Intelligence and Crime: A novel evidence for software piracy

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Intelligence and Crime: A novel evidence for software piracy

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Abstract: The aim of this paper is to test the hypothesis that software piracy rats are lower in more intelligent nations. Thus, we econometrically estimate the effect of national IQ on software piracy rates, using data for 102 nations for the year 2011. Our findings offer strong support for the assertion that intelligence is inversely related to the software piracy rates. After controlling for the potential effect of outlier nations in the sample, software piracy rate declines by about 5.3 percentage points if national IQ increases by 10 points.

Keywords: software piracy; IQ; intelligence; cross-country; institutions; copyright

1. Introduction

From a legal point of view, the intellectual property rights cover three distinct sets of rights: trademark, patents, and copyright (Besen & Raskind, 1991). Copyright refers to types of commodity information/intellectual property goods, having certain features. Information goods have two important public goods characteristics. First, their consumption is inherently non-rival. That is the use that one person makes of a piece of information does not decrease the possibility of use by others. Second, information and intellectual property goods may be non-excludable in the sense that the producer of the intellectual property goods is often unable to exclude non-payers from consuming goods without due authorization (Varian, 1998). Intellectual property law responds to this problem by giving producers certain exclusive rights that exclude non-payers from certain uses of their intellectual property goods. Although, assigning IPRs is not the only way to deal with exclusion (for instance, bundling). IPRs law recognizes that no exclusion would create poor incentives for the creation of IP goods. But at the same time, permanent intellectual property rights would lead to the standard deadweight loss of a monopoly. Thus, an adequate IP system must ensure a fair balance between these two conflicting objectives.

As regards intellectual property protection, one serious concern for copyright holders is piracy; that is, the unauthorized use of copyrighted goods. When a legal copyright exists, those who wish to gain access to the original copyrighted work must pay the copyright holder the access price. If an individual obtains access without paying a price, that person is said to have incurred an act of piracy. Even though piracy occurs for all types of intellectual property and can take many forms depending on the access type and intellectual property mechanism (Watt, 2001), one of the most worrying areas nowadays is certainly the piracy of business software applications. Business software piracy has been related to economic growth (Andrés & Goel, 2012), shadow economy (Goel and Nelson, 2012) scientific output (Asongu, 2014), innovation (Banerjee & Chatterjee, 2010), and industry profits (Gomes et al., 2013). It has been calculated that for each authentic copy distributed there are up to 10 illicit copies downloaded from internet or copied from friends or members of family (Reavis & Rumelt, 1991). According to BSA (2011 p. 1) "[t]he global piracy rate for PC software hovers at 42 percent [and] [t]he commercial value of this shadow market of pirated software climbed ... to $63.4 billion in 2011".

Consequently, investigating the determinants and effects of software piracy has been paramount object of empirical studies over the last decade (see e.g. Andrés. 2006a,b; Goel & Nelson, 2012; Bezmen et al., 2006; Chen et al., 2010; Arai, 2011; Boyce, 2011)[1]. By and large, related studies show that economic development, institutional arrangements, political regimes and cultural proxies are determinants of 'softlifting' behavior on a cross-country level. Our research offers a quite different avenue in understanding the cross-national variations in software piracy rates. We depart from a celebrated article by Lynn & Vanhanen (2002 p. 194) who claim that "national [intelligence levels] are a causal factor responsible for the differences in economic development". Based on conclusions formulated by Lynn & Vanhanen (2002) we conjecture that intelligence may be important antecedent of software piracy through which it has impact on economic growth and innovation. Notably, we presume that there are a number of channels through which intelligence is related to software piracy, the first of which is *economic development*. Related literature reports that economic development is one of the most robust predictors of software piracy rates. Economic wealth, proxied by GDP per capita, is statistically significantly and negatively associated with cross-national piracy rates (e.g., Andrés, 2006b; Andrés & Goel, 2012; Bagchi et al., 2006; Robertson et al., 2008). On the other hand, in their celebrated articles devoted to the understanding of intelligence Lynn & Vanhanen (2002, 2006)

[1]see e.g. Gomes et al. (2015) for an excellent survey on empirical literature which explains software piracy.

suggest national IQ as an explanation for cross nations variations in per-person gross domestic product (GDP) and other country-level economic outcomes. Similarly, Ram (2007), using data for 98 nations, reports that IQ has statistically significant effect on economic growth. As cognitive abilities have positive effect on economic development, we may conjecture that intelligence will be inversely related to software piracy rates. More recently, Meisenberg (2012) p. 103 concludes that "high IQ is associated not only with high per-capita GDP ... but also with more equal income distribution".

Another potential impact of intelligence on software piracy rates is *quality of institutions*. Whereas weak institutions and poor policies lead to greater 'soflifting' (Kovačić, 2007; Andrés, 2006a, there is confirmation that strong and stable institutions, competent enforcement authorities and anxiety of prosecution reduces the likelihood of infringement (Marron & Steel, 2000; Lysonski & Durvasula, 2008). Indeed, Kanyama (2014), using data on 164 nations for the years 2006 - 2010, finds that intelligence has positive impact on quality of institutions. Similarly, Salahodjaev (2015a), using Barro type growth regressions, shows that the effect democracy on economic growth is mediated by intelligence. In particular, intelligence reduces the negative association between democracy and economic growth in weak democratic economies. On the microeconomic level high IQ (educated) individuals have higher levels of political participation (e.g. Milligan et al., 2004). This is especially important because securing intellectual property rights in the digital era demands intellectual skills and competence as involved government authorities need to recognize the perceptions and rules balancing the rights of individual agents and of general users.

We may then conjecture that intelligence has negative effect on software piracy as high IQ individuals are more competent (Luciano et al., 2006; Soto-Calvo et al., 2015). For example, Sub (1996) finds that intelligence is among predictors problem solving competences. Similarly, Rigas et al. (2002) report positive correlations between IQ and problem-solving experiment (r=0.43 for Kühlhaus scenario; r=0.34 for NEWFIRE scenario).

Finally, software piracy is also symbolized by *criminal endeavor*, a behavior that has also been related to intelligence. For instance, Templer & Rushton (2011) report a negative correlation between IQ and different measures of crime (murder, rape, robbery and assault) in the USA. Earlier Rushton & Templer (2009 p. 345) conclude that "[c]ross-national differences in rate of violent crime (murder, rape, and serious assault) were significantly correlated with a country's IQ scores (mean $r =$ .25, such that the higher the IQ, the lower the rate of crime)". Bartels et al. (2010) tested the hypothesis that violent and property crimes rate are lower in states with higher IQ scores using data for the years 2005-2006. They showed that National Assessment of Educational Progress (NAEP) reading and math standardized test scores a proxy for calculating IQ estimates has significant and negative effect on crime rates in the USA. Salahodjaev (2015b) provides evidence on the impact of intelligence on the size of shadow economy. The author applies OLS method and an instrumental variable (IV) 2SLS regression technique. The estimates show that the negative effect of intelligence remains robust when controlled for conventional determinants of an underground economy. In addition, intelligence predicts the likelihood of involvement in criminal activities (Herrnstein & Murray, 1994) instrumental to reduce the software piracy rates.

This article starts from the following hypothesis:

Does any association exist between IQ and software piracy rate at a national level?

2. Data and methods

Dependent variable

The data on software piracy rate is obtained from BSA (2012). It measures the percentage of software that is being used illegally, without the purchase of a license. This variable ranges from 0 % (no piracy) to 100 % (i.e. all software installed is pirated). The BSA measures the piracy of commercial software. These estimates are one of the most reliable ones and have been used largely in empirical papers (for instance Andrés, 2006a,b; Andrés & Goel, 2012; Goel & Nelson, 2012; Gomes et al., 2013a; Banerjee et al., 2005; and Andrés & Asongu, 2013)[2]. In the current paper, we focus on end-user piracy where consumers will use the software at home, and software is not sold to the others (commercial piracy).The underlying method for estimating the piracy rate and commercial value of unlicensed software in a nation is as follows: the amount of PC software distributed subtracted from the amount of software legally obtained. Once the amount of unlicensed software is known, the PC software piracy rate is estimated as a share of total software installed for 108 nations.

Independent variable

The key independent variable is average national intelligence, measured by national IQ scores. We draw the cross-national dataset on national IQs from Lynn & Vanhanen (2012). The authors update a previous edition of national IQ data by Lynn & Vanhanen (2002). Their latest dataset contains intelligence quotient scores for 190 counties and has been extensively used in related literature over the past decade (Lynn, 2012; Daniele, 2013; Salahodjaev & Azam, 2015;

[2] See Traphagan and Griffith (1998) and Png (2010) for a discussion on the reliability of piracy data.

Obydenkova & Salahodjaev, 2016; Salahodjaev, 2016). Hereafter, after elimination potentially missing observations for the piracy rate, IQ scores extend from 64 in Cameroon to 107.1 in Singapore.

Control variables

First we control for GDP per capita. Cross-national studies report that software piracy rates are inversely related to the level of economic development (Andrés, 2006b; Bagchi et al., 2017; Kigerl, 2013).

Related studies document that nations with lower economic opportunities and more inequality are associated with greater levels of software infringement (Andres, 2006a; Chen et al., 2010). We use index of economic freedom (EFI) from Heritage Foundation as a proxy for economic freedom and opportunity. The EFI covers 10 freedoms - from property rights to entrepreneurship in majority nations of the world. Furthermore, software piracy rates are lower in nations with British civil law. Indeed, nations with British common law recognize the significance of intellectual property rights. Thus, we use binary variable for nations with British common law.

To investigate the impact of political regimes on software piracy rate we use democratic index from Freedom House. The democracy index is estimated as the average of civil liberties and political rights. Finally, to investigate the role of corruption in software piracy we use Corruption perceptions index (CPI) from Transparency International. Table 1 presents descriptive statistics.

Methodology

Based on this work and the discussions above, the software piracy rate is estimated by the following econometric model:

$$SP_i = \alpha + \beta IQ_i + X'\lambda + \varepsilon_i$$

where*SP* is the software piracy rate in country *i* in 2011, *IQ* is the measure of intelligence, *X* is the vector of control variables, and *ε* is a random error term. Summary statistics and the correlation matrix are presented in Tables 1 and 2 accordingly.

Table 1.

Summary statistics

Variable	**Description**	**Mean**	**Std. Dev.**
Piracy	Software piracy rate (%)	58.92	21.52
IQ	Nation IQ score	84.10	10.85
Economic Development	GDP per capita, PPP '000 $	10.65	15.82
EFI	Economic Freedom Index	59.75	11.78
British civil law	Dichotomous variable for countries with British civil law	0.34	0.47
Democracy	Average of civil rights and political liberties	3.67	1.97
CPI	Corruption Perceptions Index	4.02	2.10

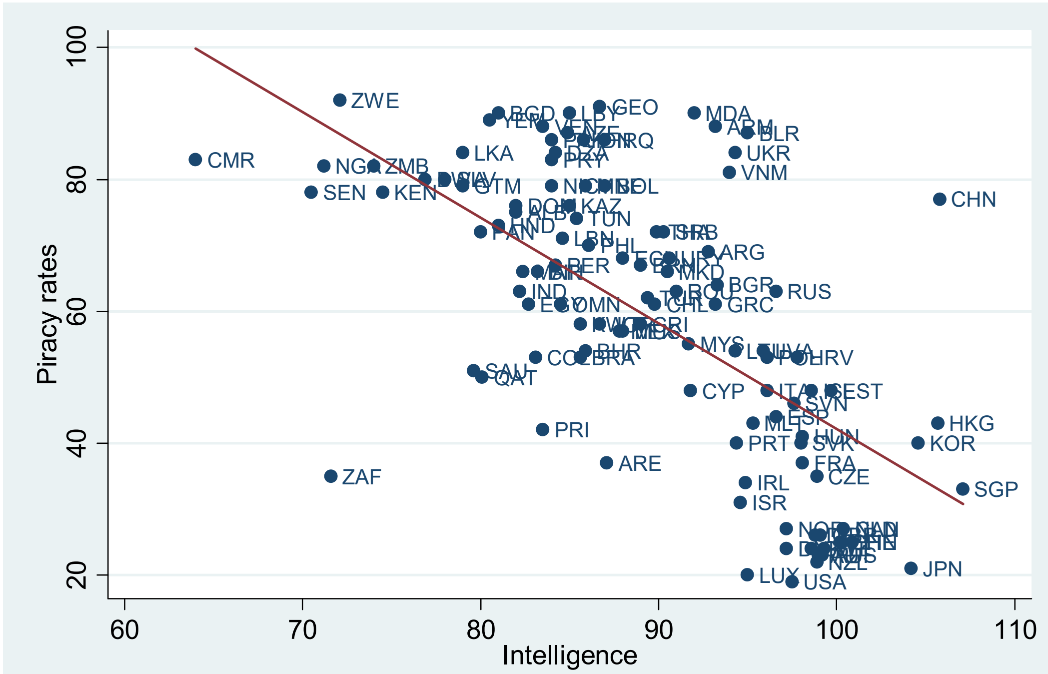

Figure 1.Intelligence and piracy

Source: Lynn &Vanhanen (2012); BSA (2012)

Table 2.

Correlation matrix

	I	II	III	IV	V	VI
Piracy	1.0000					
Intelligence	-0.6566	1.0000				
Economic development	-0.7813	0.5383	1.0000			
EFI	-0.7305	0.4955	0.5729	1.0000		
British civil law	-0.1094	-0.1694	0.0106	0.1283	1.0000	
Democracy	-0.6346	0.5092	0.4552	0.5521	-0.0807	1.0000
CPI	-0.8604	0.6299	0.8269	0.7715	0.1406	0.5931

3. Main results

The main econometric results are presented in Table 3. All estimations were conducted by using STATA. The fit of all the estimated equations is decent, as shown by the correspondingstatistics in Table 3. R^2 is better than or equal to 0.75 in all regression models.Column 1 displays the coefficients from estimating equation (1), where only GDP per capita is added as independent variable. As conjectured, both intelligence and economic development are significantly and negatively linked to software piracy rates. Piracy is lower in more prosperous nations. Consumers might view pirated software as an inferior good.This finding is consisted with other cross sectional studies (Banerjee et al., 2005; Goel and Nelson, 2012; Andrés and Goel, 2012). A 10 points increase in IQ is associated with an 7.9 percentage point reduction in software piracy, while a one standard deviation increase in economic development reduces software piracy by 11.83 percentage points (approximately half of a standard deviation).

In column 2, legal antecedents of software piracy are incorporated into regression. The first of these institutional proxies is EFI, while the remaining two are democracy index and a dichotomous variable for British civil law nations. The estimates show that these three variables are statistically significant, demonstrating a negative association with software piracy. Intelligence is negative and statistically significant at the 1% level.

Finally, in column 3,we add the corruption perceptions index (CPI). In corrupt countries bureaucrat may act in a deceptive way and involve in bribery with infringing economic agents. Indeed, related literature supplies evidencethatnations with rampant levels of bribery encounter problems in tracking and punishing piracy (Robertson et al., 2008). Our estimates show that software piracy is higher in more corrupt nations or piracy increases with corruption. This implies that pirates perceive the presence of corruption to lower the expected costs of punishment, while at the same time increasing its potential returns.. These results are in line with previous empirical studies (Banerjee et al., 2005; Andrés and Goel, 2011). Intelligence preserves its negative association, albeit at a 5% level of statistical significance. Thus, the estimates in Table 3 suggest that intelligence is significantly linked to software piracy at the cross-national sample.

Table 3.

IQ and software piracy rates: OLS regressions

	(1)	(2)	(3)
IQ	-0.7905***	-0.5574***	-0.4495**
	(0.2180)	(0.1701)	(0.1862)
Economic development	-0.7481***	-0.5208***	-0.3602***
	(0.1049)	(0.0752)	(0.1031)
EFI		-0.5236***	-0.3443**
		(0.1369)	(0.1386)
Democracy		-2.3708***	-2.0162**
		(0.8076)	(0.7774)
British civil law		-6.4710**	-4.7166*
		(2.7382)	(2.6401)
CPI			-2.5441**
			(1.1709)

Constant	140.8315***	161.0631***	147.6109***
	(18.4680)	(14.6373)	(15.7226)
N	107	102	102
adj. R^2	0.6734	0.7920	0.8007

Note: Clustered standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01

4. Robustness tests

First the reader may argue that OLS regression does not sufficiently address the endogeneity of intelligence to software piracy, and therefore, does not definitely determine a causal effect. To control for potential endogeneity and a simultaneity that may be also caused by unobserved variable correlated with IQ and software piracy, we estimate our econometric model using two-stage least squares (2SLS) regression, where intelligence is taken to be endogenous. In line with related studies, we use per capita energy consumption and continental dummies - which are highly correlated with national IQ scores, and use these instruments to explore the impact of intelligence on software piracy. Empirical studies show that these instruments are correlated with IQ but not with the errors of regression (Salahodjaev, 2015b; Kanyama, 2014). The results reported in Table 4 suggest that intelligence is negatively linked with software piracy even when we address the endogeneity problem. A 10 points increase in instrumented intelligence is now associated with 6.2 point percentage point reduction in software piracy.

The adjusted R-squared, an indicator that quantifies how well a model fits the data, - goodness-of-fit for the IV analysis from the first stage regression indicates that the instruments explain nearly 72% of the variation in IQ. Moreover, our instruments are statistically significant at the conventional levels. For example, a one standard deviation increase in per person energy consumption is associated with approximately 2.7point increase in IQ. The usefulness of the instruments is also supported by the first stage "F value" (F=22.90; p=.00)[3].

On the other hand, outlier and influential data points can have a substantial influence on estimates and inferences from cross-national data (Rodrik, 2012). Indeed, in the mean regression approach the effect of outlier on the estimate rises with the square of its size. For example, Swartz and Welsch (1986, p. 171) note: "OLS and many other commonly used maximum likelihood techniques have an unbounded influence function; any small subset of the [extreme] data can have an arbitrarily large [effect] on their coefficient estimates.". To address this limitation of OLS regression we use robust regression (RR). RR starts by fitting the model, estimating Cook's D and removing any data points for which D>1. Thenceforth RR runs iteratively: it fits a regression, estimates case weights from absolute error terms, and re-estimates the model again using those weights. These iterations end when maximum adjustment in weights falls below tolerance.

The estimates reported in Column 2 suggest that intelligence is negative and statistically significant at the 1% level. The numerical interpretation is that software piracy rate declines by about 5.3 percentage points if national IQ increases by 10 points.

Finally, we tested the robustness of our results to the inclusion of additional control variables.Illegal copying might respond to legal tendencies towards or against protected IPRs. Previous empirical literature suggests that stronger IPRs protection reduces the rates of software piracy (Andrés, 2006b). Indeed, the degree of economic development might be also correlated with judicial and policing maturity, and it is possible to interpret it as a proxy variable for property rights enforcement. For that purpose, we include the IPR enforcement index (IPR)

[3] Available from authors upon request

collected by the World Economic Forum (WEF) as a measure of the general strength of IPRs protection across countries.This index is built based on answers from local professionals and is bi-annually published in the WEF annual Global Competitiveness Report. Furthermore, this index captures the enforcement component of IPR protection which reacts the current law perspectives and practices on its protection. The survey asked whether, if intellectual property protection in your country is: (1=weak or non-existent, 7=equal to the world's most stringent). Higher values of the index indicate higher levels of IPRs protection. Responses from the experts are tabulated and averaged for each country in question. In addition to this, following Goel and Nelson (2012), we also control fora measure of punishment, the effectiveness (impartiality) of courts (Courts). This cross-country index is expected to capture the potential punishments (costs) for piracy – impartial courts lowers piracy by prosecuting more pirates and dissuading potential pirates.

The results in Column 3 indicate that intelligence remains statistically significant although at a 5% level, and has direct effect on piracy rates even after controlling for a wide specter of institutional antecedents of software piracy. Turning to additional control variables, we find that the results in line with our predictions. In addition, we also document that stronger IPR protection has negative impact on software piracy rates, as one would expect (Andrés, 2006b).

Table 4

IQ and software piracy rates: robustness test

	(1)	(2)	(3)
	IV 2SLS	RREG	RREG
IQ	-0.6192**	-0.5318***	-0.3571**
	(0.2555)	(0.1504)	(0.1575)

Economic development	-0.3661***	-0.3240***	-0.2691***
	(0.1027)	(0.0985)	(0.0957)
EFI	-0.3685**	-0.3388**	-0.2005
	(0.1640)	(0.1488)	(0.1545)
Democracy	-1.6614*	-1.7942***	-0.7305
	(0.9748)	(0.6816)	(0.7184)
British civil law	-5.8598*	-3.1040	-5.4095**
	(3.0221)	(2.4605)	(2.4543)
CPI	-2.2967*	-2.9002***	-4.5367***
	(1.1796)	(1.0980)	(1.2711)
Courts			5.5995***
			(1.5542)
IPR index			-4.8070***
			(1.4436)
Constant	161.9489***	154.4766***	134.3495***
	(20.6562)	(13.6451)	(14.7994)
N	98	102	96
adj. R^2	0.7994	0.8121	0.8223

Note: Standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01

5. Conclusion

In this article we utilize cross-national statistics on the software piracy rate, to offer a novel estimate of the association between intelligence, proxied by national IQ scores, and 'softlifting'. We find that intelligence has statistically significant negative impact on piracy rates. We also conclude that the estimates remain robust when we address potential endogeneity of IQ and for the existence of outlier countries in the sample.

On the other hand, it is crucial to highlight that albeit our findings suggest that more intelligent societies are inversely associated with the software piracy rates, this should not be taken as universal evidence that society with higher intelligent quotient is a requirement to alleviate software piracy. Our findings indicate that if ruling elite enforces policies to decrease software piracy, intelligence provides a credible proxy of the degree of consent of such policies. Indeed, agents with higher cognitive abilities are more politically active.

Our estimates extend the findings of Salahodjaev (2015b), Potrafke (2012) and Kanyama (2014), who show that intelligence predicts rent-seeking behavior, corruption and quality of institutions.

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