

Exploring a better design of copyright law

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Abstract

This study proposes a simulation model to explore how the copyright law should be designed; that is, a desirable combination of copyright length and breadth. The model also incorporates the cumulative features of content creation: the cost of creating new work decreases when larger parts of past works becomes freely available. The simulation results indicate that copyright protection should first be broad because social welfare is larger under broad protection than under narrow protection regardless of length. Then, short length is more desirable because it encourages creators to publish more works by largely reducing creation cost. Thus, for both social welfare and cultural prosperity, short and broad copyright would be the most desirable, and long and narrow copyright would be the least desirable.

Keywords: Copyright length, Copyright breadth, Simulation

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1 Introduction

People are discontent with the current copyright law, and disagreement between right holders and users has been growing. A recent example of such disagreement is seen in the Trans-Pacific Partnership (TPP) negotiations. Negotiators under the influence of large right-holding companies are proposing to extend copyright terms by another 20 years beyond the minimum copyright term (50 years) under the current TRIPS agreement, while many non-government groups including Creative Commons are opposing it.¹

Several economists have tried to mitigate this situation by analyzing an optimal level of copyright protection, focusing only on either its breadth (e.g., Novos and Waldman, 1984; Landes and Posner, 1989; Miceli and Adelstein, 2006), or the length of the copyright term (e.g., Yuan, 2005; Adilov and Waldman, 2012). Unlike for patent design, length and breadth together have not yet been explored for copyright law.²

Furthermore, most literature on optimal copyright protection focuses on the effect of a policy change on a creator's profit, which is the incentive to create a new work. The exception is Landes and Posner (1989), whose model states that a change in copyright protection level affects not only a creator's profit from a new work but also the cost of its creation. While extending copyright term increases a creator's monopolistic profit, it can also increase the cost of creation because past works are important inputs for the creation of a new work.³

This study integrates these issues and provides a theoretical framework to examine optimal combination of copyright length and breadth, incorporating both a creator's profit from new works and the creation cost. Length is the term of copyright protection, and breadth is the amount of a protected work that can be freely used or copied by non-right holders (e.g., fair-use). The model this study constructs, however, becomes too complicated to be solved analytically. In the model, past works affect future creation cost, but the dynamics of creators' decision-making is not recursive. Since the cost of creation depends on

¹Creative Commons Blog News, "An Open Letter to TPP Negotiators: Copyright Term Extension Makes No Sense," Ryan Merkley, July 9th, 2014 (<http://creativecommons.org/weblog/entry/43256>, last accessed on April 17th, 2015).

²For the literature on optimal patent design, see a survey by Rockett (2010)

³For real world examples of this, see Lessig (2004).

whether past works are protected, time itself enters the decision-making problem under finite copyright terms. Thus, instead of analytically solving for the optimal length and breadth, the effects of changes in copyright design (length and breadth of protection) are examined through numerical simulation.

The simulation is run under the following four sets of copyright design: (i) long length and broad breadth, (ii) long length and narrow breadth, (iii) short length and broad breadth, and (iv) short length and narrow breadth. The simulation results reveal that on average, the choice of copyright length marginally affects social welfare. On the other hand, the choice of copyright breadth significantly affects social welfare, which is larger under broad protection. Length, however, affects entry and exit of creators, the number of publications, and accumulation of valuable works, which are greater under short copyright. Therefore, short and broad copyright can be the most desirable, and long and narrow copyright can be the least desirable, for both social welfare and cultural prosperity.

The rest of the paper proceeds as follows. Section 2 reviews the literature on the optimal copyright design. Section 3 explains the model. Section 4 presents the results of the numerical analysis. Section 5 concludes the study.

2 Literature review on the optimal copyright design

2.1 Breadth

In the studies focusing on optimal copyright breadth, breadth is usually interpreted as the extent of protection against copying by non-right holders. Miceli and Adelstein (2006) provide a simple breadth setting and examine the optimal breadth. In their model, the quality of a work's copies ranges from zero to one. Breadth is defined as the maximum quality of the copies that does not infringe the creator's copyright. The highest quality copy is provided only by the work's creator, and the creator's copying cost is smaller than any other copiers' one. A consumer's utility depends on a copy's quality. All consumers have the same marginal benefit of quality, but they differ in their maximum desired quality. Introducing legal copies such as fair-use does not affect the creator's profit if all

the consumers buying the highest quality copy are dissatisfied with the quality of legal copies. Based on these model setting, they analyze the relationship between the optimal breadth (fair use) and copying cost.

In Novos and Waldman (1984), the breadth variable affects both a work's quality and consumers' copying costs. Consumers decide whether to buy a work's copy from the monopolistic provider or to borrow it from a secondary source for making a copy. The breadth variable affects a consumer's copying cost. When the extent of copyright protection increases, more consumers buy copies from the monopolistic provider, which increase the provider's profit and the incentive to invest in a work's quality. Assuming that consumers' copying costs differ across individuals, Novos and Waldman (1984) demonstrate that depending on the distribution of the copying costs, an increase in copyright protection can decrease the social welfare loss due to a work's low quality. They further demonstrate that total copying costs for all consumers who borrow and copy does not necessarily increase when the copyright protection level increases because consumers with high copying costs shift from borrowing to buying.

Landes and Posner (1989) offer the most comprehensive analysis of breadth.⁴ In their model, a work's copies are provided not only by the work's creator but also by the copier. Breadth affects the quantity of the copies provided by the copier. Moreover, breadth affects the cost of creation, which is different across creators, because a creator often borrows expressions of other creators' works in creating a new work. Thus, the supply of works, which is equal to the number of creators providing new titles, rises until the creation cost of a marginal creator equals the revenue from a work's copies. By solving the optimal level of copyright protection to maximize social welfare, Landes and Posner (1989) drive several implications, one of which states that the protection level should be higher for a work producing a larger total surplus.

⁴Landes and Posner (1989) explain that their copyright protection level variable can include the length of copyright term. However, their theoretical model is static. In their model, length is not distinguished from breadth, and the dynamic process of creators' behavior is ignored.

2.2 Length

Yuan (2005) takes a simple approach to analyze the optimal copyright length: summing each period's total surplus from the first to the last periods. The copyright length, which is set between the first and last periods, determines the term in which a creator is able to set the monopoly price for a work's copies. Several creators exist, and they compete in the markets for copies. The demand for a work's copy depends not only on its price but also on the prices of other works' copies. This makes the demand function complicated enough that an explicit analytical solution cannot be found, and thus, Yuan (2005) employs a numerical method to solve the optimal length problem. He finds that the optimal length is an increasing function of copying cost and a decreasing function of demand level. Therefore, short copyright length is socially optimal when copying cost decreases and the demand for copies increases. These results are obvious from the model's assumption that the copyright holders fully exploit their works. Under the assumption, small copying costs and a large demand level mean that the copyright holder earns sufficient profit to incentivize investment in a work even when the copyright term is short.

Adilov and Waldman (2013), on the other hand, conclude that infinite copyright length can be socially optimal. Their results are derived from a theoretical model where the copyright holder dynamically optimizes the sequence of each period's ex-post investment during the copyright term. Longer copyright term can keep incentivizing ex-post investment after a work is published, and consequently consumers gain a larger surplus from the value-enhanced work due to ex-post investment. Adilov and Waldman (2013) also compare the fixed-length copyright protection with the indefinitely renewable one and find that the latter is better when the returns on ex-post investments are sufficiently large.⁵

⁵Yuan (2006) also examines indefinitely renewable copyright protection and concludes that the fixed length is better. The model is an extension of Yuan (2005), adding renewal fee and ignoring ex-post investment.

3 Model

3.1 Basic assumptions

In each period denoted by t , there are N_t creators of works such as books, movies, or songs. As in the model of Landes and Posner (1989), a creator is not distinguished from a publisher, film studio, or music recording company. Both the marginal and fixed costs of making and distributing copies (or reproductions) are set to zero, and creators incur only the cost of creating new works (or the cost of expression).

Each creator i decides the number of new works s/he produces (K_{it}) at the beginning of each period. The period of a new work's publication is denoted by p , and the term of copyright protection (copyright length) is denoted by T_c . During the copyright term ($t - p \leq T_c$), a work's creator is the only provider of copies of the work and its derivative works. As in Landes and Posner (1989), all different ways to exploit a work are identically treated and called "providing copies." Each work is sufficiently differentiated, and the markets for different works' copies are independent.

Let v_{itkp} be period t 's market value of creator i 's k -th work published in period p ($\leq t$), defined as the sum of all consumers' willingness to pay for the work's copies during period t . Since the marginal cost of providing copies is zero, v_{itkp} equals the consumer surplus that is provided at the competitive price. Before a work is published, its market value v_{itkp} is unknown and defined as the following stochastic variable.

$$v_{itkp} = \begin{cases} (1 - \delta)^{t-p}v & \text{with probability } \theta \\ 0 & \text{with probability } 1 - \theta, \end{cases}$$

where $0 < \theta < 1$, $0 < \delta < 1$, and $v > 0$. A work $v_{itkp} > 0$ is a longtime seller, whose market value decreases at the rate of δ . All other works' values are set to zero.

While the above assumption is for simplicity, a little reality can be added by setting the success probability θ and the rate of a work's obsolescence δ very low. With this parameter setting, the assumption may fit the well-known fact that (a) the great majority of copyrighted works never have much market value and (b) a small percentage of titles constitutes a large share of sales of copyrighted

materials (Liebowitz and Margolis, 2005). Moreover, Liebowitz and Margolis (2005) show that the longevity of best-selling books is quite long (more than 85 years) based on sample titles reviewed in *Book Review Digest* in the 1920s.

In addition to copyright length T_c , copyright breadth z is another parameter that controls copyright protection. The breadth parameter $0 < z < 1$ determines the extent of a work's market value that its creator can appropriate. For a copyright protected work with the value $v_{itkp} > 0$, consumers pay for only zv_{itkp} of the copies because $(1 - z)v_{itkp}$ of the copies is freely available to them. Then, during the copyright term, a creator's gross profit from a work in a period is αzv_{itkp} , and consumer surplus is $\beta zv_{itkp} + (1 - z)v_{itkp}$, where $\alpha + \beta < 1$. $(1 - \alpha - \beta)zv_{itkp}$ equals dead weight loss. After the copyright term expires, all the value v_{itkp} goes to consumers.

An example that determines the extent of z is the separation between idea and expression. Copyright law protects only the latter. Distinguishing "expression" from "idea," however, can be difficult. For example, a unique story plot can be a protected "expression" rather than an "idea," which enlarges the breadth parameter z . On the other hand, expanding limitations on copyright, such as reproduction for private use or fair-use doctrine, would make z small.

All existing works of the value $v_{itkp} > 0$ contribute to new works' creation by reducing the cost of expression. Let C_t be the works' stock at the end of period t (after publications) that is used for new works' creation in the next period $t + 1$. Then, C_t is defined as

$$C_t = (1 - \delta)C_{t-1} + \sum_{i=1}^{N_t} \sum_{k=1}^{K_{it}} v_{itkt},$$

where the depreciation rate is assumed to be equal to the obsolescence rate of longtime seller works.

3.2 Dynamics of the model

The expectation of period t 's total profit of a creator i at the beginning (before publication) of the period is given as

$$E[\pi_{it}] = \alpha z E \left[\sum_{k=1}^{K_{it}} v_{itkt} \right] - e(K_{it}) + \alpha z \sum_{p=1}^{t-1} \sum_{k=1}^{K_{ip}} 1[t - p \leq T_c] v_{itkp},$$

where $e(K_{it})$ is creator i 's cost of creating K_{it} new titles in period t , and $1[t-p \leq T_c]$ is the indicator function taking 1 if $t-p \leq T_c$ and 0 otherwise. The cost of creating K_{it} new titles, which the creator i has to bear before publication, is specified as

$$e(K_{it}) = \left(1 + \frac{z \sum_{j \neq i} \sum_{p=1}^{t-1} \sum_{k=1}^{K_{jp}} 1[t-p \leq T_c] v_{j(t-1)kp}}{C_{t-1}} \right) K_{it}^2.$$

Thus, if works' stock becomes large, including other creators' less protected works, then the cost of creating new works becomes small, depending on the breadth parameter z . The cost $e(K_{it})$ decreases when z becomes smaller because greater use of other creators' protected works becomes freely available.

It is assumed that a creator who earns negative profit in a period exits from publishing new works in the next period. Then, each period's profit can be more important than the total profits during the copyright term. Moreover, a creator's decision making is not recursive because time itself enters into it. The cost of creating new works depends on whether other creators' existing works are protected, which is different by time due to finite copyright length. Thus, instead of dynamically optimizing the sequence of publishing new works, a creator is assumed to decide the number of new works published in a period by maximizing the profit during that period expected before publication.

Let \tilde{K}_{it} be the number of period t 's new works by creator i defined as a real number. In each period t , creator i solves

$$\max_{\tilde{K}_{it}} E[\pi_{it}],$$

and the solution \tilde{K}_{it}^* is given as

$$\tilde{K}_{it}^* = \frac{\alpha z \theta v}{2} \left(1 + \frac{z \sum_{j \neq i} \sum_{p=1}^{t-1} \sum_{k=1}^{K_{jp}} 1[t-p \leq T_c] v_{j(t-1)kp}}{C_{t-1}} \right)^{-1}.$$

Then, the number of creator i 's new works in period t is defined as the smallest integer larger than or equal to \tilde{K}_{it}^* , i.e. $\lceil \tilde{K}_{it}^* \rceil$.

After publication, the profit π_{it} is determined, and as noted above, creator i exits from providing new works in the period $t+1$ if $\pi_{it} < 0$. For simplicity, it is assumed that copyright protected works of exiting creators are not appropriated by other surviving creators and their copies are provided by an entity that does not publish new works.

In addition to the exit of creators, the model also incorporates new entries. The number of new creators who enter in a period t is assumed to be a stochastic variable whose mean depends on the stock of works C_{t-1} . The distribution of new entries is specified as a Poisson distribution whose mean is given as λC_{t-1}^μ , where $\lambda > 0$ and $0 < \mu < 1$.

Finally, the surplus in a period s , w_s , is defined as the sum of creators' total profits from all protected works and consumers' surpluses from all existing works minus the costs of creating new works in that period. Let \tilde{N}_t be the number of all creators in t including the creators that exited before t (N_t is the number of creators that publish new works in t). Then,

$$\begin{aligned}
w_s = & \sum_{t=1}^s \sum_{i=1}^{\tilde{N}_t} \sum_{k=1}^{K_{it}} 1[t-p \leq T_c] \alpha z v_{itkp} \\
& + \sum_{t=1}^s \sum_{i=1}^{\tilde{N}_t} \sum_{k=1}^{K_{it}} [1[t-p \leq T_c] \{ \beta z v_{itkp} + (1-z) v_{itkp} \} + 1[t-p > T_c] v_{itkp}] \\
& - \sum_{i=1}^{N_s} e(K_{is}),
\end{aligned}$$

where the first, second, and third lines correspond to creators' profits, consumers' surplus, and the cost of creating new works in period s , respectively. The total surplus from $s = 1$ to T , W_T , is given as

$$W_T = \sum_{s=1}^T \frac{w_s}{(1+\rho)^{s-1}},$$

where $0 < \rho < 1$ is the discount rate.

3.3 Settings for the numerical analysis

In the aforementioned model, the process determining W_T is dynamic and stochastic. As explained above, although a creator solves a static problem in each period, the decision-making problem depends on a period because of finite copyright term. Moreover, a creator's decision is affected by the results of other creators' decisions, which are also determined stochastically. The model is hard to deal with in an analytical way, and thus, the effects of the two copyright law parameters T_c and z on the total surplus W_T are examined by numerical

simulation.⁶

Four simulation runs are set for different parameter sets of the copyright law design, and each simulation runs for 200 periods. The parameter sets are (i) long length ($T_c = 100$) and broad breadth ($z = 0.8$), (ii) long length ($T_c = 100$) and narrow breadth ($z = 0.4$), (iii) short length ($T_c = 50$) and broad breadth ($z = 0.8$), and (iv) short length ($T_c = 50$) and narrow breadth ($z = 0.4$).

The conditions other than those of copyright law design are the same for all series of simulation runs. In the initial period ($t = 1$), there are 10 creators ($N_1 = 10$), and each of them possesses one longtime seller work with the residual copyright terms $T_c - 1$. The stock of works for creating new works in the beginning of the initial period is given as $C_0 = N_1 v$. The values of all model parameters other than T_c and z are listed in Table 1.⁷

Table 1: Simulation parameters

Parameters	Definition	Values
α	Ratio of creator's profit to a work's value	0.5
β	Ratio of consumer surplus to a work's value	0.25
δ	Obsolescence rate of works	0.01
θ	Success rate that a work is longtime seller	0.1
μ	A parameter for new entry	0.1
λ	A parameter for new entry	0.01
ρ	Discount rate for social welfare	0.05
N_1	Initial number of creators	10
v	Value of longtime seller	500

4 Simulation results

Each of the four simulation runs was repeated 200 times. Figure 1 displays the results of the total surplus W_T ($T = 1, \dots, 200$) calculated as the average

⁶A similar approach is taken by Muller and Pénin (2006), who use a simulation model to describe the dynamics of innovation networks and the role of open knowledge disclosure.

⁷The parameters of creators and consumers surpluses, α and β , are determined by the assumption that the demand curve is linear. Let the demand function for a work's copies be $p_c = a - bx$, where p_c is the price and x is the quantity. Then, the creator's (monopolist's) profit is $\frac{a^2}{4b}$, consumers' surplus is $\frac{a^2}{8b}$, and the dead weight loss is $\frac{a^2}{8b}$.

outcome of the 200 simulations. In the later figures, the labels “lb,” “ln,” “sb,” and “sn” denote “long and broad,” “long and narrow,” “short and broad,” and “short and narrow” copyright designs, respectively.

The outcomes indicate a clear difference between broad and narrow breadth: the total surplus is larger for broad breadth than for narrow breadth. On the other hand, the difference in length has little effect on the total surplus. The results imply that copyright protection needs to be broad to increase social welfare, but the choice of length does not affect social welfare.

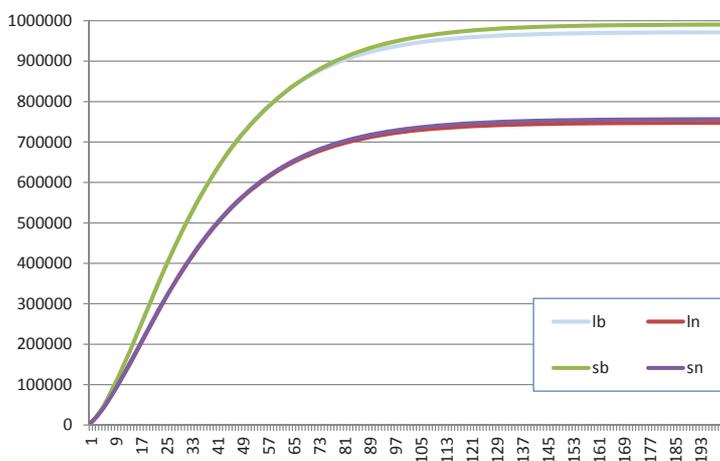


Figure 1: Comparison of total surpluses

The above results are caused by discounting the surpluses in later periods of the simulation. In the evaluation of creators’ revenues and social loss in multiple time periods, those in future periods need to be discounted to be comparable with present ones, as is stated in the seventeen economists’ amicus curiae brief in support of the petitioners in *Eldred v. Ashcroft*.⁸ The brief argues that there is no economic rationality to extend copyright length because a future profit increase by copyright extension is marginal because of discounting. The simulations’ results reflect such an argument. Only breadth is different from the first to 50th periods. After the 50th period, differences in the surpluses of the two length settings are discounted and becomes insignificant.

Comparing only the total surpluses may not be sufficient to evaluate different

⁸Brief of George A. Akerlof et al. as Amici Curiae in Support of Petitioners at 12, *Eldred v. Ashcroft*, 537 U.S. 186 (2003) (No. 01-618).

copyright law designs, and thus this study compares the results of three other variables: the number of creators who publish new works, the number of publications, and the stock of works among the four different copyright law designs. These variables can be proxies for a variety of works and cultural prosperity, both of which would be appreciated by consumers. As in Figure 1, all values are the average outcomes of the 200 simulation runs in the following figures.

First, Figure 2 depicts the dynamics of creators' exit and entry. Though remaining small, differences between long and short copyright are observed.

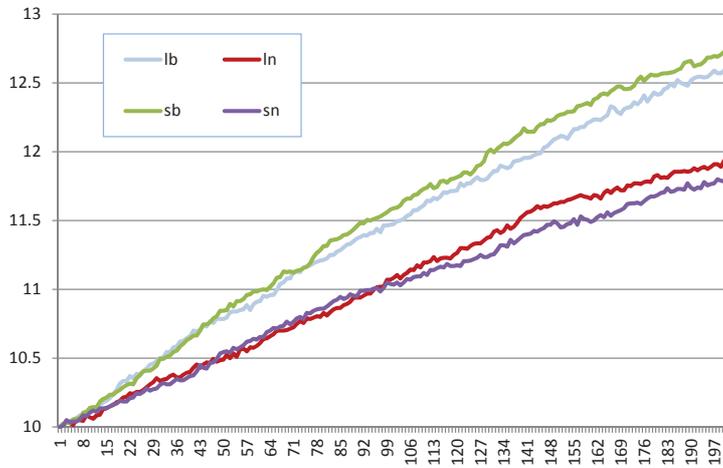


Figure 2: Comparison of the number of creators

The number of creators who publish new works tends to be higher for short length than for long length in case of broad breadth copyright designs. On the other hand, the number of such creators tends to be higher for long length than for short length in case of narrow breadth. When copyright is short and narrow, the revenues from existing works are the smallest, likely creating the largest number of exits compared to other copyright designs. On the other hand, short and broad copyright prevents exits more than long and broad copyright does, although the revenues from existing works are smaller under short length than under long length. The result can be explained by an increase in publications due to a decrease in publication cost after copyright term expiration, which is depicted in Figure 3.

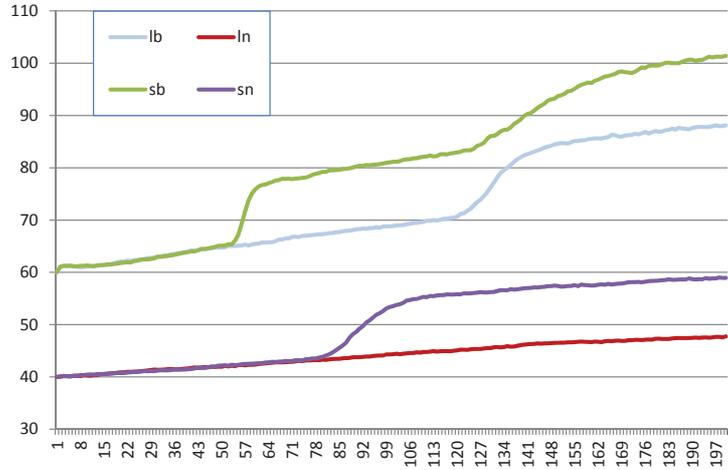


Figure 3: Comparison of publications

For short and broad copyright, a large and steep shift occurs in the level of publication numbers after the 50-th period, when the copyrights of the initial period’s longtime sellers expire. When copyright is short, past works that keep value relatively high become freely available after copyright expiration, which can largely reduce the cost of creation. Moreover, when copyright is broad, large revenues are expected from publications. Therefore, publishing a large number of new titles can be optimal for creators under short and broad copyright. Large cost reductions after copyright expirations are also observed for other copyright designs except for long and narrow copyright. When copyright breadth is narrow and thus the expected profits from publications are small, long length can be preferred by creators because it reduces the risk of exit as shown in Figure 2. However, creating new works can be further discouraged by long copyright because it maintains high creation cost.

The dynamics of works’ stocks traces the number of publications (Figure 4). The highest cultural prosperity is achieved by short and broad copyright, followed by long and broad, and then short and narrow copyright. The lowest cultural prosperity occurs under long and narrow copyright. These results reveal that the length of copyright terms matters when the quality of the market outcome, i.e., the number of titles available to consumers, is considered. From both economic and cultural perspectives, short and broad copyright is most

desirable, whereas long and narrow copyright is least desirable.

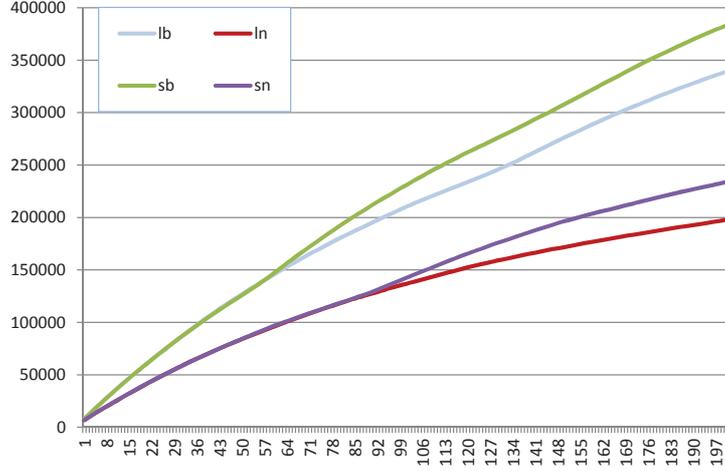


Figure 4: Comparison of the stock of works

5 Conclusion

Copyright protection is important for the provision of many commercial works. Few people question this role of copyright law. However, there has been a disagreement regarding the designing of copyright law. The length of copyright term and the breadth of copyright protection are the key issues. The literature has focused only on either length or breadth. This study integrates copyright length and breadth into a theoretical framework. The model also incorporates the cumulative feature of content creation: the cost of creating new work decreases when a larger part of past works becomes freely available. This resembles cumulative innovation models of the optimal patent design literature.

The simulation results reveal that copyright protection should first be broad. Regardless of length, social welfare is greater under broad protection than under narrow protection. Then, regardless of the breadth, short term is more desirable than long term. The result differ from that of the optimal patent design literature for cumulative innovation, which states that the same initial investment incentive is achieved under broad short patent or narrow long patent (Rockett, 2010).

Unlike technological innovation, past and future creative works do not nec-

essarily compete with each other, even when the latter borrows both the idea and the expression of the former. This makes imitation socially desirable because it efficiently boosts the variety of titles available to consumers. A real world example of such an argument is the creation of Walt Disney's cartoon *Steamboat Willie* in 1928, which was created as a direct cartoon parody of a silent film *Steamboat Bill, Jr.* and brought Mickey Mouse to life (Lessig, 2004). Therefore, copyright protection imposes both a benefit and a cost to creators. Short and broad copyright can be the most desirable because it can largely increase exploitation from contemporary works and largely reduce creation cost by freeing relatively valuable past works. On the other hand, long and narrow copyright can be the least desirable because it does just the opposite.

Some copyright law scholars argue that the digital age requires new user-privileges that grant users dramatically increased access to protected works compared to the fair-use doctrine (Parchomovsky and Weiser, 2010). A policy implication of this study would be the following: if a policy change that narrows copyright protection is combined with copyright term extension, as currently proposed by TPP negotiators, it would result in the least desirable outcome for both social welfare and cultural prosperity.

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