Determinants of the existence of unauthorized copies. A dynamic analysis with panel data*

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Abstract:*The present paper focuses on the study of the economics of copying, a subdiscipline of copyright economics, with the aim of analysing two of the most decisive factors of piracy: GDP per capita and the protection level of the IPR. There are two innovative features in the analysis: first, the study sample of 105 countries for the period 2006-2013; secondly, the econometric strategy, which will apply dynamic panel data techniques. According to the estimations, the software piracy rate depends positively on the percentage of piracy in the previous period; at the same time, software piracy presents a link in an inverted U shape respect to GDP per capita and the protection of IPR. These results represent an advance in the design of effective policies with regard to copyright; these policies should not be uniform for all countries.*

Keywords: *Economics of copying; Copyright economics; Unauthorized copy; Piracy; Dynamic panel data.*

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1. INTRODUCTION

The main concern of copyright regimes is that this category of intellectual property rights (IPR) complies with the function underpinning its existence, encouragement of creativity and, consequently, the greater social welfare.

Economic analysis has been used as an instrument to study copyright: first, copyright justification emerges of the neoclassical conception of intellectual goods as non rival and partially excludable goods (WIPO, 2003); on the other hand, economic doctrine conceives intellectual goods as an externality which must be internalized (Márquez Escobar, 2005). In this regard, since Arnold Plant (1934) developed a systematic analysis of copyright leads us to speak about a new discipline in economic analysis: copyright economics (Landes and Posner, 1989; Liebowitz, and Margolis 2005; Posner, 2005; Varian, 2005; Watt, 2011).

One of the main features of copyright economics is the coexistence of several economic approaches, in this paper we focus on the approach that applies economic instruments to the analysis and design of efficient copyright regimes from a social welfare point of view.

In the context of the knowledge society, the development of technology and Internet questions the effectiveness of copyright regimes to such an extent that unauthorised copying (or piracy) has become the main challenge of copyright policy. Although unauthorised copying is not a new issue, in the context of the digital era piracy is gaining strength; the formal modelling of the coexistence of original works together with copy works and its implications builds the economics of copying.

The study of the factors which impact on the existence of piracy is one of the main topics of this discipline as well as one of the most studied. Why does the piracy exist? Why does the level of piracy vary between countries? According to existing studies the level of piracy depends on multiple elements, such as wealth, education, culture, regulation, etc. However, the results of these studies are not concise.

The present paper focuses on the study of the economics of copying with the aim of analysing two of the most decisive factors of piracy: GDP per capita and the protection level of the IPR.

In line with the goal pursued, the present work is structured as follows. In section 2 the Economics of copying and its evolution throughout time will be presented. In section 3 we focus on the determinants of piracy through compiling the main studies. In section 4 an econometric analysis will be developed in order to determine the impact of GDP per capita and the level of intellectual protection over the level of piracy. There are two innovative features in the analysis. First, the study sample, which is 105 countries for the period between 2006 and 2013; secondly, the econometric strategy which applies dynamic panel data techniques. The analysis will be carried out with the data from OECD, World Economic Forum and Business Software Alliance. Finally, in section 5, a series of considerations will be made by way of a summary.

According to the estimations, the empirical results indicate that the software piracy rate depends positively on the percentage of piracy in the previous period; at the same time, software piracy presents a link in an inverted U shape respect to GDP per capita and the protection of IPR.

These results represent an advance in the design of effective policies with regard to IPR, specifically to copyright; these policies should not be uniform for all countries and should be designeddepending on the level of protection of IPR and the GDP per capita of each country.

2. THEORICAL BACKGROUND

Landes and Posner (1989) differentiated between copyright economics and Economics of copying. In this respect, "*the economics of copying deals with impacts on the economy that derive from technical means of reproduction, while the economics of copyright focuses on impacts of the legal framework. The two are related because if it is demonstrated that there is a loss of welfare (for either consumer or producer), that would make the case for some intervention in the market, such as copyright law. However, if the producer can obtain his profit without copyright protection, then copyright law would just distort the market.*", (Towse *et al*, 2008: 9).

There is a close connection between Economics of copying and technology; technology has impacted on the existence and challenges that this area of copyright economics has faced over time: first, the birth of the photocopier; videos and VCR reproduction technology from 70s until 80s; the next important progress was digitalization, which turnedcopies into a close substitute of the original work. The present challenge come from file sharing (P2P) and mp3, technologies that allow quick downloading of copyrighted works from the Internet.

These events have defined the development of the economic analysis of the copy, which are synthesized in the table 1.

But, which are the effects of the copy over the sales of the original works? This discipline, associated to copyright economics, has always tried to answer this question concisely. The following point offers an outline of these answers through the empirical evidence.

Table 1.Evolution of the economic analysis of the copy

Novos and Waldman (1984)	Copy work generates underproduction and underuse, consequently the copy involves a loss of social welfare.
Johnson (1985)	Technological changes encourage the reproduction.
Liebowitz (1985)	Indirect appropriation.
Besen (1986)	Copy work generates different results: a) If the price of the original work is greater than the cost of copy, consumers will copy; in this context producers can up the price of the original works and consequently they will take advantage of the indirect appropriation. b) If the price of the original work is only slightly greater than the cost of copy, producers will down the price of the original work and, so, will compete with the copy work.
Takeyama (1994)	He applies the indirect appropriation theory for network externalities. If there are network externalities, the not authorized copy can increase social welfare.
Varian (2000)	He applies the indirect appropriation theory for the P2P file sharing. There are three situations where the producer's benefits are increased: a) If transaction costs < marginal costs b) If there is a limited number of uses c) If the preferences are heterogeneous
Varian (2005)	Effects of the price fixing of a monopolist when there is a copyist.
Johnson and Waldman (2005)	When the market is flooded of copies, the price is reduced until it is equal to the cost of copy; this is not profitable for creators.

Source: Author's own based on Towse *et al* (2011)

3. EMPIRICAL EVIDENCE

One of the challenges of copyright regimes is that these instruments must coexist with unauthorised copies of the products which them protect, namely piracy. The attempt to get a formal modelling for the economics of copying is not a trivial issue, it is the area of copyright economics which has worked harder than another one.

Dias Gomes (2014) collects three typologies of models which study the economics of copying:

a) Diffusion models:

These models were analysed by Bass (1969), these describe the process of how new products are adopted by the interaction between consumers and potential consumers; with this aim the behaviour of the agents who innovate and copy are modelled. Even though this model has been extended, at its core it tries to predict the potential sales of copyrighted goods or the potential piracy of these goods.

Between the main results obtained by this category of models we can highlight the following: the impact of piracy on the legal sales (positive effect); how piracy is developed on the time; and how the price of a product can be optimized in order to get high profits.

b) Network externalities

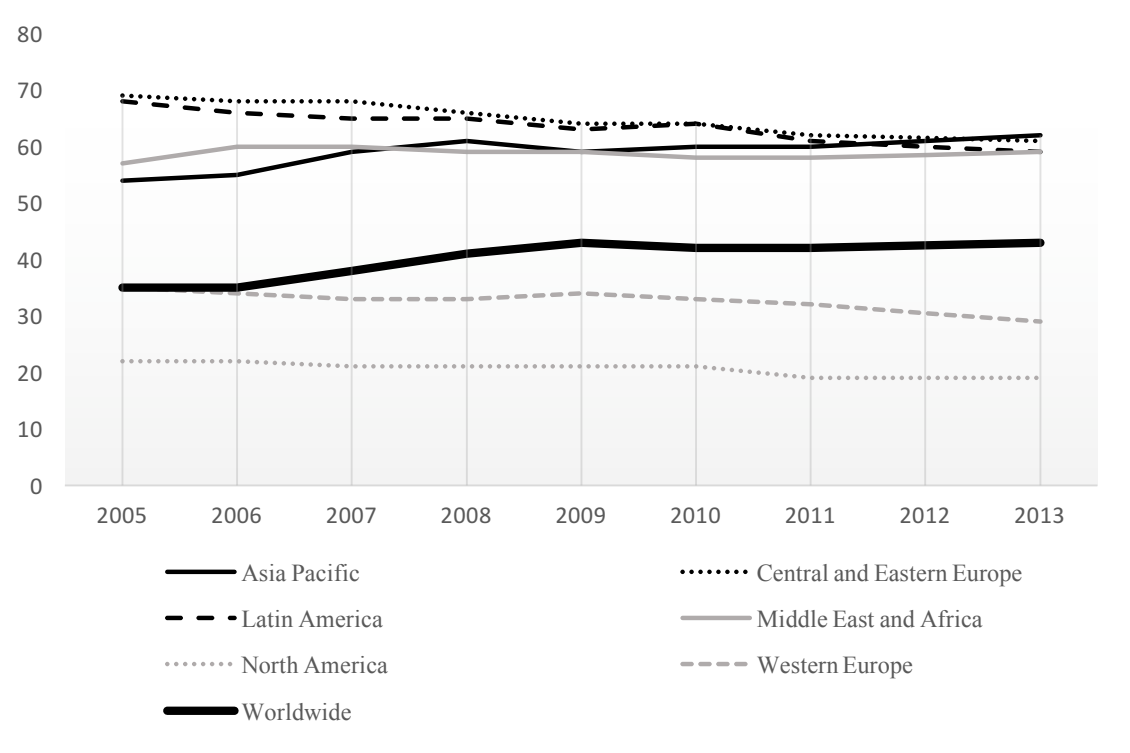
These models analyse to what extent piracy is beneficial when network externalities exist. One of the conclusions that can be drawn from this typology of models is that when network externalities exist, the piracy is beneficial if the products affected are for private use; however, if a trade interest exists piracy will not be efficient, even if there are network externalities.

c) Game theory models

These models study which protection level is the best for a specific good (protected by copyright) when piracy exists.

Once the three typologies of models of the economics of copying have been examined, it is necessary, first, to analyse which factors determine the existence of unauthorised copies. Graph 1 reflects the software piracy rates by region, these have been built by the trade association namely Business Software Alliance[1] (we denote by BSA). Why is piracy greater in one country than another? Which are the determining factors? Current literature which answers these questions is extensive; the study of the piracy has been focused on the software industry in the past two decades.

Graph 1. Software piracy rates by region



Source: Author's own based on BSA

[1] It is a non-profit trade association in the software market. Its statistics are used, at international scope, as an instrument to gauge the piracy in the software industry, especially, and also in the copyright industry in general. The piracy rate is calculated as the quotient between software unauthorised copies and the total of installed software.

Husted (2000) develops a cross section analysis in order to study the main determinants of software piracy. The author uses a sample of 39 countries and data from the year 1996. Of all the variables which were included in the model, the significant variables are the following: GDP per capita, GINI index and the level of individualism[2] in a country. All these variables have a negative relation to the software piracy rate, so the countries with higher per capita wealth, higher inequality wealth and higher individualism levels are those which have lower piracy rates.

Rodríguez Andrés (2006) searches for the determinants software piracy levels in existing copyright regulation. In this respect, does higher copyright protection imply lower piracy in a country? In order to answer this question, he applied panel data techniques (this is the first study to do so in the field of piracy) for 23 European countries during the years 1994, 1997 and 2000. Another of the added values of this study is the construction of a software protection index.This index gauges the membership to international treaties which are related to copyright law and the implementation of its rules. The main results of this study are: (1) the existence of a negative link between the level of software protection and piracy; (2) the relationship between piracy and GDP growth has an inverse U-shape. In conclusion, it seems when the more protected the software, the more the increase of the piracy rate.

Continuing the analysis of piracy in the software industry, Dias Gomes *et al* (2013, 2014) focus on the economics, labour, technology, education and cultural factors with the aim of explaining software piracy. In their 2013 work, the authors apply dynamic panel data techniques to examine the factors which contribute to the economic losses caused by software piracy. The scope of the study is international and the timespan ranges from 1994 to 2000. Results show the following links:

- Education. Government spending is positively related to the economic losses generated by software piracy, while there is a negative relationship between software piracy and the number of years of education.
- Technology. While the number of patents has a positive link with the losses caused by piracy, the number of trademarks has an inverse relationship with the dependent variable.
- Labour market. Youth unemployment and a more skilled labour force increases the losses induced by piracy, while employment in the service sector has an inverse effect.
- Innovation. R & D spending in an economy reduces the losses by software piracy.

Later, Dias Gomes *et al* (2014) collect the studies which analyse the determinants of piracy in the software industry. Results are synthesized in the table 2.

[2]Hofstede (1997) identifies the individualism with the society where the ties between people are weak or broken.

Table 2.Determinant factors of the software piracy

DIMENSION	VARIABLES	LINK
Economic	GDP per capita	Negative
	GINI index	Negative
	HDI (Human Development Index)[3]	Positive
Cultural	Individualism	Negative
	Masculinity	Negative
	Distance of power[4]	Positive
Education	Educative level (education spending, compulsory education duration, schooling rate)	Negative
Legal	Rule of Law[5]	Undetermined
	Software protection level (international treaties, law enforcement)	Negative

Source: Author's own based on Dias Gomes *et al* (2014)

A study which concludes with important results, in the context of the economics of copying, was developed by Montoro and Cuadrado (2008). In this case the scope of the analysis is not the software industry, but the music industry. These authors contrasted the following hypothesis: the legal origin of the different copyright regimes predetermines the level of piracy. With this aim, the demand of original products in the music industry was examined during 1999-2005. Copyright regimes are classified into two main families, the Common Law countries[6] and the Civil Law countries[7].

According to their empirical results, the differences between copyright regimes explain the level of piracy; specifically, major effectiveness in copyright protection is reached in Common Law countries. Another relevant result reached by the cited study is that the

[3] Index built by the United Nations Development Programme (UNDP) which gauges the level of development of a society through three parameters: health, education and wealth.

[4]Hofstede (1997) defines it as the level which the less powerful member of a society hopes the existence of differences in the power levels. The higher the value of this variable, the biggest the expectations about some people will have much more of power than others; while when a low level of power distance exists, people will have the expectations about people must have the same rights.

[5] Built by the World Justice Project, it is a variable which reflects the rule of law based on eight pillars: limitation in the government power, lack of corruption, open government, fundamental rights, order and security, regulatory compliance, civil justice and penal justice.

[6]England, Wales, Ireland and a great portion of the old colonies of the United Kingdom, including the U.S.A., Australia, New Zeeland and Canada (with the exception of Quebec).

[7]France, Germany and Nordic countries.

economic growth of an economy leads to a rise in the demand of original products in a more than proportional way; this last result opens the hypothesis about the piracy is an inferior good.

As stated above, one of the challenges of the economics of copying is the examination of the effects that unauthorised copies have on the sales of original products. Vazquez and Watt (2011) tried to solve this challenge through the analysis of the piracy (at large) by applying prey-predator behaviour[8]. Original products are the prey while pirate versions of these products are the predator. On this basis, original products not will be removed by copies but activities of creators will be diminishing, so the growth of pirate copies reduces original products.

Novos and Waldman (2013) developed a brief survey of the main studies which have contributed to the development of the economics of copying. We can highlight that the existence of unauthorised copies leads to major protection of copyright regimes. These can be justified by the underproduction – underconsumption balance[9] which the regulation of copyright regimes must face. The technological development, as stated above, improves the access of consumers to copyrighted products, it means that the losses derived of underconsumption will decrease and the losses generated by underproduction will increase. With the aim of achieving balance, regulation acts in an opposite direction, so in the end balance will be reached but with major protection. This process would develop in a vicious circle form (technology development – copyright protection), and, consequently, it would question the effectiveness of anti-piracy laws.
The versatility and variety of studied models leads to results which are neither homogeneous nor concise. As a whole, some features of the cited models will be presented down below (Watt, 2011):

- Copying generates negative and positive effects on social welfare.
- The problem of the copying models is that there are close substitutes regarding to the original work.
- Most of the models study the options of the owner of the potentially copied product.
- Low credibility of piracy data generated by these models.

This last factor can be explained by the difficulty for gauging the effects generated by a copy. To some extent, copy contributes, in a positive form, to produce free publicity. But we must remember it is irrelevant in a Lockean society[10]. Really, negative effects

[8]This model was proposed in the form of independent equations by Alfred J. Lotka and Vito Volterra in 1925 and 1926 respectively; the philosophy of the model is based on the next affirmation: in an initial and given population, predators deplete the prey population until this population is so small that it is insufficient to predators been fed; consequently (since the prey is the food of predators) predators population will also be reduced. In this context, prey population is safe and then it will start to increase; this last situation will lead to a new increment in the predator population and, as time goes on, a cycle of increases and decreases interrelated populations of the two species will be observed.

[9] As stated in the table 1, Novos and Waldman (1984) identified losses in the level of welfare which were generated by two different ways: while the existence of copies leaded to a underproduction situation, the existence of copyright laws prevented consumers could access to products which price was equal to marginal cost, leading to a underconsumption situation.

[10] John Locke's theory (1689) defines the intellectual property as a natural right, it means that the factor which gives the property to a subject over an element is the linked work to this element, whether that element be material or not.

are the most notable; proof of this statement is the presumption that the cost of a unit of pirated product is equal to the loss of the sale of a unit of original product, but this is not correct because original and unlawful copy are not always perfect substitute products (Watt, 2009).

The predominance of negative effects before positive effects can be explained by the existence of lobbying organisations led by owner's guilds; this is worrying because these results form the basis for a lot of proposed changes in copyright regulation.

4. EMPIRICAL ANALYSIS

In order to gauge the impact that GDP per capita and the protection of IPR have on the level of piracy, we use an econometric analysis based on panel data methods. The sequence is the followings: first we show the variables used by our study, then the methodology is described and, finally, we present the main results.

4.1. Data

Our dataset includes 105 countries during 2006-2014.It is worth mentioning that our study is the first to use a large sample of countries.

We use three variables: BSA, GDPpc and IPP. Table 3 provides a statistical description of the variables.

- BSA: The proportion of pirated software, published by the BSA (Business Software Alliance) each year.
- IPP: The level of IPR protection. This indicator is a part of the Global Competitiveness Index (GCI), developed by the World Economic Forum. It ranges from 1 to 7, where the highest score is evidence of a strongly enforced protection.
- GDPpc: Gross domestic product per capita, drawn from the World Bank's World Development Indicators.

Table 3. Study variables. Statistical description

Variable	Obs	Mean	Std. Dev.	Min	Max
BSA	729	59.63512	21.28202	18	95
IPP	814	3.955857	1.186011	1.639485	6.479026
GDP_PC	840	19099.18	21638.73	327.1991	113731.7

4.2. Methodology

Another of the contributions of this study is the methodology. The linear regression model proposed:

$$lnBSA_{it} = \alpha_i + \beta_1 lnIPP_t + \beta_2 (lnIPP)_t^2 + \beta_3 lnGDP\_PC_t + \beta_4 (lnGDP_{PC})_t^2 + \varepsilon_{it} \quad (1)$$

Where we use the natural logarithm of BSA, IPP and GDPpc for country *i* during year *t.* Parameter α_i reflects the specific individual effects, whilst ε it is the error term.

The present analysis is characterised by exploring the level of impact that GDPpc and IPP have on software piracy. These are the variables that,according to previous studies, are the most influential. However, there are more factors which affecta country's piracy level, namely education, innovation or cultural factors. Additionally, if we consider the fact that piracy can influence the IPR protection (IPP), the proposed model could suffer from endogeneity problems.

Because of the difficulty finding proxy variables, in order to solve the endogeneity problem, model 1 will be estimated by GMM or Generalized Method of Moments; this means that we will apply lags as instruments of the endogenous variable (lnIPP and $lnIPP^2$ in our case). Consequently, the proposed model is the following:

$$lnBSA_{it} = \alpha_i + \beta_1 lnBSA_{t-1} + \beta_2 lnIPP_{t-1} + \beta_3 (lnIPP)_{t-1}^2 + \beta_4 lnGDP\_PC_t + \beta_5 (lnGDP_{PC})_t^2 + \varepsilon_{it} \quad (2)$$

By applying model 2 we can contrast if the effect of IPR protection on the piracy level is ex post or immediate.

The sequence of the analysis is divided into three phases: first we estimate model 1 using static techniques and afterwards, GMM will be applied in order to estimate model 2; lastly, we analyse staticic or dynamic estimation. In detail, our procedure is:

1. Estimation through static panel data techniques (model 1). There are five stages:
    a. First, we apply Ordinary Least Squares (OLS) to a pool of data composed of our sample countries and their observations.
    b. In the second stage, panel data analysis stars by estimating parameters under the fixed effects model (FE) and random effects model (RE).
    c. Evaluation of data pooled estimates (OLS) vs. panel data (FE and /or RE).
    d. The fourth stage evaluates the suitability of the panel data models using the Hausman test.
    e. The final stage gauges the resulting estimations selected by analysing heteroskedasticity, autocorrelation, and contemporary correlation, where necessary.

2. GMM estimation (model 2). We implement our estimation in three stages:

a. Estimator selection

We use the Roodman's estimator (2006), namely xtabond[11]. This estimator uses equations with level and difference variables with the aim of instrumentalizing endogenous variables. This procedure is known as System GMM.

There are two reasons that explain our choice. First, we use panel data on arelatively short length of time (from 2006 to 2013), which means that we can reject other estimators, such as Arellano and Bond's (2001). On the other hand, regarding estimators such as Arellano and Bover's (1995), xtabond2 offers more advantages such as the possibility of excluding the lag of dependent variables as regressors. This last observation becomes even more significant for our case. It is necessary to study the possibility of including the lag of EAP and CPI, or not, in the model.

Figure 1. System GMM equations

$$Y_{it} = \alpha Y_{i,t-1} + \beta X'_{it} + \varepsilon_{it}$$
$$\varepsilon_{it} = \mu_i + \vartheta_{it}$$
$$E(u_i) = E(\vartheta_{it}) = E(\mu_i \vartheta_{it}) = 0$$

Where:

Y_{it}, dependent variable for the person *i* during year *t*

X_{it}, independent variable for the person *i* during year *t*

Where the error term ε_{it} has got two orthogonal components

$$\mu_i = fixed\ effect$$
$$\vartheta_{it} = indiosyncratic\ shocks$$

b. Estimation mechanism

It is necessary to differentiate between the One Step and Two Step mechanisms. While the former is used for estimating the matrix of homoscedastic weights, the Two Step mechanism uses the heteroscedastic covariance matrix; consequently, we will apply the Two Step procedure.

c. Analysis of the quality of the estimated model selected

Once the model has been estimated by xtabond2, the most correct estimator, from an econometric point of view, will depend on the presence of heteroskedasticity and autocorrelation problems.

- Heteroskedasticity. This is a common problem of dynamic models. In order to avoid it, we must order STATA to implement the vce(robust) command.
- Autocorrelation. Arellano and Bond's test, whose null hypothesis is the absence of autocorrelation, will be executed. We will apply the following range: $z(Ar(2)) > 0{,}05$[12].

[11] It is not a Stata command, but it is a Roodman's extension (2006).

[12] Because the existence of first-rate correlation is likely, if we estimate the model by applying x_{t-1}regressor, it would be skewed. Thus, the estimator uses x_{t-1} lags like instruments. Henceforth, if second-rate correlation does not exist, the first lag like instrument (x_{t-2}) would be appropriate.

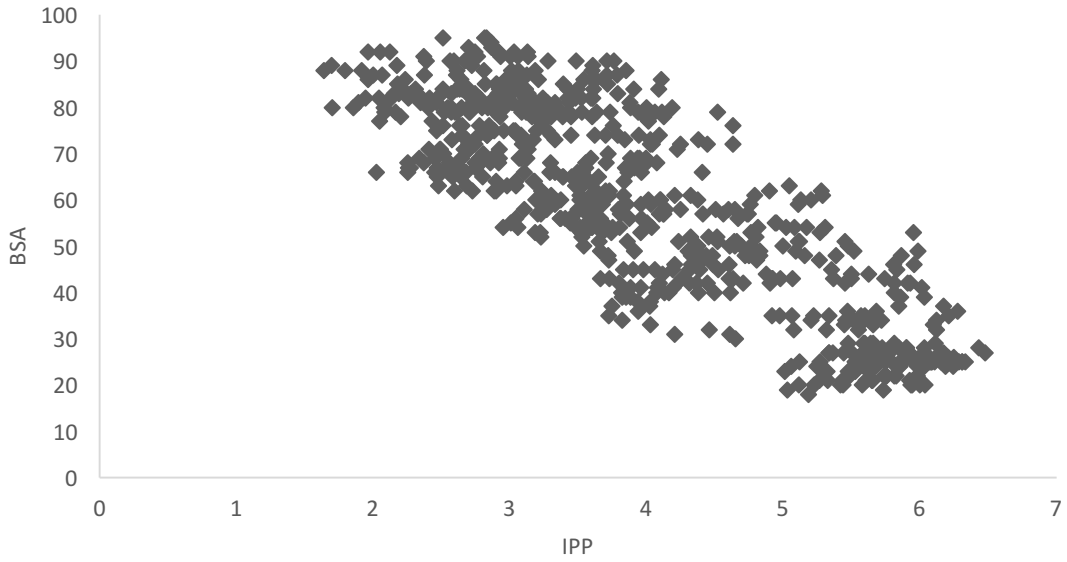
3. Static vs. dynamic estimation. A model must be valued by dynamic estimation if it meets the following requirements:
    a. Hansen's test. This test evaluates the instruments and sheds light on the presence of endogeneity. In this context, if the null hypothesis is accepted the model has an endogeneity problem. Consequently, the model must be estimated by applying dynamic estimation. Specifically, the following range will be considered: $0{,}1 \leq X^2 \leq 0{,}8$[13].
    d. Number of instruments < Number of groups.

4.3. Results

Before showing our estimation's results, it is necessary to study the link between the variables through the following dispersion graphs (graphs 2 and 3).

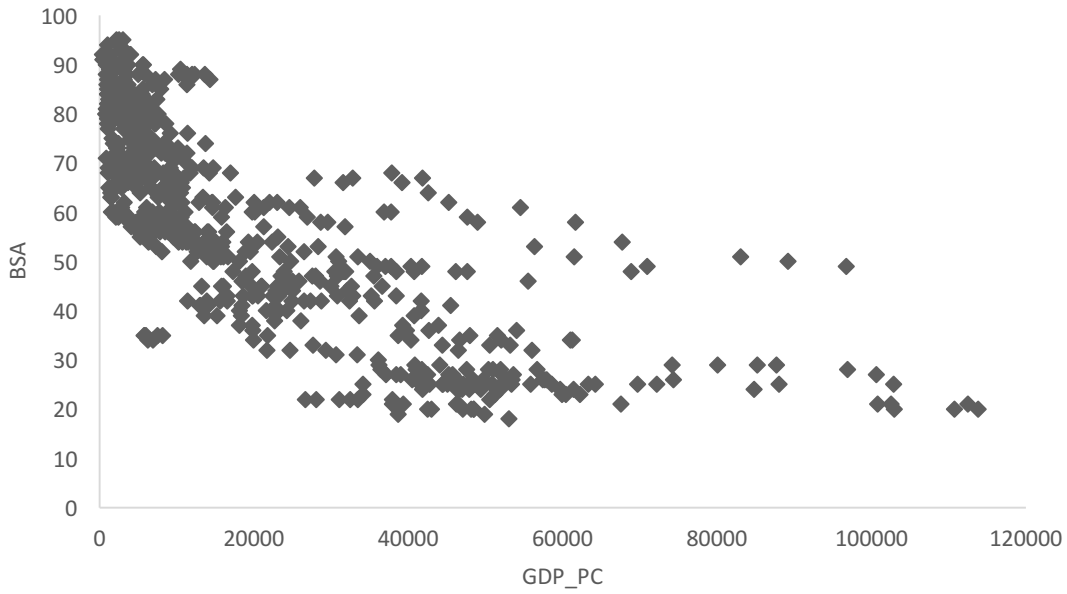
According to these graphs a negative link could exist between BSA and the independent variables (GDPpc and IPP); however, this relationship is not so clear. This makes it necessary to apply the previous econometric models (1 and 2) in order to determine which is the influence of GDPpc and IPP over BSA.

Graph 2.IPP vs BSA



[13] Some properties of Hansen's test can not be checked when the value of the test is close to 1 and, henceforth, null hypothesis about suitability instruments must be rejected; just as the value of the test is less than 0, 05.

Graph 3.GDPpcvs BSA



4.3.1. Static model

The table 4 shows all the estimates for model 1.

Table 4. Model 1 estimates

Variable	OLS	FE	RE	FINAL_FE
lnIPP	1.1541032***	-.30413911***	-.21135618**	.56818501*
lnIPP2	-.6865954***	.14177144***	.0851899**	-.38474715*
lnGDP_PC	.60425365***	.74943965***	.94040311***	.90938436**
lnGDP_PC2	-.09830019***	-.11169387***	-.13973608***	-.13944499***
_cons	3.0771027***	3.0950732***	2.8103708***	2.7755997***
N	707	707	707	707
r2	.79917458	.34635202	-.13973608***	-.13944499**
r2_a	.79803027	.22830188		
F	698.39335	79.216379		
Chi2			510.34813	625.82655

legend: * p<0.1; ** p<0.05; *** p<0.01

Model 1 must be estimated by panel data techniques instead of OLS (we apply significance tests of fixed effects and Breusch and Pagan's significance tests); specifically, model 1 must be estimated applying FE instead of RE according to the results of the Hausman test. The final estimate, named FINAL_FE, collects model 1 as estimated by FE after the heteroskedasticity, autocorrelation and contemporary autocorrelation problems have been corrected.

According to the FINAL_FE estimate we can conclude that there is an inverted U-shaped relationship between BSA and GDPpc. These empirical results also suggest that the link between BSA and IPP is identical in nature to the previous one (for a 10% significance level). However, due to the casual relationship between BSA and IPP and also to the omission of variables in model 1, it is necessary to execute the endogeneity analysis via a dynamic model.

4.3.2. Dynamic model

Table 5 shows the estimates for model 2 by applying GMM.

As we can see, for a 10% significance level, estimates where all the variables are statistically significant are GMM3 and GMM4. However it is necessary to analyse the quality of these estimates.

Table 5. Model 2 estimates

Variable	GMM1	GMM2	GMM3	GMM4	GMM5
lnIPP L1.	2.2743846***	2.4543363***	-73580469*	2.4195649**	2.1650151**
lnIPP2 L1.	-1.109523***	-1.1564096***	-.25977597*	-1.078249**	-1.0806297***
lnGDP_PC L1.	-.75612448				
lnGDP_PC2 L1.	.08529914				
lnIPP	-.24997525	.10355387			
lnIPP2	.17530539	.04895816			
lnGDP_PC	2.5029031***	1.6126504***	1.1054358***	1.6363918***	.1027086
lnGDP_PC2	-.31663222***	-.22055793***	-.12507492***	-.21975395***	-.04158483
BSA L1.			.01874024***		
_cons					3.5457076**
N	603	603	498	604	604
r2					
r2_a					
F					
Chi2	67793.739	58687.737	285575.24	47189.948	419.09925

legend: * p<0.1; ** p<0.05; *** p<0.01

Table 6 collects the quality of each estimate. We must remember that, in order for an estimate be correct, the following conditions must be met:

- Hansen test: $0{,}1 \leq X^2 \leq 0{,}8$
- Arellano-Bond test: $z(Ar(2)) > 0{,}05$.
- Number of instruments < Number of groups.

Table 6. Conditions for validity of estimates

	GMM1	GMM2	GMM3	GMM4	GMM5
Hansen test	Yes	Yes	Yes	Yes	Yes
Arellano-Bond test	No	No	Yes	No	No
Instruments nº <groups nº	Yes	Yes	Yes	Yes	Yes

According to the results showed in the table 6, GMM3 is the highest quality estimate. Consequently, the rate of piracy software positively depends on the piracy rate in the previous period, the protection level of the IPR and lastly the GDP pc; the relationship between piracy and the square of IPP and GDP pc has an inverted U-shape.

4.3.3. Static or dynamic model

On the basis of the specified methodology, we select a dynamic estimate instead of a static estimate if the null hypothesis of the Hansen test is accepted and, at the same time, the number of the instruments used is not greater than the number of the groups.

As was demonstrated in the previous point (4.3.2), the GMM3 estimate meets all the benchmarks. Consequently, the model is endogenous and, thus, GMM3 is a better estimate than the FINAL_FE estimation.

4.3.4. Discussion

On the basis of the estimates, the empirical results show that software piracy positively depends on the rate of piracy in the previous year.

If we suppose a linear relationship, when IPRs are more protected, the rate of piracy is greater. However, it seems that there is a square relationship between the studied variables (in an inverted U-shape). This means that in the countries where intellectual protection is low, a positive increment in IPR protection leads to greater levels of software piracy; nevertheless, the effect of countries which apply strong protection when there is a positive increment in the IPR protection is to reduce the amount of software piracy.

Concerning the GDPpc, its impact on the rate of software piracy is similar to the effect of the protection of IPRs. So, if a linear relationship is assumed, the greater the GDPpc, the greater is software piracy. But due to the existence of a square relationship between these variables, it can be said that the effect of a greater GDPpc over the rate of piracy varies according to itself; consequently, when the countries have a low GDPpc the piracy would be a normal good, but countries with higher GDPpc piracy would become an inferior good.

These results represent a progress for designing efficient policies in the scope of IPRs. According to the empirical results, these policies must not be uniform for all countries, and policies will depend on the level of protection of IPR and the GDPpc of each country.

5. CONCLUSIONS

The efficiency of copyright regimes is assessed in the context of the digital era taking the number of unauthorised copies generated from an original copy as a reference. The economics of copying is a field within copyright economics that tries to provide an answer to the question of why illegal copies exist, the effects that these have on the production of original works and what measures can be adopted to face this issue. The versatility and heterogeneity of the patterns developed to provide an answer to the three stated questions are the basis of the main challenge for the economics of copying: the formal modelling of the unauthorised copy's behaviour.

The present paper has focused on one of the more controversial aspects in the economics of copying, the analysis of the determinant factors of piracy. Specifically we have studied two of the main determinants: GDP per capita and the level of intellectual protection. With this aim, we have developed a study by applying dynamic panel data techniques to a sample of 105 countries for the period 2006-2014. The variables are software piracy, GDP per capita and the level of intellectual right protection. The size of the sample and the econometric strategy have been the innovative features of the analysis.

According to empirical results we can highlight three remarks. First, the higher the rate of piracy in a given year, the higher the piracy in the next. Second, the impact of the level of intellectual protection on piracy is not equal for every country: while greater protection reduces piracy in countries with strong protection of IPR, for countries where protection is low, larger protection increases the level of piracy. Third, the relationship between piracy and wealth is similar to the link between piracy and intellectual protection; so, wealth positively impacts on piracy when countries have a low GDP per capita. However, piracy decreases in countries with major wealth.

Consequently, these results suggest that copyright regulation, specifically anti-piracy policies, must not be uniform in every country; the anti-piracy policies must take into account wealth and existing copyright regimes.

These results represent a progress when efficient policies related to IPR will be designed.

For future research, it would be beneficial to analyse the impact of social, cultural and educational variables over piracy.

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