

## SHOULD DIFFERENT INFORMATION ECONOMIES HAVE THE SAME DURATION OF COPYRIGHT?

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ABSTRACT. Copyright has been increasingly internationalized and, recently, more and more harmonized. However, there has been little theoretical study of international copyright. This paper develops and analyzes a non-cooperative two-country model of copyright, where two countries trade in information goods and each with an open and competitive information goods industry sets copyright policy to pursue self-national interest. The model suggests that an increase in demand for information goods in a country calls for longer copyright protection in this country and shorter protection in its trading partner; decreases in fixed or per-product creative costs in a country with lower such costs call for marginally shorter protection; and an improvement in the economies of creative scale in a country with better economies of creative scale calls for marginally longer protection. Understanding these rational responses of nations to changes in creative technologies and markets should be helpful for international copyright-policy making.

### 1. INTRODUCTION

With globalization and the growing importance of information goods in the world economy, copyright has increasingly been internationalized. This internationalization has been exemplified by the signing of the Berne Convention in 1886, the establishment of the *World Intellectual Property Organization* (WIPO) in 1967, the *Agreement on Trade Related Aspects of Intellectual Property Rights* (TRIPs) in 1994, and the signing of the WIPO Copyright Treaty in 1996.

International copyright has been more and more harmonized recently. This growing harmonization has been captured in the 1993 European Union (EU) directive harmonizing term of protection of copyright in EU, the U.S. 1998 Sonny Bono Copyright Term Extension Act, harmonizing term of copyright in U.S. with that

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The author wishes to thank Professor F. M. Scherer of Harvard University for comments and pointers to the patent literature and a referee for suggestions improving the exposition of the paper. This study was partially supported by a grant from the Roger Williams University Foundation to Promote Scholarship and Teaching and by Grants-in-Aid for Scientific Research for the Promotion of Science ((B) 20402034) in Japan.

of EU, and the extension of copyright terms in many other countries since then, harmonizing their copyright terms with that of the U.S.

Theoretically, copyright policy is apparently international. Because residents of any one country are consumers of the information goods of many others, copyright policy has cross-country welfare effects on the residents of all countries; and because the demand from residents in any one country constitutes an incentive for creators in others, the demand conditions in this country affect the optimal copyright policy of other countries. Furthermore, the copyright policy of one country can affect the optimal policy of another, and vice versa, through the effect of each country's policies on the other's creators, who must abide by the policy of the country of the market to which they are selling.

Despite the above apparent practical and theoretical international dimensions, few theoretical studies can be found about international copyright. Extant economic copyright models, for example those in Novos and Waldman (1984), Johnson (1985), Liebowitz (1985), Besen and Kirby (1989), Landes and Posner (1989), Yoon (2002), and Yuan (2005), assume a single copyright policy maker and a single market for information goods and do not incorporate international trade.

Several existing papers study international patent policy, for example Berkowitz and Kotowitz (1982), Scherer (2004), Scotchmer (2004), and Grossman and Lai (2004). However, patent differs from copyright in important ways. For example, independent creation and consequent distribution of close and substitutive works are allowed and are commonplace in copyright, but not in patent. For the case of patent, there is often a race to invent. In the end of the inventive race, the winner takes all in the form of a patent, which prohibits selling of close substitutes during the life of the patent.

The present paper investigates how national governments choose their individual national copyright policies, taking into account the policies of other nations, assuming each government is nationally self-interested. The paper presents a model for a simple world of two countries, that trade information goods, each with an open and competitive information goods industry and a market for such goods, each setting its copyright policy to maximize its own national welfare, taking the other country's copyright policy as given. We analyze the model to see whether the copyright policies of the two countries will be the same or how they differ in relation to the differences in demand and creative technologies between the countries.

The differences between this study and the studies on patent mentioned above can be seen in the following. Berkowitz and Kotowitz (1982) model a small country facing a world which does not respond to patent policy of the country. Scherer (2004) estimates the effect on global welfare of a uniform international patent versus that of a weaker patent protection for pharmaceutical products in poorer countries.

Scherer does not employ an explicit model of patent policy-making by national governments. Similar to the present study, Scotchmer (2004) and Grossman and Lai (2004) use two country models. However, they both assume a single inventor per country and there is no interaction, substitutive or otherwise, among the invented products. Therefore, in those models, there is no competition in either the markets for these goods or their invention. As noted above, competition among close substitutes is permitted under copyright law, so long as the creative expression in one work is not actually copied by the author of another. Even in patent, competition within the same class of products, such as drugs, is found to exist (Lichtenberg and Philipson, 2002). And whether there is competition among inventors for patent is known to be critical for optimal patent policy (Palmer and Rafiqzaman, 1986). Another difference between this study and the above patent studies is that this study allows for more complex, potentially more realistic, cost and demand functions, due to its use of numerical analysis.

The main results of the paper are the following: (a) an increase in the demand for information goods in one country calls for longer copyright protection in that country and shorter protection in its trading partner; (b) decreases in the fixed and per-product creative costs in a country with lower such costs call for marginally shorter protection; (c) an improvement in the economies of creative scale in a country with better economies of creative scale calls for marginally longer protection. Consequently, the country with the larger demand for information goods prefers longer copyright protection to induce larger global creative industries. The country with the smaller demand for information goods may adopt a minimal copyright protection policy and free ride on the creative industries induced by the other; a country with an advantage in lower fixed and per-product creative costs uses a shorter copyright term; and a country with an advantage in economies of creative scale may use a longer protection term.

The rest of paper is organized as follows. The next section develops the model. Section 3 solves the model by numerical methods and presents the results of those simulations. Then the paper concludes.

## 2. THE MODEL

Assume a world information economy composed of two countries. Each country has a sector of creators and a market with consumers for information goods. A creator in either country develops original information products and sells copies of its products on the domestic and foreign markets. The two markets may differ in the level of demand for information goods. Creators in different countries may differ with respect to creative costs, perhaps due to the differences in technological

development and general business/regulatory environments. The reproduction cost of information goods is assumed to be the same across countries and creators.

The copyright authority of each country maximizes welfare in its own country. It sets its copyright policy to maximize the total surplus of creators and consumers of the country, taking the copyright policy of the other country as given. The policy adopted by a country applies to both domestic products and foreign products on the market of that country, consistent with the national treatment requirement in international copyright laws. If prices of the same products differ on the two markets or copyright protection on one market expires before on the other, an effective ban on parallel importation will be assumed.

The policy variable available to the copyright authority in this model is duration. Duration is a key variable of copyright, and it may be interpreted more generally as strength of copyright. Other aspects of copyright will be assumed fixed and uniform across the two countries.

Assume the following notation:

$i, j$ : indices of creators of country 1 or 2;

$n_1$ : number of creators in country 1;

$n_2$ : number of creators in country 2;

$s_{1i}$ : number of first copy products of creator  $i$  in country 1;

$s_{2i}$ : number of first copy products of creator  $i$  in country 2;

$S$ : total number of first copy products  $S = n_1 \times s_1 + n_2 \times s_2$ ;

$c_{1i}(s_{1i})$ : creative cost of creator  $i$  of country 1;

$c_{2i}(s_{2i})$ : creative cost of creator  $i$  of country 2;

$b$ : reproduction cost per copy of creators of both country 1 and 2;

$p_{11it}$ : price per copy of products of creator  $i$  of country 1 in country 1 at time  $t$ ;

$p_{12it}$ : price per copy of products of creator  $i$  of country 1 in country 2 at time  $t$ ;

$p_{21it}$ : price per copy of products of creator  $i$  of country 2 in country 1 at time  $t$ ;

$p_{22it}$ : price per copy of products of creator  $i$  of country 2 in country 2 at time  $t$ ;

$p_{11-it}$ : vector of prices of products of all creators, other than  $i$  of country 1, in country 1 at time  $t$ ;

$p_{12-it}$ : vector of prices of products of all creators, other than  $i$  of country 1, in country 2 at time  $t$ ;

$p_{21-it}$ : vector of prices of products of all creators, other than  $i$  of country 2, in country 1 at time  $t$ ;

$p_{22-it}$ : vector of prices of products of all creators, other than  $i$  of country 2, in country 2 at time  $t$ ;

$T_1$ : copyright duration of country 1;

$T_2$ : copyright duration of country 2;

$d_{11it}(s_{1i}, s_{1-i}, s_{2i}, p_{11i}, p_{11-i}, t)$ : rate of demand for products of  $i$  of country 1 in country 1 at time  $t$ ;

$d_{12it}(s_{1i}, s_{1-i}, s_{2i}, p_{12i}, p_{12-i}, t)$ : rate of demand for products of  $i$  of country 1 in country 2 at time  $t$ ;

$d_{21it}(s_{1i}, s_{2-i}, s_{2i}, p_{21i}, p_{21-i}, t)$ : rate of demand for products of  $i$  of country 2 in country 1 at time  $t$ ;

$d_{22it}(s_{1i}, s_{2-i}, s_{2i}, p_{22i}, p_{22-i}, t)$ : rate of demand for products of  $i$  of country 2 in country 2 at time  $t$ ;

$cs_1$ : consumer surplus of country 1;

$cs_2$ : consumer surplus of country 2;

$\gamma$ : social discount rate for consumers and creators in both countries.

The profit of creator  $i$  of country 1 is:

$$\pi_{1i} = \int_0^{T_1} (d_{11it}(p_{11it} - b)e^{-\gamma t} dt + \int_0^{T_2} (d_{12it}(p_{12it} - b)e^{-\gamma t} dt - c_{1i}(s_{1i})) \quad (1)$$

The first term is the quasi-rent from selling its products on the market of country 1 during copyright duration of that country from time 0 to time  $T_1$ ; the second term is the quasi-rent from selling on the market of country 2 during copyright duration from time 0 to time  $T_2$ . The third term is the total creative cost of creator  $i$  creating  $s_{1i}$  first copy products.

Similarly, the profit of creator  $i$  of country 2 is:

$$\pi_{2i} = \int_0^{T_1} (d_{21it}(p_{21it} - b)e^{-\gamma t} dt + \int_0^{T_2} (d_{22it}(p_{22it} - b)e^{-\gamma t} dt - c_{2i}(s_{2i})) \quad (2)$$

A creator chooses prices and number of first copy products to create to maximize profit. The first-order conditions (assuming concavity) are:

$$\frac{\partial \pi_{1i}}{\partial p_{11it}} = 0 \quad (3)$$

$$\frac{\partial \pi_{1i}}{\partial p_{12it}} = 0 \quad (4)$$

$$\frac{\partial \pi_{1i}}{\partial s_{1i}} = 0 \quad (5)$$

$$\frac{\partial \pi_{2i}}{\partial p_{21it}} = 0 \quad (6)$$

$$\frac{\partial \pi_{2i}}{\partial p_{22it}} = 0 \quad (7)$$

$$\frac{\partial \pi_{2i}}{\partial s_{2i}} = 0 \quad (8)$$

A creator also decides whether to enter or stay on the market. The information goods industries are assumed to be open. Therefore, the marginal creator makes zero economic profits. If all creators in a country have the same technology, they will all make zero profit. That is:

$$\pi_{1i} = 0 \quad (9)$$

$$\pi_{2j} = 0 \quad (10)$$

The consumer surplus of country 1 can be written as:

$$\begin{aligned} cs_1 = & \sum_{i=1}^{n_1} \int_0^\infty \left( \int_b^\infty d_{11i} dp_{11it} \right) e^{-\gamma t} dt + \sum_{i=1}^{n_2} \int_0^\infty \left( \int_b^\infty d_{21i} dp_{21it} \right) e^{-\gamma t} dt \\ & - \sum_{i=1}^{n_1} \int_0^{T_1} \left( \int_b^{p_{11it}^*} d_{11i} dp_{11it} \right) e^{-\gamma t} dt - \sum_{i=1}^{n_2} \int_0^{T_1} \left( \int_b^{p_{21it}^*} d_{21i} dp_{21it} \right) e^{-\gamma t} dt \quad (11) \end{aligned}$$

Where  $p_{11it}^*$  and  $p_{21it}^*$  are the prices chosen by creator  $i$  of country 1 and creator  $i$  of country 2, respectively, on the market of country 1 during the period of copyright protection. The first term is country 1's consumer surplus from all products of creators of country 1, if the products were priced at marginal reproduction cost  $b$  from the moment they are created; the second term is the surplus from products of creators of country 2, if the products were priced at reproduction cost  $b$  from the moment they are created; the third term is the loss in consumer surplus from the products of the creators of country 1 due to copyright protection, which lasts from time 0 to  $T_1$ ; and the fourth term is the loss in consumer surplus from the products of the creators of country 2 due to the same copyright protection.

Similarly, the consumer surplus of country 2 is:

$$\begin{aligned} cs_2 = & \sum_{i=1}^{n_1} \int_0^\infty \left( \int_b^\infty d_{12i} dp_{12it} \right) e^{-\gamma t} dt + \sum_{i=1}^{n_2} \int_0^\infty \left( \int_b^\infty d_{22i} dp_{22it} \right) e^{-\gamma t} dt \\ & - \sum_{i=1}^{n_1} \int_0^{T_2} \left( \int_b^{p_{12it}^*} d_{12i} dp_{12it} \right) e^{-\gamma t} dt - \sum_{i=1}^{n_2} \int_0^{T_2} \left( \int_b^{p_{22it}^*} d_{22i} dp_{22it} \right) e^{-\gamma t} dt \quad (12) \end{aligned}$$

Where  $p_{12it}^*$  and  $p_{22it}^*$  are the prices chosen by creator  $i$  of country 1 and creator  $i$  of country 2, respectively, on the market of country 2 during the period of copyright

protection. Here the demands are from the market of country 2; and copyright duration lasts from time 0 to  $T_2$ .

We assume all creators in a given country have the same technology, and they all make zero economic profit. Social welfare is then the same as consumer surplus.

The problem of the copyright authority of country 1 is to set duration  $T_1$  to maximize the social welfare  $cs_1$ , given the behavior of creators of the two countries as described in (3)-(10) and the duration  $T_2$  set by country 2. The first order condition (again, assuming concavity) is:

$$\frac{dcs_1}{dT_1} = 0. \quad (13)$$

Similarly, the problem of the copyright authority of country 2 is to set duration  $T_2$  to maximize the social welfare  $cs_2$ , given creator behavior (3)-(10) and  $T_1$  set by country 1. The first condition (assuming concavity) is:

$$\frac{dcs_2}{dT_2} = 0. \quad (14)$$

### 3. MODEL SPECIFICATION AND RESULTS

The model needs to be solved to see how the two countries choose their copyright durations in relation to the characteristics of the two markets and creative technologies of the two countries.

**3.1. Specification of Demand and Cost Functions.** Solving the model requires specific forms of the demand and cost functions. To that end, I assume the following demand and cost functions:

$$d_{11it} = D_1 s_{1i} \left( \sum_{j=1}^{n_1} s_{1j} + \sum_{j=1}^{n_2} s_{2j} \right)^{\alpha-1} p_{11it}^{-\delta} \prod_{j \neq i} p_{11jt}^{\frac{\beta}{n_1+n_2-1}} \prod_{j=1}^{n_2} p_{21jt}^{\frac{\beta}{n_1+n_2-1}} g_1(t) \quad (15)$$

$$d_{12it} = D_2 s_{1i} \left( \sum_{j=1}^{n_1} s_{1j} + \sum_{j=1}^{n_2} s_{2j} \right)^{\alpha-1} p_{12it}^{-\delta} \prod_{j \neq i} p_{12jt}^{\frac{\beta}{n_1+n_2-1}} \prod_{j=1}^{n_2} p_{22jt}^{\frac{\beta}{n_1+n_2-1}} g_2(t) \quad (16)$$

$$d_{21it} = D_1 s_{2i} \left( \sum_{j=1}^{n_1} s_{1j} + \sum_{j=1}^{n_2} s_{2j} \right)^{\alpha-1} p_{21it}^{-\delta} \prod_{j \neq i} p_{21jt}^{\frac{\beta}{n_1+n_2-1}} \prod_{j=1}^{n_1} p_{11jt}^{\frac{\beta}{n_1+n_2-1}} g_1(t) \quad (17)$$

$$d_{22it} = D_2 s_{2i} \left( \sum_{j=1}^{n_1} s_{1j} + \sum_{j=1}^{n_2} s_{2j} \right)^{\alpha-1} p_{22it}^{-\delta} \prod_{j \neq i} p_{22jt}^{\frac{\beta}{n_1+n_2-1}} \prod_{j=1}^{n_1} p_{12jt}^{\frac{\beta}{n_1+n_2-1}} g_2(t) \quad (18)$$

and

$$g_1(t) = \begin{cases} 1 - \frac{t}{T_{01}} & \text{if } t < T_{01}(1 - \theta_1) \\ \theta_1 & \text{otherwise} \end{cases} \quad (19)$$

$$g_2(t) = \begin{cases} 1 - \frac{t}{T_{02}} & \text{if } t < T_{02}(1 - \theta_2) \\ \theta_2 & \text{otherwise} \end{cases} \quad (20)$$

and

$$c_{1i}(s_{1i}) = c_{01} + a_1 s_{1i}^{\rho_1} \quad \forall i \text{ of country 1} \quad (21)$$

$$c_{2i}(s_{2i}) = c_{02} + a_2 s_{2i}^{\rho_2} \quad \forall i \text{ of country 2} \quad (22)$$

where  $0 < \alpha < 1$ ,  $\delta > 1$ ,  $\beta > 0$ ,  $0 = \theta_1 < 1$ ,  $0 = \theta_2 < 1$ ,  $\rho_1 > 1$ ,  $\rho_2 > 1$ , and  $D_1, D_2, T_{01}, T_{02}, c_{01}, c_{02}$  and  $a_1$  and  $a_2$  are positive constants.

The main features in the demand functions (15)-(18) are described as follows:

- (1) There are five factors which multiplicatively affect the demand for products of a creator: (i) the number of first copy products of the creator, (ii) the total number of first copy products on the market from all creators, (iii) the price of products of this creator, (iv) the prices of products of other creators, and (v) time.
- (2) The total demand for all information products of all creators on a market increases with the total number of first copy product. The parameter  $\alpha$  is the speed of the increase. It describes the consumers' preference for product variety. And  $0 < \alpha < 1$  represents the assumption that the products are substitutes.
- (3) Total demand is distributed among creators in proportion to their numbers of first copy products, everything else being equal.
- (4) The demand for the products of a creator decreases with the price charged by the creator. The parameter  $\delta$  is the price elasticity.  $\delta > 1$  is necessary for the consumer surpluses to be finite.
- (5) The demand for the products of a creator increases with the prices of other creators. The parameter  $\beta > 0$  is the cross-price elasticity.



- (6) The demands in the two markets decrease over time to residual levels of  $\theta_1$  and  $\theta_2$  of the original demands in time  $T_{01}(1 - \theta_1)$  and  $T_{02}(1 - \theta_2)$ , respectively.

The markets in the two countries may differ in the level of demand,  $D_1$  and  $D_2$ , and the residual demand,  $\theta_1$  and  $\theta_2$ , and the time it takes for the demands to drop to the residuals,  $T_{01}(1 - \theta_1)$  and  $T_{02}(1 - \theta_2)$ .  $T_{01}$  and  $T_{02}$  will be referred to as the economic life of products on the two markets. Otherwise, each market treats all domestic and foreign products similarly. Consumers in the two countries have the same price elasticity, cross-price elasticity, and preference for variety, as represented by the common values of  $\delta$ ,  $\beta$ , and  $\alpha$ , respectively.

The main features of the creative cost functions of (21) and (22) are described as follows:

- (1) There are fixed costs to enter the creative industries in both countries, which are  $c_{01}$  and  $c_{02}$ , respectively.
- (2) There are decreasing returns to scale in creation in both countries, as reflected in the parameters  $\rho_1 > 1$ ,  $\rho_2 > 1$ , respectively.
- (3) The levels of variable creative costs also depend on the parameters  $a_1$  and  $a_2$ , respectively, which will be referred to as the “per-product creative cost” parameters.

Creators within one country have identical creative costs. Creators of one country may differ from creators of the other country in fixed creative cost, per-product creative cost, and economies of creative scale, perhaps due to technological and general regulatory differences.

Given the multiplicativity of the factors affecting the demand, the common price elasticity, and the common reproductive cost of  $b$  for all products, it turns out that creators set prices which are uniform for all products, all creators, at all moments of time:

$$p_{11it} = p_{12it} = p_{21j} = p_{22j} = p = \frac{\delta}{\delta - 1} b \quad (23)$$

Given the identical cost functions within one country, it can also be shown that creators of one country all create the same number of first-copy products:  $s_{1i} = s_{1j} = s_1$  and  $s_{2i} = s_{2j} = s_2$ .

In order to obtain results for price  $p$ , sizes of creators,  $s_1$  and  $s_2$ , total number of first-copy products  $S$ , duration of copyright  $T_1$  and  $T_2$ , and consumer surpluses  $cs_1$  and  $cs_2$ , it is necessary to further solve the model. Given the complexity of the assumed demand and cost functions, an analytical solution is not tractable. Thus, numerical methods are used to solve the model for given values of the parameters in the demand and cost functions.

**3.2. Baseline Solution**<sup>1</sup>. Assume the following parameter values:

$$\begin{aligned}
 & [D_1, D_2, \alpha, \delta, \beta, b, T_{01}, T_{02}, \theta_1, \theta_2, \gamma, c_{01}, c_{02}, a_1, a_2, \rho_1, \rho_2] \\
 & = [7 \times 10^6, 7 \times 10^6, 0.3, 2, 0.5, 5, 100, 100, 0.001, 0.001, 0.05, 3 \times 10^5, \\
 & \quad 3 \times 10^5, 10^4, 10^4, 1.2, 1.2]
 \end{aligned} \quad (24)$$

For these parameters, the numerical solution to the model is the following:

$T_1$	$T_2$	$s_1$	$s_2$	$S$	$cs_1$	$cs_2$
7	7	63	63	6224	\$0.8 B	\$0.8 B

The above parameter values represent that the creators of two countries are assumed to have the same technologies and consumers the same preferences. Given the above parameters, the copyright durations are 7 years in both countries; creators in both countries each create 63 original products; the total number of first-copy products is 6,224; and consumer surpluses for both countries are \$0.8 billion.

Figure 1 shows the optimality of the solution for each creator and for each country. If a creator deviates from the optimal size of 63, the creator will incur a loss, given that both countries adopt the optimal duration of copyright of 7 years and other creators stay at their optimal sizes. When either country deviates from the optimal duration, the welfare of the country will be lower than the maximum of \$0.8 billion, given that the other country maintains the optimal duration and the creators behave as described by the model.

It may be interesting to note that the numbers of creators of the two countries are indeterminate in the model, given the baseline parameter values. The national origin of the creators does not matter to the consumers, the copyright authority, and the solution of the model.

### 3.3. The Effect of Relative International Demand on Copyright Duration.

It is interesting to know the effect of the relative sizes of the markets of the two countries on their respective durations of copyright. To investigate the effect, I now change the level of demand of country 1,  $D_1$ , while fixing the other parameters at the values listed in (24). The result is shown in Figure 2. The parallel result of changing the demand level of country 2,  $D_2$ , is shown in Figure 3.

First, observe that, in Figure 2, the optimal copyright duration of country 1 increases and that of country 2 decreases with the level of demand of country 1. This continues until the copyright duration in country 1 reaches a maximum of 14 years and that of country 2 reaches a minimum of zero. Conversely, as the demand of country 1 decreases, the copyright duration of that country decreases and that

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<sup>1</sup>The mathematical workings for the numerical solution are available upon request from the author.

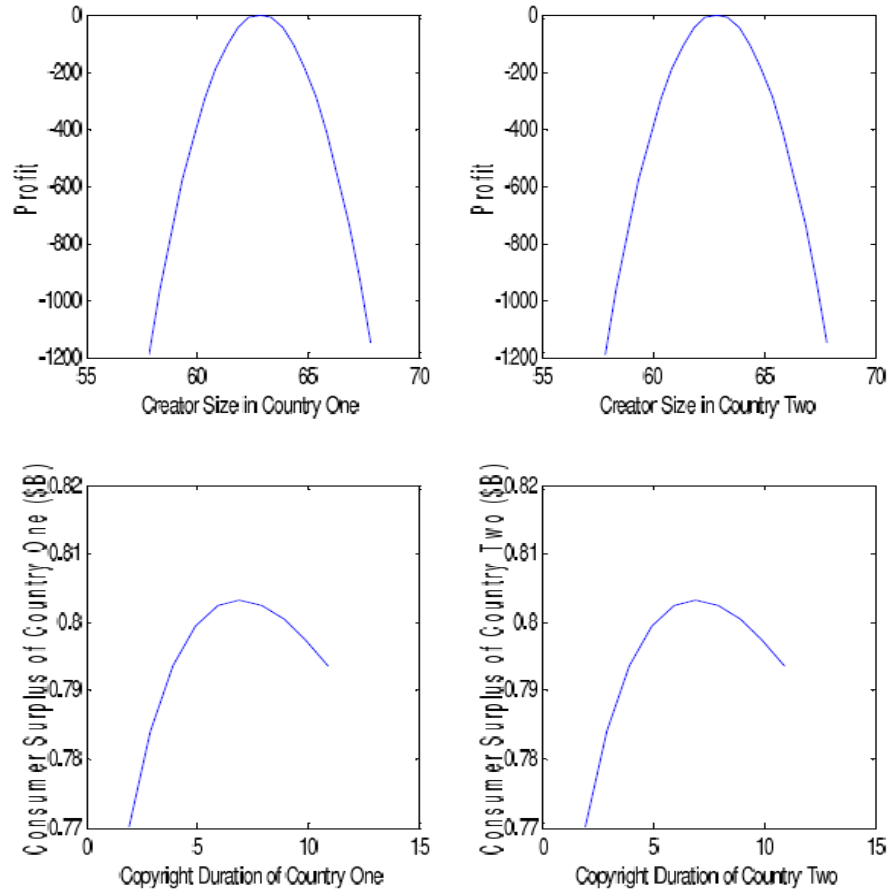


FIGURE 1

in country 2 increases. This continues until the duration in country 1 reaches a minimum of zero and that in country 2 reaches a maximum of 14. Parallel observations apply to Figure 3.

This result is similar to that of Grossman and Lai (2004) but contrary to that of Scotchmer (2004) for patents. This result is also the opposite of the result of Yuan (2005), which is based on a single country model.

Why does an increase in consumer demand in one country increase the optimal copyright duration in that country and decrease the optimal copyright duration in the other country? In the single country model of Yuan (2005), changing the demand in a country has three individual effects on copyright duration in the country: (a) a higher demand means that more information products should be created and calls for longer protection to induce their creation; (b) a higher demand provides for higher profitability for creators during copyright protection and reduces

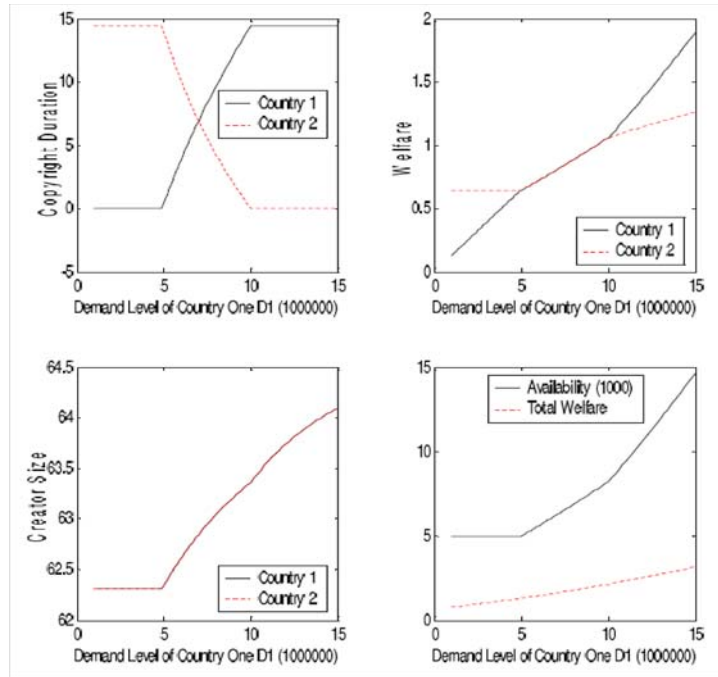


FIGURE 2

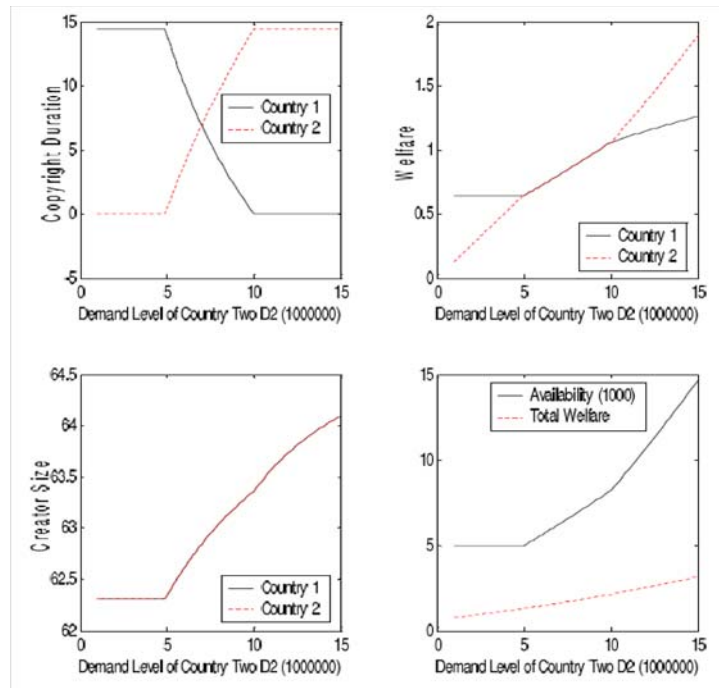


FIGURE 3

the need for longer copyright protection; (c) a higher demand increases the dead-weight loss from copyright protection and calls for shorter protection. In the single country model, the negative effects of (b) and (c) for shorter protection dominate the positive effect (a) for longer protection.

In a two country model, however, in addition to the above three individual effects, an increase in demand in one country (say, country 1) represents an increase in the creative incentive for creators in the other country (country 2). It reduces the need for copyright protection in country 2. Therefore, the copyright duration in country 2 decreases with the level of demand of country 1. This reduction in duration in country 2, in turn, represents a decrease in incentive for creators of country 1. And this decrease in incentives needs to be compensated by an increase in copyright duration in country 1, resulting in a fourth individual effect. And this fourth effect seems to change the balance, resulting in the net effect of longer duration in country 1.

It may be worth noting the opposite direction of the effects on duration in this and the foreign country from a change in a country's market size. An increase in the size of the market in a given country leads to the other country reducing copyright duration but to an increase in duration domestically.

Second, observe that the consumer surplus in both countries, the number of first-copy product per creator, and the total number of first-copy products all increase with the level of demand in either country. This can be seen in Figures 2 and 3.

Third, observe that a larger size of market does not always give a country more power or higher welfare. In the second graph of Figure 2, the welfare of the two countries is the same when  $D_1$  is between about  $[4.9 \times 10^6$  and  $10^7]$ . Within this interval for the value of  $D_1$ , the countries can respond to the changes in the level of demand in country 1,  $D_1$ , by changing their copyright durations. For example, when the demand in country 1 increases, it is in the interest of country 2 to lower its copyright duration and, in turn, country 1 will extend its duration. In equilibrium, the two countries end up with exactly the same social welfare. This happens, when there is symmetry between the two countries in parameters other than demand levels of  $D_1$  and  $D_2$ , and that the duration of the smaller country has not reached zero and that of the larger country has not reached its maximum of 14 years. Beyond the interval  $[4.9 \times 10^6$  and  $10^7]$  of  $D_1$ , copyright duration in the smaller country cannot be further reduced and that in the larger country cannot be further extended. The larger country will achieve higher welfare than smaller country.

Finally, Figures 4 and 5 show the results of changing the economic life of products. It can be seen that the more slowly the demand for information products dissipates over time, i.e., the longer the economic life of information goods in a country, as represented by larger  $T_{01}$  or  $T_{02}$ , the longer is the protection in the

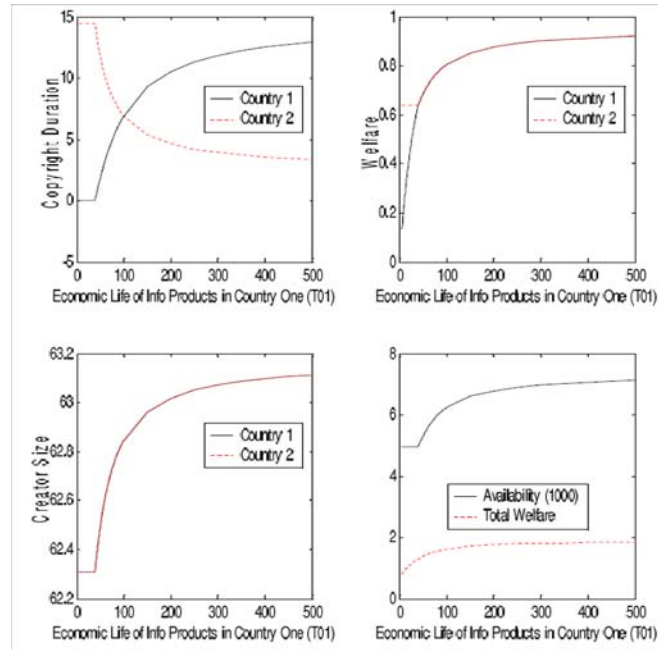


FIGURE 4

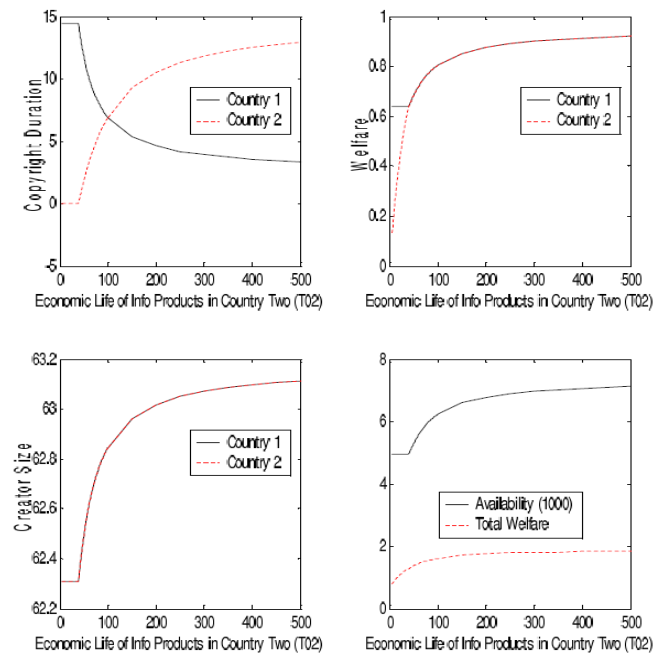


FIGURE 5

country and the shorter is the duration in the other country. The other country can afford shorter protection because of the longer protection given to its information goods in this country.

**3.4. The Effect of Relative International Creative Costs on Copyright Duration.** It is interesting to consider the effect of the relative creative costs on the optimal copyright in the two countries. First, consider the effect of relative fixed creative costs. To do that, we vary the parameter  $c_{01}$ , the fixed cost of creation in country 1, while keeping the values of the other parameters as in (24), and we recalculate the model. The result is shown in Figure 6. In Figure 6, the curves for the copyright durations of the two countries coincide; as do the curves showing the welfare of the two countries. The figure shows that when a country improves its fixed cost of creation relative to the other country (lower than 300,000 in our case), both countries will have slightly shorter optimal copyright protection; and if a country's fixed creative cost increases beyond a limit (300,000 in our case), further increases in the cost in the country have no effect on copyright duration or welfare, as the creators of that country are out of the markets. Changing the fixed cost of country 2,  $c_{02}$ , gives parallel results, as is shown in Figure 7.

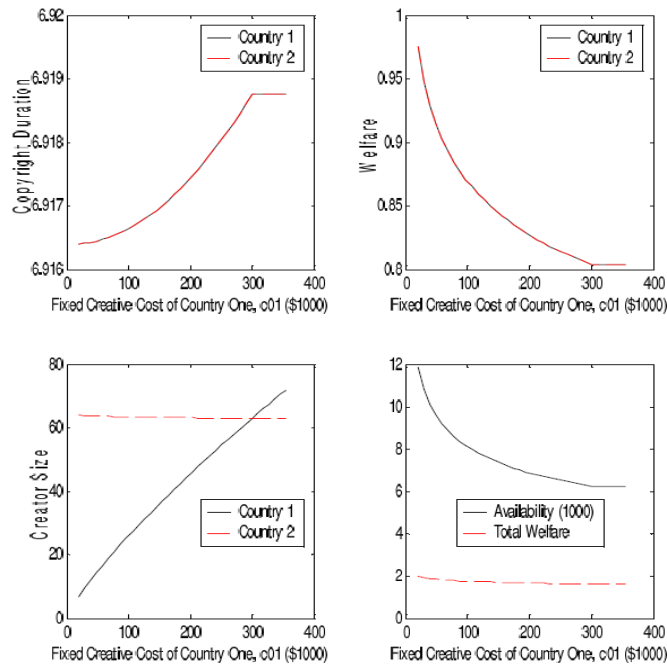


FIGURE 6

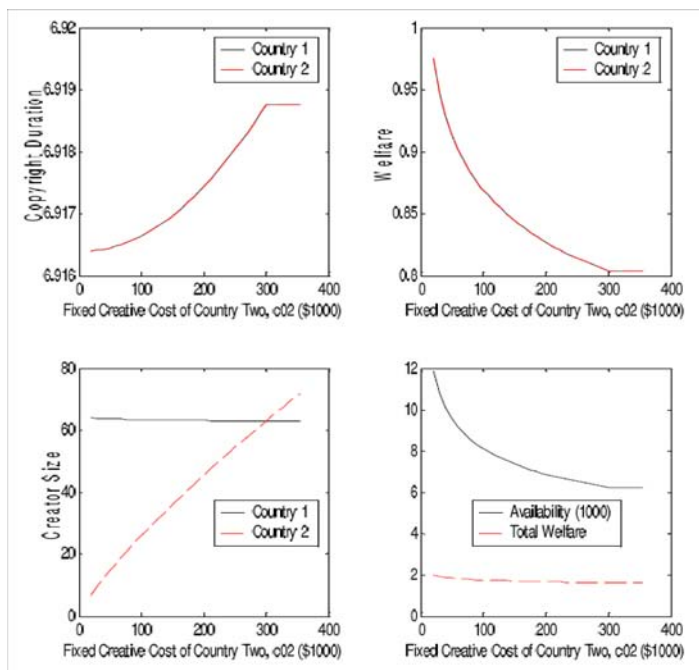


FIGURE 7

Second, consider the effect of the relative per-product creative cost. To do that, we vary the parameter,  $a_1$ , of country 1, keeping the values of the other parameters as in (24), and then we recalculate the model. The result is shown in Figure 8. In Figure 8, again the duration curves of the two countries coincide; as do the welfare curves of the two countries. Figure 8 shows that when a country strengthens its advantage in terms of a lower per-product creative cost,  $a_1$ , both countries will have slightly shorter optimal copyright; and if a country has higher per-product creative cost, further changes in the cost in that country have no effect on duration or welfare, as creators of the country are out of business. Changing the parameter  $a_2$  of country 2 gives parallel result, as is shown in Figure 9.

Third, consider the effect of relative economies of creative scale. To do that, we vary the parameter  $\rho_1$ , which represent the diseconomy of scale in country 1, while keeping the values of the other parameters as in (24), and we then recalculate the model. The result is shown in Figure 10. It shows that when a country improves its advantage in returns to creative scale, both countries will have slightly longer optimal copyright duration; and if a country has a disadvantage in returns to creative scale, changes in the diseconomies of creative scale have no effect on duration or welfare. Changing the parameter  $\rho_2$  of country 2 gives parallel results, as is shown in Figure 11.



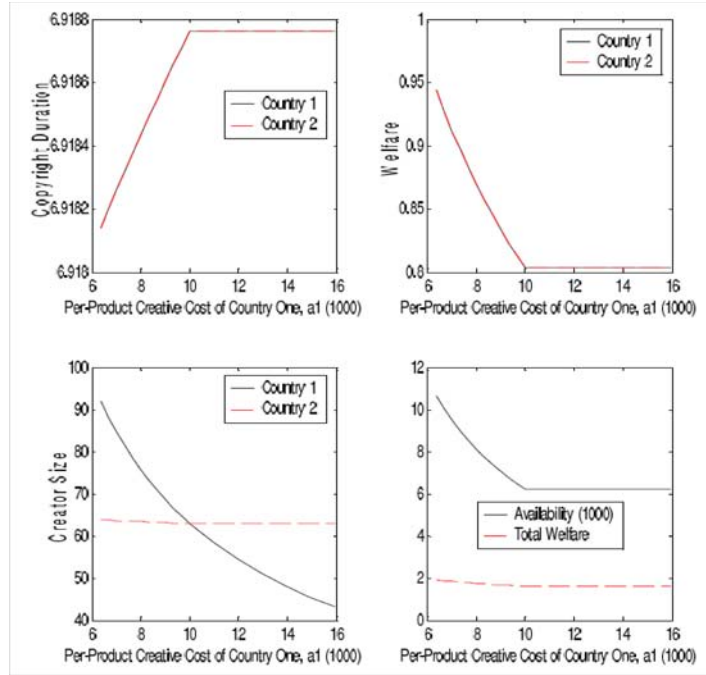


FIGURE 8

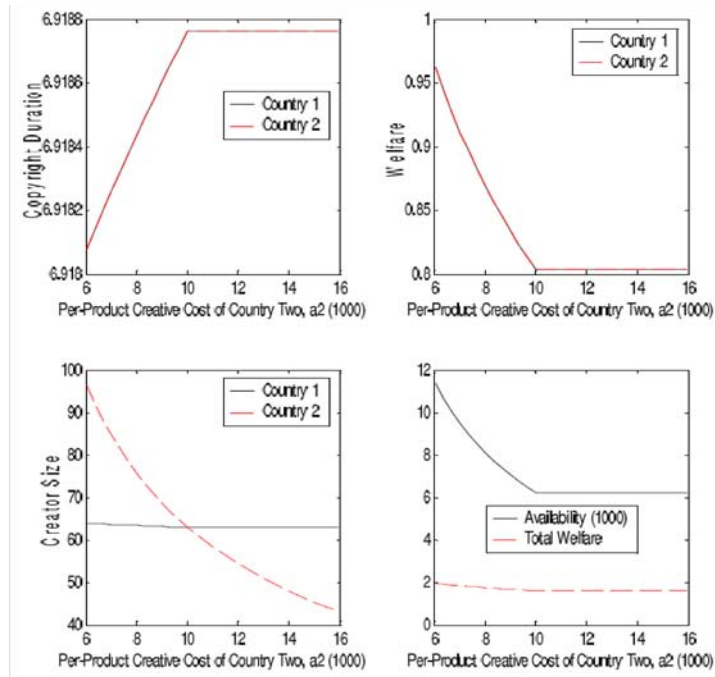


FIGURE 9

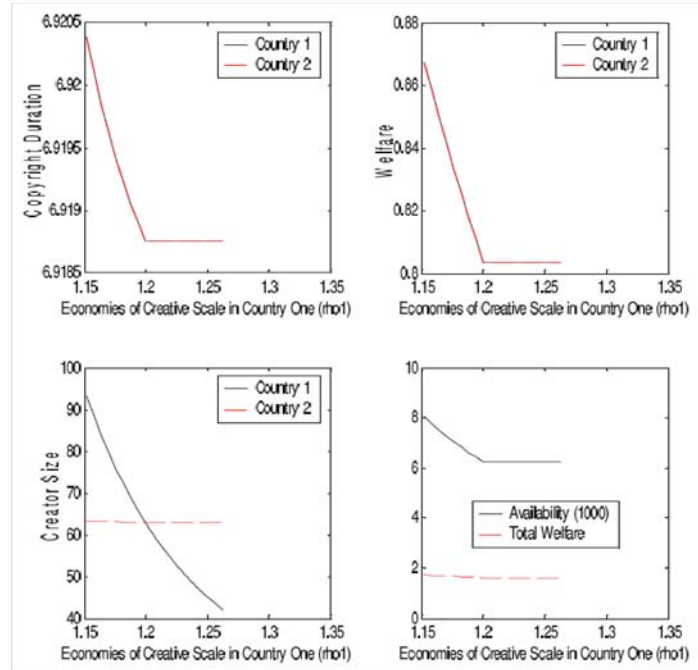


FIGURE 10

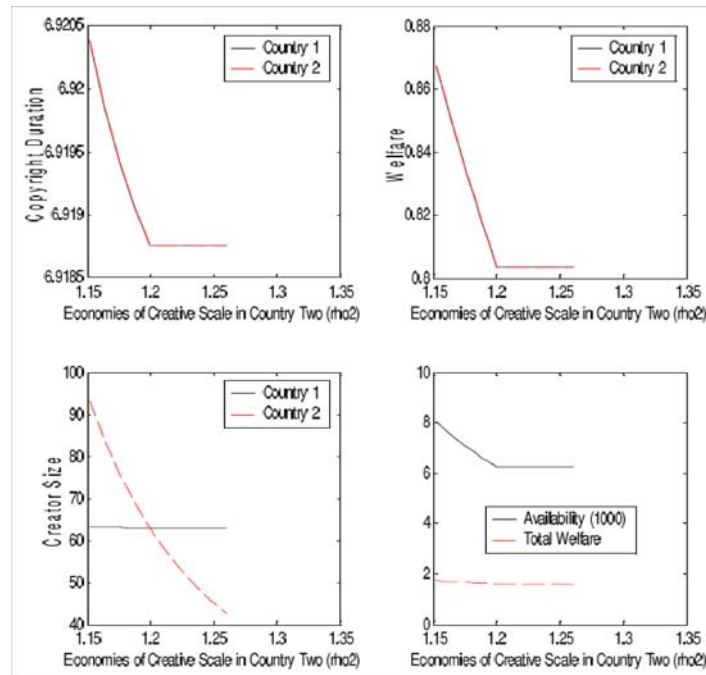


FIGURE 11

Some comments are in order on the effects of creative costs. First, the effects of changing creative costs on the size of creators, availability of information goods, and welfare are substantial, as can be seen in Figures 6 to 11. This is because creative costs directly affect the creative decisions of creators and the net social welfare from the created goods.

Second, the effects on optimal duration of copyright are rather marginal. The effects with the above parameter values are in the magnitude of one hundredth of one year in our results.

Why might the effects of creative costs on copyright duration be small? Increases in the creative cost of a country have two effects that work in opposite directions on the duration of copyright in the country: on the one hand, higher creative costs mean that information products are less desirable to the society as a whole of the country, which implies a lower incentive for creation and calls for a shorter copyright duration in the country. On the other hand, higher creative costs mean lower profits for creators of the country. That is, higher creative costs are disincentives for creators, which reduce the need for shortening copyright protection in the country. These two individual effects tend to cancel each other out.

In addition, in a two country model, when the creative costs in a country decrease (resp. increase), creators of this (resp. the other) country may simply take over market share from creators of the other (resp. this) country. Therefore, the impact of the change in creative costs on consumers and copyright policy is small.

Third, only cost changes in the leading country, i.e. that with lower creative costs, have any effect on copyright duration or welfare. Changes in the other country have no effect, so long as it remains at disadvantage in creative technologies.

Fourth, it may be interesting to compare the results with copyright policy in the real world. Countries with creative advantages seem often to call for more intensive copyright protection. The result that optimal copyright duration reduces with decreases in fixed or per-product creative cost in the leading creative country does not support such a policy. On the other hand, the increase in optimal copyright duration with improvements of economies of creative scale in the leading creative country is consistent with such a policy.

Fifth, one might be curious about why lower fixed and per-product creative costs in a country call for shorter copyright duration while less severe diseconomies of creative scale call for longer copyright. Lowering either cost represents enhanced incentive for creation. The results say that creators over-react to lowering of fixed and per-product creative costs, which is correctable with a reduction in copyright duration, but they under-react to a reduction in the diseconomy of creative scale, which is correctable by longer copyright protection.

The question becomes, why do creators over-react to lower fixed and per-product creative costs but under-react to the lessening of diseconomies of creative scale? The answer may be because fixed and per-product creative costs affect creative decisions about all first-copy products equally. In contrast, diseconomies of scale affect mainly the decision of the marginal first-copy product. In addition, the effect on copyright in the other country may be explained as a reaction to changes in duration in this country.

Finally, simply note that the results about the effect on duration of alterations in fixed and per-product creative costs differ from those of Grossman and Lai (2004) and Scotchmer (2004) for patent.

#### 4. CONCLUSION

This paper presents a model in which two countries trade information goods, each with an open and competitive information goods industry, a market for information goods, a copyright authority setting copyright policy to maximize its own national welfare while taking the other country's copyright policy as given.

The analysis suggests that an increase in demand for information goods in a country calls for longer copyright protection in this country and shorter protection in its trading partner; a decrease in fixed and per-product creative costs in a country with lower such costs calls for a marginally shorter protection; and an improvement in the economies of creative scale in a country with better such economies calls for a marginally longer protection.

Therefore, a country with larger demand for information goods would prefer longer copyright protection; a country with improving and relatively low fixed and per-product creative costs would call for shorter copyright; and a country with an increasing advantage in economies of creative scale may prefer longer protection.

The model assumes non-cooperativeness in international copyright policy making, symmetry among the products and between markets, monopolistic competitiveness in the information goods industries, and copyright authorities driven by national social welfare. Relaxing some of these assumptions is left for future study.

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