Effectiveness of intellectual property regimes 2006-2011 (empirical evidence)

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Abstract The analysis and implications of copyright provide the foundation for copyright economics, where an array of different streams of thought coexist feeding a number of controversies that at the same time both hinder and enrich the research agenda. One of the keenest debates concerns the relation between copyright and competition policy. The goal of the current work is to explore to what extent competition policy determines the level of protection afforded to copyright. The paper also analyses the effect of other variables such as education, innovation, culture and national wealth. Panel data techniques are applied for a sample of eight countries over the period 2006 to 2011. Findings show that copyright protection is more intense in countries which have more effective competition policy laws, and which perform better in education and wealth. The link with regard to spending on culture proves negative, opening up a range of hypotheses for formulating cultural policy goals and instruments. In terms of countries, those in the Mediterranean area display the weakest regimes for protecting intellectual property.

Keywords Intellectual Property Rights · Copyright Economics · Competition Policy · Panel data techiniques

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1 Introduction

Intellectual property regimes play a key role in regulating knowledge. Copyright seeks to reward and encourage creativity, which is the driving force behind creative or knowledge goods and services. The analysis and implications of this right forms the basis of copyright economics.

Various streams of thought coexist within the discipline feeding a series of controversies that both hinder and at the same time enrich the research agenda. The debate surrounding how to adapt these copyright regimes to the digital era is currently at the forefront of this agenda.

Given such a context, one of the key debates concerns the relation between copyright and competition policy. Copyright gives creative goods and services a monopoly, justified by their ability to encourage innovation.

The present work seeks to explore this relation by examining to what extent competition policy influences copyright protection. The effect of other variables such as education, innovation, culture and a countrys wealth are also analysed.

In line with the goal pursued, the structure of the present work is as follows.

We first establish the bases of copyright economics or copyright by analysing the approaches and dilemmas that shape it.

We then focus on one of the main trade-offs within copyright economics, the link between competition policy and copyright. Despite pursuing a similar goal, they differ in the mechanisms applied, which might spark certain conflicts that prove hard to resolve.

In order to verify the hypothesis that copyright protection and competition policy are complementary mechanisms, we conduct an empirical analysis drawing on panel data for the period 2006-2011, where, for four contrasting copyright regimes, we explore the link between the two institutions in addition to the relation between copyright and other variables associated to education, innovation, culture, and national income.

2 Copyright Economics

Copyright is the branch of law regulating the rights of authors of original works of creation, as well as the other rights acquired for varying reasons (historical, economic) which are linked to the former.

As an economic discipline, copyright economics first emerged in the work of Arnold Plant *The Economic Aspects of Copyrights in Books* in 1934. Aside from said work, certain references concerning the issue may be found in the literature of classical economists such as Adam Smith. However, it was not until the mid 19th that copyright began to gain ground in the analysis of intellectual property (Hurt and Schuman, 1966; Breyer, 1970; Novos and Waldman, 1984; Johnson, 1985 [1]; Liebowitz, 1985; Landes and Posner, 1989), with industrial property, and specifically patents, forming the focus of the bulk of the analysis.

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[1] Cited in Towse et al (2011).

One crucial area in the study of copyright economics is that of creative goods or knowledge goods (Chen and Png, 2003; Bomsel and Ranaivoson, 2011; Audley and Boyer, 2011) which has come to determine the economic analysis of copyright. Such goods display the following particular features (Torrent, 2009; Shapiro and Varian, 2000:2):

- Production and reproduction costs: such goods are expensive to produce but cheap to reproduce.
- Experience goods.
- Decreasing marginal utility in access to them (output saturation).
- Technology dependent: lock-in or costs arising from changes in technology.
- Network externalities: they generate positive feedback, fostering dominance of a single technology.
- Managed through intellectual property.

Having defined the features that characterise knowledge goods, we focus on copyright economics as such, exploring the approaches and dilemmas inherent in the analysis thereof.

2.1 Approaches

One of the obstacles to studying copyright economics is the coexistence of differing analytical approaches. Towse et al (2011) specify four:

a. Political economics with regard to monopoly
   This is one of the oldest dilemmas. Copyright confers a position of privilege on the owner of the work similar to a legal monopoly thereon, contravening the principles of the doctrine of competition, whilst at the same time proving necessary in order to reward the author. Contrasting opinions exist as to whether the market power conferred by copyright on its owner is less than that obtained through absolute monopoly (The Allen Consulting Group, 2003; Yoo, 2005 [2]). This issue will be explored in greater depth in point 3.

b. Intellectual property rights and public goods
   This approach analyses goods protected by copyright as public goods. These are non-rival and non-excludable goods (Arrow, 1962 [3]) . It can be said that, under this assumption, the creative goods market fails, given that there are incentives encouraging consumers not to pay for the good, thus making them free-riders. Copyright acts as a mechanism to prevent free-riders. The effectiveness of intellectual property rights (hereinafter IPR) in thus called into question (Towse et al, 2011).

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[2] Cited in Towse et al (2011).
[3] Cited in The Allen Consulting Group (2003).

c. Economic analysis of copyright
This approach analyses copyright doctrines (protection of expression, derived works, rented works, duration and limitations) applying economic analysis (pricing theory, welfare economics, public choice theory). The seminal work par excellence which applied economic analysis to the doctrines of intellectual property law is that published by Landes and Posner (1989). Said authors focus on the positive and negative incentives of creativity, leaving aside market failure. They posit that, in order to maximise creativity, protection of the author needs to be balanced with the costs that this entails for other authors. The most hotly contested issues concern establishing the optimal level of protection in the space and time of the copyright (Yoon, 2002; Varian, 2005).

d. Alternatives to copyright and rejection of intellectual property law
Most of the authors who champion this approach agree that copyright is not an efficient mechanism, given the fact that the power which it confers on the owner to set a monopoly price and discriminate in prices leads to inefficient social monopoly known as intellectual monopoly (Boldrin and Levine, 2002). The role of copyright as an incentive for creators is also called into question, since it is felt that it only serves to safeguard the commercial interests of those who exploit it (Kretschmer and Hardwick, 2007[4] ; Liebowitz, 2011). The alternatives considered include those related to Varians commercial models (2005) - subscriptions, joint sale of accessories, or sale of customised versions - .

2.2 The dilemmas of copyright economics

As with all disciplines, copyright economics needs to face up to a series of controversies. We draw on Watt (2011a) to set out the key dilemmas:

a. Consumer access *vs* creator incentives
This is the most commonly addressed dilemma in the literature. The disagreement is sparked by the cost structure of knowledge goods. If the price is fixed in accordance with the marginal cost as the competitive market dictates, said property would not exist since insufficient revenue would be generated to cover fixed costs. Market power is required to fix a price above the marginal cost that will serve as an incentive to the creator. Yet, this then restricts access for those consumers who are not willing to pay said price, contributing to an irretrievable loss which is characteristic of monopolies. Striking a balance between access and incentives lies at the heart of the IPR problem (Landes and Posner, 1989).

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[4] Cited in Towse et al 2011.

b. Static *vs* dynamic effects

This dilemma relates to the accumulative aspect of creation; the construction of scientific knowledge is grounded on the creation of one work based on another. On the one hand, sufficient level of protection is required to encourage creation, whilst on the other, over protection may stifle accumulative creation. Searching for access to an authors work and creating further knowledge based on it may prove to be a costly task.

c. Duration, depth and scope

An optimal combination needs to be achieved for these three dimensions; in most countries, the duration is the lifetime of the author plus 70 years; the depth is identified with the protection of the expression of the ideas; scope refers to those acts which are deemed infractions only limited by the doctrine of fair use[5] . The predicament is sparked by the fact that there is a very fine line between what is optimal and what is not, necessitating a specific solution to be found.

d. Copyright *vs* competition policy

This is currently one of the most topical dilemmas. Monopoly associated to copyright causes irretrievable productive loss. This is because conferring the power of monopoly leads to irretrievable loss (due to the monopolistic nature) while at the same time also providing consumer surplus and profits for the creator derived from the consumption and production of creative goods. We now explore this trade-off in greater depth.

3 Copyright *versus* competition policy

Exploring the relation between competition policy and copyright is a key cornerstone in copyright economics. As mentioned in point 2, these rights grant the author certain privileges over the protected good, specifically to exercise monopoly and fix prices above the marginal cost until such time as the protected good enters the public domain, thus breaching the principle of market competition and violating the basis of competition policy (intellectual monopoly).

In general, economic doctrine considers that, except in certain circumstances, copyright does not confer a monopoly, since the market power it generates is less than that produced by absolute monopoly. Nevertheless, access to products protected by copyright is not optimal given its cost structures (high fixed costs as opposed to practically non-existent marginal costs), which means that in order to recover costs the price is established above the marginal cost leading to a loss of efficiency.

According to Oliveira and Fujiwara (2010) for a conflict to arise between competition policy and IPR two conditions must be met: a) a trade-off between competition (short-term allocative efficiency) and innovation (dynamic

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[5] The fair use doctrine considers that the exclusive rights given to the copyright owner do not include the right to prevent others from fair use of the copyrighted work.

long-term efficiency); b) contradictory objectives between the two institutions (intellectual property encourages innovation through market power whereas competition policy restricts the use of market power). Whether such conditions are fulfilled is debatable (Oliveira and Fujiwara, 2010; Ganslandt, 2008).

The hypothesis defended in the present work is that we are faced with two institutions that pursue a common goal, namely encouraging creativity and innovation and creating greater social welfare. Nevertheless, the means that each uses to achieve this end are contradictory. Whereas competition policy removes practices and behaviour which restrict competition, copyright favours the creation of legal monopolies altering the competitive paradigm.

These two institutions embrace elements which are both convergent and divergent, accounting for the difficulty involved in analysing the interrelation between competition policy and copyright (Ramello, 2002) and potentially sparking certain tension between them.

3.1 Keys to the controversy

In order to get to the heart of the debate, the particularities of each doctrine must be explored in depth. For this purpose, a series of aspects where copyright and competition policy differ have been pinpointed (table 1).

a. Origin The seeds for competition policy were first sown in the 1890 Sherman Law in the USA in response to alliances to emerge among large firms working in the same line of business. The origins of copyright date back to the 18th century in Great Britain with the Statute of Anne in 1709 whose main goal was motivate art, literature, and science. In general, both institutions share a political basis in their raison *dtre*. In addition, there are those who hold that in their beginnings both pursued the same goal, namely to combat monopoly (Nicita and Ramello, 2006). In its early days, the Statute of Anne seems to have contributed more to weakening the market power of printers and distributors than to giving authors just remuneration and incentives to create works.

b. Internationalization
This is where one of the major weaknesses of competition policy lies. Unlike copyright through the Berne Convention, competition policy has no text setting out the basis for regulating competition policy at an international scale. One collateral problem emerges when applying the principle of the national treatment of IPR set out in the TRIPS[6] . Said principle states that foreign owners of IPR must *ex ante* be afforded the same rights as nationals. The problem arises when the government authorities in each country might feel tempted to redistribute revenue from foreigners to nationals by applying competition policy ex post.

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[6] Agreement on Trade Related Aspects of Intellectual Property Rights.

Table 1 Keys to the conflict between copyright and competition policy

Items	Copyright	Competition policy
Ultimate goal	To encourage innovation and social welfare	To encourage innovation and social welfare
Origin	Political	Political
Internationalization	Yes	No (binding)
Market failure supporting its existence	Public goods/preferential goods	Oligopolistic market structures
Causes market failure?	Monopolistic market structure. Standard protection for non-standard knowledge goods	No internationalization (binding). Hard to apply to knowledge goods
Scope of action	L/t: encouraging innovation through exclusive rights	Questionable, depends on the school of thought
Intertemporal commitment	Ex ante application	Ex ante (promotion) and ex post application (defence)

c. Market failure supporting its existence
The raison *dtre* of competition policy is to combat monopolistic behaviour, which sparks irretrievable loss of efficiency for society by establishing prices above the marginal cost as stipulated in competitive behaviour and a reduction in the amount available. Copyright also acts as a mechanism to correct inefficiencies in the market by internalising the problems to emerge from the non-rival and non-excludable nature of knowledge goods.

d. Does copyright/competition policy lead to market failure?
No empirical evidence whatsoever exists to suggest that competition policy leads to market inefficiency. The same cannot be said, however, of copyright. The existence of these property rights grants the owner of the protected work a legal monopoly and certain market power which might lead to anticompetitive behaviour, the area of application of competition policy (Ramello, 2002).

e. Weaknesses
The question arises as to whether competition policy is adapting to the new needs posed by the knowledge society. There are three areas where the competitive strategies of the knowledge economy clash with competition laws (Shapiro and Varian, 2000: 17): mergers and take-overs, agreements

between firms, and abuse of a dominant position. Likewise, the current context requires adapting copyright regimes so as to provide more effective protection for knowledge goods. Technological progress has meant that it is possible to make perfect copies of any work and to distribute them virtually cost-free, which poses a major threat to the creative industry.

f. Area of operation
  Whereas competition policy acts by regulating business behaviour and structures, copyright intervenes at a structural level by defining the authors rights *vis--vis* the areas where protection is offered, as well as the duration and limits thereof.

g. Time scale
  In order to analyse this dimension, in the issue of competition policy we must resort to the streams of economic thinking that have championed the definition of this institution. The Harvard school fixes the objectives as short-medium term, whereas the long term is the horizon set by the Chicago and Austrian schools. In the case of copyright, the long-term time horizon prevails for achieving its ultimate objective, namely fostering creativity and innovation for enhancing social welfare.

h. Intertemporal commitment
  Once again, two alternative applications coexist as regards competition policy: *ex ante* and *ex post*. Whereas defending competition is an *ex post* activity, promoting it is applied *ex ante*. If copyright is to achieve its aim of encouraging innovation and creativity, it must be applied *ex ante*. The problem might arise when the competition authorities feel tempted to restrict or repeal copyright protection if it leads to significant market power.

4 The effectiveness of copyright regimes. Empirical evidence

In order to gauge the relation between competition policy and copyright, we draw on econometric analysis. We also study the link between copyright and other variables which we feel to be crucial with regard to how effective the former is.

  To do this, we use a linear regression model for the period 2006 to 2011. Eight different economies have been taken (Spain, Italy, France, Germany, UK, and USA). The dependent variable is a copyright index which evaluates the intensity of the protection this institution affords. The dependent variables belong to five different categories: competition policy, education, innovation, culture, and wealth of an economy.

  The (dependent and independent) study variables are first presented. The initial hypotheses are then established, before moving on to their verification based on the proposed model. The results obtained are then given.

4.1 Copyright index

One goal of the present work, namely exploring the link between competition policy and copyright, supports the need for a variable or index which directly reflects the level of protection of copyright regimes for each of the economies considered in the analysis.

At an international scale there is no indicator focussing exclusively on copyright protection. One benchmark is the International Property Rights Index (IPRI), an indicator drawn up each year by the Property Rights Alliance (USA). On a scale of 0 to 10, it gauges the level of copyright protection at an international scale by analysing ten variables split into three criteria: legal and political context; physical property rights, and intellectual property rights.

For the case in hand, we base our approach on this latter sub-index with the aim of constructing a copyright indicator. The items considered in the IPRI are: (1) intellectual property rights protection; (2) protection of patents; (3) copyright piracy. In our case, we chose to replace the second item for copyright protection. This reflects how intensely copyright is applied by assessing five standards: (1) cover; (2) copyright restrictions; (3) duration of the protection; (4) application; (5) membership of international treaties.

In accordance with these criteria established by the IPRI, Zekos (2012) posit a technique for drawing up a copyright index which measures their economic impact accurately and objectively. With this purpose in mind, it provides the weights and variables to be used when constructing the index. Said index would form part of a general intellectual property rights index.

The method chosen to devise the copyright index merges the general lines of the IPRI with the weights and variables proposed by Zekos (2012) to specifically assess copyright protection. Figure 1 details its structure.

Various aspects need highlighting. Firstly, in line with the IPRI technique, an indicator of IPR protection devised by the Property Rights Alliance has been included as an integral part of the Global Competitiveness Index (GCI). This variable contains the results of an opinion poll reflecting a countrys intellectual property protection. Responses range from 1 to 7, where the lowest score evidences little and non-enforced protection, and the highest score is indicative of strong and enforced protection. In our case, a change has been made in the scale of this variable to range from 0 to 1.

In order to construct the item related to copyright piracy, we drew on the statistics published by the BSA (Business Software Alliance) each year on software piracy. Since this index measures how intense copyright protection is, we considered the amount of software protected by copyright that is consumed legally. Therefore, the greater the amount consumed legally in a country, the greater the intensity being applied in the IPR.

As regards copyright treaties administered by the WIPO, we considered those contemporary to the period of study established in the analysis (2006 2011). Two further treaties have been drawn up over the last few years: the
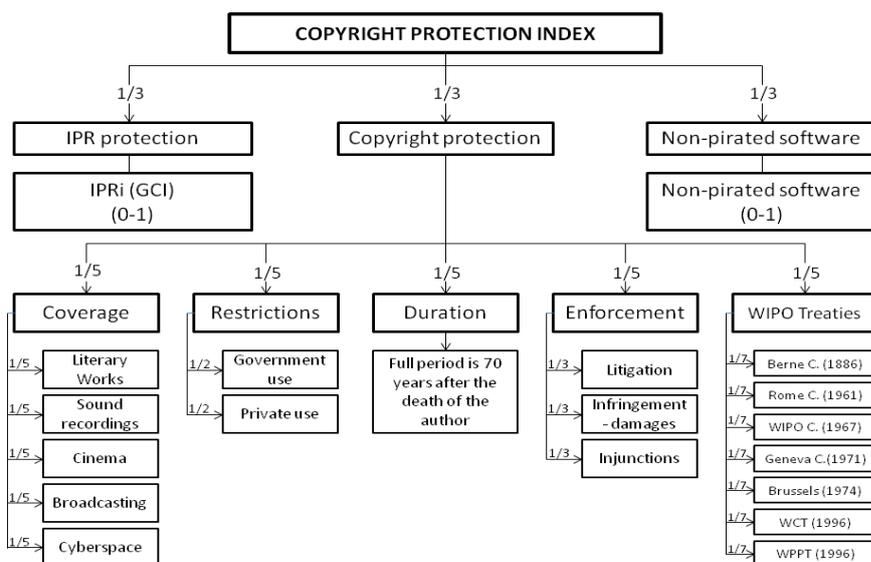
Fig. 1 Methodology copyright index

Treaty of Beijing (2012)[7] and the Treaty of Marrakech (2013)[8] . For calculating the remaining variables that make up the copyright protection item, we used the legislation of each country included in the present study.

The range of the index constructed varies between 0 and 1; the higher the score a country obtains, the more intense the copyright protection and vice-versa.

The most significant variables are IPRi (GCI), non-pirated software, and the treaties administered by the WIPO. In the remaining variables, countries concur in the score and maintain it throughout the period. Nevertheless, regimes differ greatly. Point 4.5 examines this indexs evolution over time and between countries, showing the difference in the effectiveness of the copyright regimes between them.

4.2 Selecting independient variables

Annex sums up the variables initially used in the study. These belong to five different categories which might impact the level of copyright protection.

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[7] The Treaty of Beijing on Audiovisual Performance, signed in Beijing on 24 June 2012, includes comprehensive coverage of performers of audiovisual works within the protection framework of copyright at an international scale.

[8] The Treaty of Marrakech to facilitate access to works published for the blind, those suffering visual impairments or who have other difficulties accessing printed texts, signed in Marrakech on 27 June 2013.

In order to obtain a better fit which has greater explanatory power and also to remove any collinearity problem, the number of regressors is reduced, keeping one variable for each block mentioned. To achieve this, variable selection techniques were used, specifically the stepwise procedure. If we also consider the quality of the variables initially proposed to achieve a good fit and one which can offer as much explanatory power as possible, the independent variables that will form part of our study are those shown in table 2:

Table 2 Description of the study variables

Variable	Obs	Mean	Std. Dev.	Min	Max
AntitrustE	48	5.27928	.6797167	3.703527	6.192313
RD	48	2.404663	.8982045	1.127324	3.938342
Cult	48	9.70531	1.554551	7.151312	12.22573
Educ	48	11.08333	1.14545	8	13
lnGDPpc	48	10.61894	.1642611	10.24084	10.9465

where *AntitrustE* is the effectiveness of the antitrust policy; *Educ* is the length of compulsory education; *RD* corresponds to spending on R&D over GDP; *Cult* reflects household spending on cultural and recreational activities over total spending; *GDPpc* is per capita GDP.

4.3 Initial hypothesis

a. Copyright *vs* competition policy
   Throughout point 3 a bibliographical review has been offered highlighting the complementarity between copyright and competition policy. Despite the conflicts which might emerge between them, the two do actually pursue the same ultimate goal of enhancing social welfare (Ramello, 2002; Nicita and Ramello, 2006; Ganslandt, 2008; Katz and Veel, 2013; Zekos, 2013).
   The initial hypothesis is the existence of a positive relation between the effectiveness of the competition policy and the intensity of copyright protection.

b. Copyright *vs* education
   This hypothesis is based on the empirical analysis carried out by Rodrguez Andrs (2006) comparing the piracy variable to variables related to those of IPR, education, R&D, trade and the wealth of the various countries. What is key in this sense is the link between piracy and IPR, with an inverse

relation emerging. Based on this finding, the link between IPR (specifically copyright) and education may be established.

Continuing with the aforementioned analysis, the result for the relation between piracy and the variable reflecting a countrys level of educational attainment displays a negative sign, such that a convergent relation between IPR and the education variable may be said to have been established (Ginarte and Park, 1997; Scalise, 1997; Marron and Steel, 2000)[9].

The findings of Dias Gomes (2014), who explores the link between piracy and variables associated to education, among others, reach the same conclusion; namely a divergence between piracy and education; in other words complementarity between copyright and education.

As mentioned earlier, the variable chosen for this category is the duration of compulsory education, the suggestion therefore being that the longer the period of a countrys compulsory education, the more intense the copyright protection.

c. Copyright *vs* investiment in R&D

We once again turn to the findings to emerge from the analysis by Rodrgues Andrs (2006) to establish the hypothesis concerning the existence of a positive relation between copyright and a countrys investment in R&D. Frame (1987), and Ginarte and Park (1997) posit that a country with intense R&D activity offers greater incentives for boosting intellectual property. In our case, the hypothesis conjectured is that the greater the weight of R&D over GDP, the more intense the copyright protection will be.

d. Copyright *vs* culture

There is no empirical evidence available on which to base our verification of these variables.

It is obvious that IPR, specifically copyright, play a major role in the cultural and creative industries. As highlighted in point 2, copyright functions as a mechanism to (partially) correct the problem of free-riders given the non-rival and non-excludable nature of goods protected by copyright. Copyright thus constitutes a source of funding and acts as an incentive to artistic and cultural production.

Based on this notion, it may be said that the greater the existing protection of creative (cultural) goods, the more this will spur cultural activity. Yet, the relation between greater copyright protection and higher spending is by no means clear, since strong protection might discourage people from spending and result in their engaging in activities outside the law. The sign of the hypothesis must therefore be left unresolved.

e. Copyright *vs* a country's wealth

Broadly speaking, the literature consulted concurs in pointing to a positive relation between protection of IPR and national wealth (Husted, 2000; Rodrguez Andrs, 2006; Ganslandt 2008; Dias Gomes, 2014).

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[9] Cited in Rodrguez Andrs (2006).

A positive link is assumed to exist between an economys per capita GDP growth and the intensity of copyright protection.

4.4 Proposed model

We opted for panel data analysis with the following characteristics:

− Given that the dependent variable is associated to copyright protection, eight countries were chosen covering the two intellectual property reference models (Montoro and Cuadrado, 2008): Anglo-American (USA and UK) and Continental Europe. The latter has been subdivided into three models: continental (Germany and France); Mediterranean (Spain and Italy), and Nordic (Finland and Sweden).
− The study covers the period 2006 to 2011.

The following model merges all the ideas and observations established in the preceding points:

$$
\begin{aligned}
CopyrightI_{i,t} = \alpha_i + \beta_1 AntitrustE_{i,t} + \beta_2 Educ_{i,t} + \beta_3 RD_{i,t} + \\
+ \beta_4 Cult_{i,t} + \beta_5 ln(GDPpc)_{i,t} + \varepsilon_{i,t}
\end{aligned}
\tag{1}
$$

where $CopyrightI_{i,t}$ is the copyright index for country i during year t; the remaining variables are described in point 4.2. Parameter α_i reflects the specific individual effects, whilst $\varepsilon_{i,t}$ is the error term.

The empirical analysis is conducted in various stages. First, a pool of data for years and countries is constructed applying the Ordinary Least Squares model (OLS) where the behaviour of the dependent variable is also analysed. Panel data analysis commences at the second stage by estimating parameters under the fixed effects model (FE) and random effects model (RE). The third stage evaluates the suitability of the panel data models using the Hausman test. The fourth stage gauges the quality of the estimation model selected by analysing heteroskedasticity, autocorrelation, and contemporary correlation, where necessary. Finally, the results are discussed.

4.5 Results and analysis

The results of the econometric analysis are summed up in table 3.

As indicated, grouped data are first analysed. Studying the evolution of the dependent variable over the period for each country is important (figure 2).

Significant differences seem to exist between countries. Which countries offer the strongest copyright protection? To answer this question a series of dummies have been created regarding the categories of countries previously established (Anglo-American, continental Europe, Nordic, and Mediterranean)
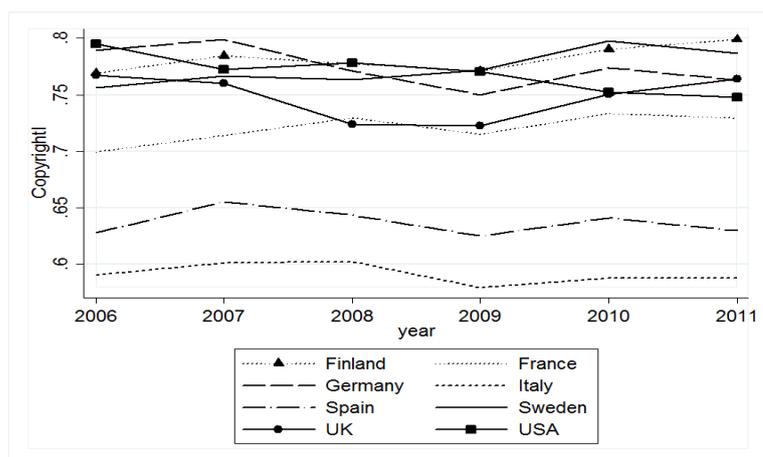
Fig. 2 Evolution of the copyright index

including them as regressors with regard to the dependent variable (*CopyrightI*). The result of the OLS regression (column of table 3) indicates that there are significant differences between the groups of countries, with the Mediterranean countries (Spain and Italy) affording least copyright protection, whereas the Nordic countries (Finland and Sweden) exhibit the strongest copyright regimes.

Having examined the behaviour of the dependent variable, the model established is then estimated (1) by OLS. The second and third columns are where said regression is concentrated. The proposed model offers a high determination coefficient ($R^2 = 95$), and proves significant globally. All the variables are significant at 5% with the exception of household spending on culture, which is significant at a higher level. The same model is reproduced in a robust version (column 3).

Panel data processing is then applied. The next stage in the analysis applies the FE and RE models to estimate the regressor parameters. Columns 4 to 7 show these estimations. These FE and RE models are significant globally. In the case of FE (column 4) the non-significant variables at 10% are *RD* and *Educ*. However, the comparison of the fixed effects significance bears out the suitability of performing this regression using FE as opposed to MCO.

F test that all u_i=0:   F(7, 35) =   5.95   Prob > F = 0.0001

Fig. 3 FE *vs* OLS test

For the RE case, this test is carried out using the Breusch-Pagan test known as the *Lagrange Multiplier Test for Random Effects*. The null hypothesis of this test is that $\sigma^2 = 0$. If the test is rejected, then there is a difference between

Table 3 Estimated models

Variable	OLS_C	OLS	OLS_rob	FE	FE_rob	RE	RE_rob	AR1	HET	FET_AR1
cont	.132837									
	.009841									
	13.4982									
	3.0e-17									
nord	.163422									
	.009841									
	16.6062									
	1.4e-20									
anglo	.144422									
	.009841									
	14.6755									
	1.5e-18									
AntitrustE		.038871	.038871	.031766	.031766	.039613	.039613	.039613	.039613	.039613
		.006882	.006232	.010087	.015492	.007459	.008107	.008107	.008107	.008107
		5.64831	6.23683	3.149	2.05051	5.31091	4.8866	4.8866	4.8866	4.8866
		1.3e-06	1.8e-07	.003344	.079471	1.1e-07	1.0e-06	1.0e-06	1.0e-06	1.0e-06
RD		.026815	.026815	-.0266	-.0266	.029572	.029572	.029572	.029572	.029572
		.005194	.004976	.0215	.026361	.0062	.004562	.004562	.004562	.004562
		5.1622	5.38899	-1.238	-1.009	4.76933	6.48198	6.48198	6.48198	6.48198
		6.3e-06	3.0e-06	.223981	.346281	1.8e-06	9.1e-11	9.1e-11	9.1e-11	9.1e-11
Cult		.004932	.004932	-.0326	-.0326	.003403	.003403	.003403	.003403	.003403
		.002474	.002743	.008705	.008369	.003299	.0024	.0024	.0024	.0024
		1.9937	1.7979	-3.741	-3.891	1.03145	1.41758	1.41758	1.41758	1.41758
		.052705	.079383	.000657	.00597	.302329	.156314	.156314	.156314	.156314
Educ		.016525	.016525	.005679	.005679	.015533	.015533	.015533	.015533	.015533
		.002645	.002962	.006909	.001616	.003277	.002708	.002708	.002708	.002708
		6.2489	5.57844	.821954	3.51484	4.74058	5.73691	5.73691	5.73691	5.73691
		1.7e-07	1.6e-06	.416667	.009795	2.1e-06	9.6e-09	9.6e-09	9.6e-09	9.6e-09
lnGDPpc		.07849	.07849	.042971	.042971	.066584	.066584	.066584	.066584	.066584
		.023228	.017703	.02415	.016409	.02592	.015805	.015805	.015805	.015805
		3.37915	4.43369	1.77936	2.61867	2.56881	4.21277	4.21277	4.21277	4.21277
		.001579	.000065	.083867	.034476	.010205	.000025	.000025	.000025	.000025
_cons	.614274	-.6098	-.6098	.417533	.417533	-.4680	-.4680	-.4680	-.4680	-.4680
	.006959	.236058	.183727	.278325	.222333	.263659	.155336	.155336	.155336	.155336
	88.2745	-2.583	-3.319	1.50016	1.87796	-1.775	-3.013	-3.013	-3.013	-3.013
	3.7e-51	.013366	.001875	.14254	.102473	.075874	.002586	.002586	.002586	.002586
N	48	48	48	48	48	48	48	48	48	48
r2	.886614	.950894	.950894	.434021	.434021					
r2_a	.878883	.945048	.945048	.239971	.366643					
F	114.685	162.657	205.487	5.36795	.					
chi2						405.289	1451.62	1451.62	1451.62	1451.62

legend:b/se/t/p

MCO and RE, and it is therefore preferable to use the random effects method. In the case studied, estimation should be performed using MCO:

```
         Breusch and Pagan Lagrangian multiplier test for random effects

         CopyrightI[country,t] = Xb + u[country] + e[country,t]

         Estimated results:
                             Var      sd = sqrt(Var)

             Copyrig~I    .0047977        .0692652
                    e     .0001445        .0120211
                    u     .0000275        .0052469

         Test:   Var(u) = 0
                             chibar2(01) =     0.74
                           Prob > chibar2 =   0.1950
```

Fig. 4 Breusch and Pagan test

Stage three involves identifying the most suitable estimator, for which the Hausman test is applied. The outcome is shown in table 3, reflecting the suitability of applying FE as opposed to RE. Yet, prior to drawing any conclusions, the quality of the model needs to be studied. Stage four checks for the possible existence of heteroskedasticity, serial correlation, and contemporary correlation, which would bias the models results.

In order to check for the presence of heteroskedasticity, the modified Wald test is used[10] . In our case, the null hypothesis of homoscedasticity is rejected. What we have is a violation of Gauss-Markov assumptions.

```
         Modified Wald test for groupwise heteroskedasticity
         in fixed effect regression model

         H0: sigma(i)^2 = sigma^2 for all i

         chi2 (8)  =      32.27
         Prob>chi2 =      0.0001
```

Fig. 5 Wald test

Secondly, we address the problem of serial correlation or autocorrelation, in other words when errors $e_{i,t}$ are not independent with respect to time. In our case, it is highly likely that the level of copyright protection in t is associated to the level of protection in $t-1$. Using the Wooldridge test, we verify the null hypothesis of no autocorrelation. Clearly, if it is rejected, it may be concluded that autocorrelation is indeed present. For a 5% significance level, the following output shows that there is a problem of autocorrelation.

The problem of contemporary correlation refers to the error correlation of at least two or more time units t. We would face a problem of this nature if there were unobservable characteristics in certain units that related to unobservable characteristics in other units. In our case, in order to pinpoint this

[10] This comparison is applied because the Breusch-Pagan Multiplier Lagrange Test is sensitive to the assumption of error normality.

```
Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
    F(  1,      7) =     6.337
             Prob > F =    0.0400
```

Fig. 6 Wooldridge test

kind of problem, we use Pesarans CD test[11] , where the null hypothesis is that there is cross-sectional independence. As can be seen in the output, at 5% significance H_0 is not rejected, such that there is no problem of contemporary correlation.

```
Pesaran's test of cross sectional independence =    1.660, Pr = 0.0970

Average absolute value of the off-diagonal elements =    0.390
```

Fig. 7 Pesarans CD test

In these conditions, we have a model estimated using FE which exhibits problems of heteroskedasticity and autocorrelation. To correct the latter, we applied a grade 1 (AR1) autoregressive fixed effects model with term (ρ) which controls for the dependence of t with respect to t-1. The AR1 model with fixed effects is shown in column 7.

The problems of autocorrelation and heteroskedasticity may be solved using *Feasible Generalized Least Squares* or FGLS, or *Panel Corrected Standard Errors* or PCSE. Given the greater accuracy of PCSE, first the problem of heteroskedasticity is corrected (column 8) and then the joint problem of heteroskedasticity and autocorrelation (column 9) using these estimators.

Having reached this point, we are in a position to establish the following relations with regard to the level of copyright protection (*Copyright* in our analysis):

Table 4 Results of the variables relation

Variable	Sign found
Effectiveness of anti-monopoly policy	(+)
Duration of compulsory education & Political	(+)
R&D GDP	(?)
Household spending on culture (% total spending)	(-)
lnGDPpc	(+)

[11] We used this test since it proved impossible to apply the Breusch-Pagan test. In our case, the number of individuals (eight countries) exceeds the number of periods (2006-2011).

5 Final conclusions

Although the early days of copyright economics as a branch of economics date back to the 1930s, the bulk of the research and progress has appeared over the last twenty years. The fact that intellectual goods are considered public goods given their non-rival and non-excludable nature has fostered the analysis of copyright since it provides the chance to use many of the economic tools employed in public economics.

The search for a balance between access and incentives is another of the trade-offs which is yet to be resolved. If copyright is famous for one thing it is for the wave of debates and controversies it arouses with regard to its function as a tool that fosters creativity, said disputes having only increased with the onset of the digital era.

Another of the more controversial issues surrounding this discipline (and which has given rise to one of the keenest debates) is the link between copyright and competition policy. The very nature of creative goods makes copyright law prone to spawning monopolist behaviour whilst at the same time growing stronger thanks to its ability to promote innovative activity.

We face two institutions that pursue a common goal, namely to enhance social welfare. Yet, the features which define the two and how they are enforced lie at the heart of a certain clash between them and make studying them no easy task.

The present work explores the extent to which competition policy, together with education, innovation, culture, and a countrys national wealth might determine the level of copyright protection, for which purpose panel data analysis has been applied.

The findings to emerge substantiate the initial notion of a complementarity between copyright and competition policy.

Likewise, the initial hypotheses concerning wealth and education have also been supported. As a countrys per capita rent and levels of educational attainment increase, so does the intensity with which it protects copyright. The link with regard to indicators of innovation does not, however, prove significant.

Particularly worthy of attention are the findings obtained concerning household spending on cultural and recreational activities, which points to the likely existence of a negative relation. As shown, there is a negative relation between household spending on these activities and the extent of copyright protection. This finding fuels the debate regarding the role of copyright as a means of funding the cultural sector.

The difference in terms of groups of countries vis--vis how intense copyright protection is has proved to be significant, such that the Nordic countries afford greater copyright protection, followed by the Anglo-American, continental European, and Mediterranean countries.

In order to improve the quality of the analysis and achieve more significant results, a more detailed study of each category is necessary, for which end the time horizon must be extended and further work must be carried out into the econometric analysis.

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6 Annex

Table 5 Category 1: Innovation and R&D

Variable	Source	Definition	Measure	Period
Innovation capacity	World Economic Forum	Extent to which firms in a country have the capacity to innovate	Ranges from 1 to 7. 1: Zero capacity 7: Great capacity	2006-2011
Quality of research institutions	World Economic Forum	Quality of a countrys scientific research institutes compared to the rest of the countries in the world	Ranges from 1 to 7. 1: Amongst the worst in the world 7: Amongst the best in the world	2006-2011
University-industry collaboration	World Economic Forum	The extent to which universities and firms cooperate in R&D	Ranges from 1 to 7. 1: Zero cooperation 7: Full cooperation	2006-2011
Scientists and engineers	World Economic Forum	Availability of scientists and engineers in a country	Ranges from 1 to 7 1: No availability 7: Wide availability	2006-2011
Internet use	World Economic Forum	Individuals who use Internet	%	2006-2011
Internet subscriptions	World Economic Forum	Wideband Internet users	Units per 100 inhabitants	2006-2011
R&D	OECD	Total spending on R&D over GDP	% of GDP	2006-2011
R&D personnel	OECD	Employees in the R&D sector	Units per 1000 employees	2006-2011

Table 6 Category 2: Competition policy

Variable	Source	Definition	Measure	Period
Local competition	World Economic Forum	Intensity of competition in local markets	Ranges from 1 to 7. 1: Null intensity 7: Extreme intensity	2006-2011
Market dominance	World Economic Forum	Extending domination in markets	Ranges from 1 to 7. 1: Dominated by a minority of business groups 7: Domination spread around many firms	2006-2011
Antitrust effectiveness	World Economic Forum	Extent to which competition policy fosters competition	Ranges from 1 to 7. 1: Does not promote it 7: Promotes it effectively	2006-2011
Business procedures	World Economic Forum	Number of procedures required to set up a business	Units	2006-2011
Business days	World Economic Forum	Number of days required to set up a business	Units	2006-2011
Trade barriers	World Economic Forum	Extent to which non-tariff barriers restrict the capacity of the goods imported to compete in the domestic market	Ranges from 1 to 7 1: Severe restrictions 7: No restrictions	2006-2011
Economic freedom	Heritage Foundation	Assesses the economic freedom in an economy in accordance with four pillars: rule of law, restrictions on government, regulatory efficiency, and open markets	Ranges from 0 to 100 0: No economic freedom 100: Total economic freedom	2006-2011
Business freedom	Heritage Foundation	Extent of freedom in business. It forms part of one of the pillars of economic freedom index	Ranges from 0 to 100 0: No freedom 100: Total freedom	2006-2011

Table 7 Category 3: Culture

Variable	Source	Definition	Measure	Period
Public spending on culture	OECD	Public spending devoted to cultural and recreational activities	National currency, millions	2006-2011
Public spending on culture GDP	Authors own based on OECD	Public spending devoted to cultural and recreational activities over GDP	% GDP	2006-2011
Household spending on culture	OECD	Household spending on cultural and recreational activities	National currency, millions	2006-2011
Household spending on culture/total spending	Authors own based on OECD	Household spending on cultural and recreational activities over total spending	% of total spending	2006-2011
Household spending on culture GDP	Authors own based on OECD	Household spending on cultural and recreational activities over GDP	% GDP	2006-2011
Film production	UNCTAD	Number of short films made in a country	Units	2006-2011
HICP index	EUROSTAT	Mean annual price index of cultural and recreational activities	Base index=100	2006-2011
HICP index	EUROSTAT	Mean price variation rate of cultural and recreational activities	No variation=0	2006-2011

Table 8 Category 4: Education

Variable	Source	Definition	Measure	Period
Duration of compulsory education	UNCTAD	Years of compulsory education in each country	Years	2006-2011
Public spending on education	World Development Indicators	Total public spending (current and capital) on education, expressed as a percentage of GDP in a given year	% GDP	2006-2011
School enrolment, tertiary	World Development Indicators	Total enrolment in tertiary education expressed as a percentage of the total population of the five-year age group following on from secondary school leaving.	%	2006-2011
Tertiary graduates	OECD	Graduates in tertiary education and advanced research programmes	Units	2006-2011

Table 9 Category 5: Wealth

Variable	Source	Definition	Measure	Period
GDP	OECD	Gross national product of an economy or country	National currency, current prices, millions	2006-2011
Population	UNCTAD	Number of inhabitants in a country	Thousands	2006-2011
GDPpc	World Development Indicators	GDP divided by the countrys population half way through the year	Current dollars ($)	2006-2011
GINI index	OECD	Extent to which the distribution of an economys income between individuals or households differs from a perfectly equitable distribution	Ranges from 0 to 100 1: Perfect equity 7: Total inequity	2006-2011