*, *IPRs laws*, *WIPO treaties*, *Multilateral treaties* and *Bilateral treaties*. *Main IP laws* and *IPRs laws* are IP laws that are enacted by the legislature and enforced by the institutions. WIPO administered treaties are defined from the day they enter into force for the contracting party. IP relevant Bilateral and Multilateral treaties are also collected with respect to the date they are enforced by the contracting parties. *Constitution* is a dummy variable of whether IPRs are enshrined in the constitution and take the values of 1 if enshrined and 0 otherwise. The control variables include: tertiary school education, software piracy rate and the degree of internet penetration. From intuition and common sense, the first and third should have a positive correlation with contribution to knowledge by means scientific publications. Conversely, the expected sign of software piracy may depend on the level of industrialization: a negative sign for industrialized economies and a positive effect in less developed countries.

The summary statistics (with presentation of countries), correlation analysis (depicting the nexuses among key variables used in the paper), and variable definitions (with corresponding sources) are shown in the appendices. The 'summary statistics' (Appendix 1) of the variables shows that, they are quite comparable. The objective of the correlation matrix

(Appendix 2) is to attenuate concerns of overparameterization and multicollinearity. Based on an initial examination of the correlation coefficients, there do not appear to be any serious issues in terms of the nexuses to be estimated. Definitions and corresponding sources of the variables are presented in Appendix 3.

The exploratory estimation approach consists of employing Hetersocedasticity and Autocorrelation Consistent (HAC) standard errors Ordinary Least Squares (OLS) and HAC panel fixed effects to control for the unobserved heterogeneity. For more subtlety and robustness in the analyses, both contemporaneous and non-contemporaneous estimations are provided. While the former is contingent on present values of the independent variables, the latter uses lagged values of the independent variables. Accordingly, as documented by Murray and Stern (2005), there may be a substantial lag (often many years) in IPRs protection laws before the KE fruits in terms of scientific publications. Given the exploratory character of this analytical exercise, we do not provide the OLS specifications which are well known. However, these can be provided upon request.

3. Empirical Results

This section aims to examine two main issues: (1) the correlation between IPRs protection mechanisms and scientific publications and; (2) how the contemporaneous nature of the independent variables matter in the investigated relationships. The results are provided in Table 1 below. While results of the first issue are presented in Panel A, those of the second are displayed in Panel B.

As concerns the first issue, the following findings could be established. (1) The enshrinement of IPRs laws in the Constitution has a positive correlation with the outcome variable. (2) *Multilateral treaties*, *Main IP law*, *WIPO treaties* and *Bilateral treaties* have positive correlations with scientific publications while, *IPRs laws* has a negative correlation.

With regards to the second issue, but the for tiny exception of *Multilateral treaties* not being positively correlated with the dependent variable in the panel fixed effects estimations, the findings in Panel B are broadly consistent with those of Panel A.

The significant control variables have the expected signs. Accordingly, internet penetration and tertiary school enrolment are positively correlated with the outcome variable.

Table 1: Contemporaneous and Non-contemporaneous Panel OLS and Fixed Effects

	Dependent variable: Scientific and Technical Journal Articles					
	Panel A: Contemporaneous Estimations					
	Ordinary Least Squares (OLS)			**Fixed Effects**		
Constant	**0.793***	**0.776*****	0.807	**2.070*****	**1.853*****	**1.877*****
	(0.054)	**(0.002)**	(0.168)	**(0.000)**	**(0.000)**	**(0.000)**
Constitution	**0.555****	**0.471*****	-0.143	---	---	---
	(0.000)	**(0.005)**	(0.459)			
Main IP Law	**0.341*****	**0.272*****	**0.277****	**0.072*****	**0.056*****	0.003
	(0.000)	**(0.000)**	**(0.012)**	**(0.003)**	**(0.001)**	(0.833)
IPRs Law	-0.039	-0.043	-0.055	**-0.026*****	**-0.040*****	**-0.017***
	(0.504)	(0.376)	(0.163)	**(0.004)**	**(0.000)**	**(0.059)**
WIPO treaties	**0.332****	**0.376*****	**0.277***	0.009	-0.0005	-0.009
	(0.010)	**(0.005)**	**(0.093)**	(0.381)	(0.951)	(0.676)
Multilateral treaties	---	-0.014	**-0.066*****	---	**0.029*****	-0.015
		(0.586)	**(0.001)**		**(0.005)**	(0.132)
Bilateral treaties	---	**0.445*****	**0.449*****	---	0.038	**0.058****
		(0.001)	**(0.004)**		(0.174)	**(0.014)**
Tertiary Education	---	---	-0.323	---	---	**0.514*****
			(0.289)			**(0.005)**
Software Piracy	---	---	-0.181	---	---	-0.097
			(0.363)			(0.147)
Internet Penetration	---	---	**0.427***	---	---	0.014
			(0.068)			(0.546)
Adjusted R^2	0.421	0.524	0.812	0.174	0.276	0.287
Fisher	**15.396*****	**15.510*****	**23.587*****	**403.97*****	**383.79*****	**321.15*****
Countries	10	10	9	10	10	9
Observations	80	80	48	80	80	48

Panel B: Non-Contemporaneous Estimations

	Ordinary Least Squares (OLS)			Fixed Effects		
Constant	**0.776***	**0.787*****	0.563	**2.015*****	**1.896*****	**1.912*****
	(0.055)	**(0.001)**	(0.297)	**(0.000)**	**(0.000)**	**(0.000)**
Constitution (-1)	**0.653*****	**0.563*****	-0.181	---	---	---
	(0.005)	**(0.001)**	(0.337)			
Main IP Law (-1)	**0.323*****	**0.270*****	0.170	**0.072*****	**0.054*****	**0.047*****
	(0.000)	**(0.000)**	(0.197)	**(0.002)**	**(0.002)**	**(0.000)**
IPRs Law (-1)	-0.037	-0.046	-0.032	**-0.029*****	**-0.034*****	-0.018
	(0.538)	(0.370)	(0.451)	**(0.000)**	**(0.000)**	(0.108)
WIPO treaties (-1)	**0.352*****	**0.416*****	0.300	**0.035*****	**0.031*****	**0.027*****
	(0.008)	**(0.003)**	(0.142)	**(0.000)**	**(0.001)**	**(0.000)**
Multilateral treaties (-1)	---	-0.024	**-0.100*****	---	0.015	-0.012
		(0.370)	**(0.000)**		(0.216)	(0.480)
Bilateral treaties (-1)	---	**0.479*****	**0.453****	---	**0.066****	**0.073*****
		(0.001)	**(0.026)**		**(0.013)**	**(0.003)**
Tertiary Education	---	---	-0.024	---	---	0.376
			(0.943)			(0.228)
Software Piracy	---	---	-0.024	---	---	-0.078
			(0.911)			(0.161)
Internet Penetration	---	---	**0.523***	---	---	-0.019
			(0.058)			(0.650)
Adjusted R^2	0.422	0.517	0.801	0.245	0.295	0.301
Fisher	**13.596*****	**13.321*****	**20.750*****	**429.47*****	**380.59*****	**301.00*****
Countries	10	10	9	10	10	9
Observations	70	70	45	70	70	45

*;**;***: significance levels of 10%, 5% and 1% respectively. ( ): p-values. (-1): lagged independent variables. IP: Intellectual Property. IPRs: Intellectual Property Rights. WIPO: World Intellectual Property Organization. The variable 'Constitution' is not included in the fixed effect estimations because it is dummy: 1 or 0.

Our findings have broadly shown that, IPRs protection channels could be pro-scientific publications. Accordingly, the adoption of tighter IPRs regimes will also facilitate the inflows of innovation and technology transfers (Lee & Mansfield, 1996), stimulate exports (Maskus & Penubarti, 1995) and, increase the likelihood of investment undertaken by multinational enterprises (Mansfield, 1994; Seyoum, 1996). The positive side of these findings is consistent with the Maskus (2000) caution that, weaker IPRs might not necessarily be beneficial to developing countries as it may cause them to become dependent on older and less efficient technologies.

Conversely, the negative correlation between the IPRs law channel and publications could have a threefold explanation. First, this scenario may reflect the anticommons theory documented by Murray & Stern (2005) which predicts that the citation rate to a scientific

journal should fall after formal IPRs associated with the publications are granted. Ceteris paribus, the perception of decreased citations owing to a potential upholding of IPRs may deter the quest to publish to some extent. Second, the finding broadly reflects the Chinese model of KE. Accordingly, whereas there has been a clear positive nexus between IPRs and KE in much of East Asia, China has largely remained the exception to this rule (Chandra & Yokoyama, 2011, p. 46)[6]. Hence, evidence from the IPRs law channel may be reflecting the Chinese paradigm. This side of the findings is in accordance with Andrés & Asongu (2014b) who have shown that, from the education dimension of KE, adoption of tight IPRs regimes may negatively affect human development by diminishing the literacy rate and restricting diffusion of knowledge. Thirdly, consistent with Asongu (2014a) who has also found a positive nexus between the IPRs law channel and software piracy, the negative nexus on publications could result from issues in the enforcement of the IPRs laws by government organs. Hence, investigating this concern could be an interesting future research direction. Accordingly, based on the results, it could be established that a less tight IPRs law channel related to 'scientific publications' (at least in the short-run) may engender the much needed positive correlation. Hence, enable knowledge spillovers imperative for growth and development.

In addition to specific policy implication discussed above, we propose six broad policy measures that could be applied to further boost scientific publications. First, political and socio-economic issues preventing students from pursuing education to the research level should be tackled. Second, governments of sampled countries should provide incentives for research purposes. Third, academic advancement should not be based on political appointments but on objective peer assessments. Fourth, the issue of brain drain should be effectively tackled. Fifth, the culture of academic promotion based on teaching and oral

[6]China's success story in attracting FDI is attributed to its spectacular growth track record; relatively better executive power, good infrastructure, abundant educated labor force and, a large domestic market.

examinations should be evenly complemented with publication-based portfolios[7]. Sixth, as Wantchekon et al. (2014) has shown recently, educational role models have substantial positive externalities.

4. Conclusion

This paper has been an extension of the debate on the nexuses among the strength of IPRs and knowledge economy spillovers by means of scientific publications. It has examined how Africa's share in the contribution to global scientific knowledge can be boosted with existing IPRs mechanisms. The findings which broadly indicate that tight IPRs are incentives to knowledge contribution can be summarized in main two points. First, the enshrinement of IPRs laws in a country's Constitution is a good condition for knowledge economy. Secondly, while Main IP laws, WIPO treaties and Bilateral treaties are positively correlated with scientific publications, IPRs law is negatively correlated with contribution to knowledge. While correlations are not causalities and the study remains expositional, it does however offer interesting insights into the need for IPRs in the promotion of knowledge contribution within sampled countries of the continent.

[7] For example, university lecturers with an extensive teaching experience are more likely to pass the oral examination for promotion in CAMES (African and Malagasy Council for Higher Education).

Appendices

Appendix 1: Summary statistics and presentation of countries

Panel A: Summary Statistics

		Mean	S.D	Min	Max	Obser.
Dependent Variable	Scientific & Technical Journals Articles	2.159	0.583	1.120	3.286	80
IPRs Protection Channels	Constitution	0.100	0.301	0.000	1.000	110
	Main IP Law	1.409	0.921	0.000	3.000	110
	IPRs Law	1.481	2.035	0.000	7.000	110
	WIPO treaties	2.809	0.795	2.000	4.000	110
	Multilateral treaties	9.972	3.209	4.000	17.000	110
	Bilateral treaties	0.354	0.551	0.000	2.000	110
Control Variables	Tertiary Secondary Education	0.992	0.304	0.380	1.486	67
	Software Piracy	0.485	0.222	0.034	0.720	95
	Internet Penetration	2.822	0.809	1.301	4.727	110

Panel B: Presentation of Countries

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

S.D: Standard Deviation. Min: Minimum. Max: Maximum. Obser: Observations. IP: Intellectual Property. IPRs: Intellectual Property Rights. WIPO: World Intellectual Property Organization.

Appendix 2: Correlation analysis

IPRs Protection Channels						Control Variables				
Const.	MIPL	IPRL	WIPO	Multi	Bilat	TSE	Piracy	Internet	STJA	
1.000	0.016	-0.243	-0.187	-0.461	0.115	0.400	0.306	0.123	0.185	Const.
	1.000	0.554	0.019	0.301	0.361	0.403	-0.092	0.599	0.481	MIPL
		1.000	0.301	0.454	0.132	0.002	-0.121	0.289	0.241	IPRL
			1.000	0.242	-0.116	-0.330	0.097	0.310	0.354	WIPO
				1.000	0.217	0.030	-0.407	0.490	0.122	Multi
					1.000	0.274	-0.206	0.411	0.434	Bilat
						1.000	-0.436	0.477	0.249	TSE
							1.000	-0.012	-0.178	Piracy
								1.000	0.696	Internet
									1.000	STJA

Const: Constitution. MIPL: Main Intellectual Property Rights. IPRL: Intellectual Property Rights Law. WIPO: WIPO treaties. Multi: Multilateral treaties. Bilat: Bilateral treaties. TSE: Tertiary School Enrolment. Piracy: Software piracy rate. STJ A: Scientific & Technical Journal Articles.

Appendix 3: Variable definitions

Variables	Signs	Variable definitions	Sources
		Panel A: Dependent Variable	
Scientific Publications	S&T JA	Logarithm of Scientific and Technical Journal Articles	World Bank (ADI)
		Panel B: IPRs Protection Channels	
Constitution	Const.	IP Laws are enshrined in the constitution	WIPO
Main IP law	MIPL	Main Intellectual Property Law	WIPO
IPRs law	IPRL	Intellectual Property Rights Law	WIPO
WIPO treaties	WIPO	World Intellectual Property Organization treaties	WIPO
Multilateral treaties	Multi	Multilateral IP treaties	WIPO
Bilateral treaties	Bilat	Bilateral IP treaties	WIPO
		Panel C: Control Variables	
Tertiary School Enrolment	TSE	Logarithm of Tertiary School Enrolment (% of Gross)	World Bank (ADI)
Software Piracy	Piracy	Logarithm of Software Piracy Rate	World Bank (ADI)
Internet Penetration	Internet	Internet users (per 100 people)	World Bank (ADI)

ADI: African Development Indicators. WIPO: World Intellectual Property Organization. IP: Intellectual Property.

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