Is Imitation Bad for the Production of Creative Works?

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Abstract

This paper develops a theoretical framework to discuss the positive role of imitative works where creators often have private information about their creative abilities and may need outside investment. The main results show that stronger piracy protection increases an incentive to create with a higher return, but it itself cannot solve the inefficient investment problem due to information asymmetry; there exists complementarity between two fronts of copyright protection. When weak piracy protection yields overproduction, strong protection against imitation can minimize the related inefficiencies. However, when strengthening piracy protection brings the underproduction of creative works, allowing imitative works can be beneficial to society.

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1. Introduction

"Good artists copy, great artists steal" is one of the famous quotes from Pablo Picasso[1]. It may show profound difficulties in distinguishing between imitation and inspiration, which may be separated by a thin line. Many famous artists such as Picasso, Liechtenstein, and Sturtevant,[2] to name a few, copied the existing works, but they end up creating their innovative style. At the same time, this copy-first-and-steal-later argument seems to reflect a somewhat different perspective on the social value of imitation, which can be another form of creative processes. This paper focuses on creator's behavior during the creative process, and shows there may exist the welfare-enhancing role of secondary works that copy the portion of original works when two types of inefficiency exist; one from creators' private information on their creative ability and the other from a low return on investment due to end-user piracy.

In this paper, we introduce some aspects associated with the production of creative works, but they have been neglected from the previous studies on intellectual property rights: information asymmetry between creators and investors, and two types of copyright infringement-one from the supply side and the other from the demand side. One of the overlooked aspects is financial constraints faced by potential creators due to the characteristics of creative works. Before producing new works, the most critical assets of creators would be their "original" ideas or "unique" expressions of previous creative works. However, these assets are hard to be verified by third parties since they are not "original" or "unique" anymore after others observe them. Combined with these characteristics, there exists asymmetric information between creators and investors since creators know more about their creative abilities and intangible assets.

Supply-side infringement involves the production of very similar products to original products, but it has some distinctive features compared to demand-side infringement. While most of the demand-side infringement consists of the clear-cut cases of end-user piracy, there exists a great deal of debate on "fair use" of a copyrighted work, which does not infringe the author's right. One of seminal work on fair use by Leval (1989) discussed the ambiguity around the judicial procedure

[1] This quote is from Picasso, but it may be originated from in T. S. Eliot; "Immature poets imitate; mature poets steal; bad poets deface what they take, and good poets make it into something better, or at least something different. The good poet welds his theft into a whole of feeling which is unique, utterly different than that from which it is torn."

[2] For the article about her innovatively imitative works, see http://www.bbc.com/culture/story/20141112-great-artists-steal.

on fair use and proposed a new consideration into the fair use analysis: transformative use, which measures whether and to what extent a secondary use transforms the original copyrighted work. However, since the transformative concepts were introduced the 1994 case *Campbell v. Acuff-Rose Music, Inc.*, the courts are divided on clarifying the scope of the transformative inquiry (Tomassian, 2016).

Despite the high level of judicial uncertainty for supply-side infringement concerning the fair use doctrine, relatively little formal analysis of the production of creative works has been done. This paper tries to shed lights on this by explicitly modeling the behavior of creators between creating originals and imitative works, which may not be considered as fair use. This paper considers a situation where potential creators with heterogeneous creative ability may make their own choice of production mode; high-ability creators choose to produce original creative works, while low-ability ones opt to produce overly imitative works. They use similar expressions from the previous original works, which may potentially infringe the copyrighted original, but doing so can save the creator's efforts. Comparing with producing original works, therefore, it requires a lower cost with the reduced expected returns due to a possible cost from infringement liability. When protection against supply side-infringement is weak, we observe the creators produce additional imitative works since it can be considered as a watered-down version of a creative original. It can also be socially efficient methods for low-ability creators to participate in the creative process as long as the reduced expected returns cover the lower cost. At the same time, the availability of the low-cost-with-reduced-returns option attracts some of the original creators to switch to produce imitative works.

Demand-side infringement, on the other hand, involves consumers' illegal reproduction and distribution of copyrighted products, referred to as end-user piracy. This type of piracy has been analyzed under different market structures where consumers make their own choice of how they acquire the copyrighted products; buy an original or make an illegal copy, which can be viewed as an imperfect substitute for the original. The presence of actual threats or possibility of piracy limits creator's profitability which, in turn, has an adverse effect on the incentive to improve quality or to create new products in the viewpoint of dynamic efficiency. Therefore, strong piracy protection has been proven to have positive effects on the production of creative works.

Combining the investment process with asymmetric information and end-user piracy, this paper shows that an increase in piracy protection can reduce inefficiencies due to overinvestment, while it can increase loss in efficiency due to underinvestment. In the extended model, we consider the effect of copyright protection against both demand-side and supply-side infringement. The two effects can work as complements; when weak piracy protection yields overproduction, strong protection against imitation is required to minimize the related inefficiencies. However, when strengthening piracy protection brings underproduction of creative works, weak protection against imitation encourages low ability creators to produce imitative works, which can be beneficial to society.

Intellectual Property (IP) protection aims to promote innovation and artistic creation by granting limited-term exclusive rights to the IP owners. However, with the advent of digital technology and the Internet, information goods (i.e., creative works including books, music, movies) are more vulnerable to the threat of piracy, which makes it difficult to recoup initial investment due to the non-rival and non-exclusive nature of information goods. In this section, we briefly review recent theoretical contributions-starting with basic economic modeling of end-user piracy, economic implication of different market structure, and the responses of IP holders and society.

The first set of studies on end-user piracy consider a single producer who has a copyrighted creative work but faces a threat from piracy (see, for example, Novos and Waldman, 1984; Landes and Posner, 1989; Yoon, 2002; Landes and Posner, 2003; Posner, 2005; Bae and Choi, 2006; Cremer and Pestieau, 2009; Benerjee, 2011)[3]. Responding to this, when piracy becomes real threats, the monopolist can respond with either implementing limit price or accommodating piracy. This constraint on monopoly pricing can improve social welfare in the short run while its reduced profits discourage potential creators from developing new creative works in the long run[4]. In this setting, the optimal level of copyright protection against piracy becomes more important to balance between the 'underutilization loss' in static efficiency consideration and the 'underproduction loss' in dynamic efficiency consideration. Digitalization, on the other hand, enables the owners of information goods to use digital rights management (DRM) technology to control how consumers use their contents. Some studies have focused on how private DRM systems and public copyright

[3] Also see Peitz and Waelbroeck, 2006; Belleflamme and Peitz, 2010, 2014 for recent theoretical development.
[4] Some studies show the positive relationship between the presence of end-user piracy and copyright owner's profits with an extension of sampling effect (see, i.e., Peitz and Waelbroeck, 2006); network effect (see, i.e., Takeyama, 1994; Belleflamme, 2003; Gayer and Shy, 2003); Indirect appropriation (see, i.e., Liebowitz, 1985; Varian, 2000; Watt, 2005).

protection affects the equilibrium level of piracy, pricing, development incentives, and social welfare jointly (see, i.e., Park and Scotchmer, 2005; Ahn and Shin, 2010; Choi et al., 2010; Bae et al., 2017).

In the above theoretical literature on piracy, creators are willing to engage in the production of original works if they expect to earn more than their initial investment when sufficient profit is guaranteed with strong piracy protection. It implicitly assumes that creators do not face any financial constraints, which may not be true especially if they are not well-established figures in their fields. Therefore, our paper aims at filling this gap by presenting a simple model of the investment process in which potential creators with private information need outside investment for their projects. We build our models based on two seminal papers: Stiglitz and Weiss (1981) and De Meza and Webb (1987). Stiglitz and Weiss (1981) assume heterogeneous entrepreneurs regarding their riskiness in their projects and show asymmetric information yields underinvestment since high-risk entrepreneurs are the last ones to stay in the market as their expected repayment to loans becomes smaller as interest rates rise. On the other hand, De Meza and Webb (1981) change the nature of asymmetric information to the probability of success and show that overinvestment is possible with adverse selection. In their model, since risk-neutral banks set their loan rate concerning the average success probability, which adversely attracts projects with below average probability. We modify De Meza and Webb by introducing the creator's ability as private information where investors looking for a higher chance of matching with a high ability creator use their repayment rate as a screening device. In this model, we can show that overinvestment [underinvestment] are observed with weak [strong] piracy protection[5].

Following the underlying economic models, some studies have been extended to different market structure. (see, i.e., Shy and Thisse, 1999; Jain, 2008; Minnitti and Vergari, 2010, Beard et al., 2018). For example, Beard et al. (2018) use Salop's circular city model to investigate the optimal number of creative works with the presence of two types of copyright infringement: vertical infringement (i.e., piracy) and horizontal infringement (i.e., imitation). Within the framework, the optimal copyright policy can be achieved by using the complementary relationship between strong piracy protection and enhanced protection against imitation. In this paper, we

[5] Boadway and Keen (2005) use a generalized model of credit market with asymmetric information which yield both overinvestment and underinvestment as equilibrium where returns and the probability of success of projects are private information.

rather focus on the investment process between creators and investors to investigate the relationship between copyright protection against the demand side and supply side infringement.

The remainder of this paper is organized as follows. In section 2 we introduce a basic model with a brief introduction of Bae and Choi (2006)'s theoretical framework with the presence of end-user piracy and followed by the investment process between investors and creators. In section 3, we introduce another option for creators, imitation, and analyze the effect of imitative works on two different levels of copyright infringement. In section 4 the rational expectation model of consumer's expected quality of the creative works is developed to check the robustness of our main analysis. The paper concludes with some remarks and suggestions for future research.

2. Basic Model

Before we propose the theoretical framework, the timing of our analysis is as follows; in the first stage, the authority decides and announces the levels of protection against both piracy and imitation. In the second stage, a potential creator and an investor are randomly matched. The investor only knows the distribution of the creator's ability but is not able to detect the true value of the creator who has been matched. Maximizing expected profit, the investor makes an offer, and the creator decides whether to accept the offer and produce a creative work or to reject it. In the third stage, if the creator accepts the offer, then he/she produces his/her work with a fixed quality and determines the level of price for his/her creation.

2.1. The Short-run Analysis[6]

After a successful matching process, the creator completes his/her new work, which has a fixed level of quality denoted by θ. We assume that a successful creator becomes monopoly facing a group of consumers whose total number is normalized to unity. In the short run analysis after production of the new work is complete, consumers learn the quality of the work. Following Yoon (2002) and Bae and Choi (2006), they have heterogeneous valuations towards the original work and have two options to acquire the creative work; buy an original or make an unauthorized copy.

[6] In this section we closely follow rotations and results from Bae and Choi (2006). We change their general distribution of consumer's valuation to the uniform distribution, so that we can clearly show the effect of piracy protection on the comparative statics analysis.

Let v denote consumer's gross utility consuming an original product and is uniformly distributed between 0 and 1. Consumer *i* has the utility of buying an original given by

$$U_B(v_i; p) = \theta v_i - p \quad (1)$$

where p denotes the price charged by the creator. The other option available for consumers is to make an illegal copy of an original which is assumed to have the following two different types of costs: constant reproduction costs and type-dependent degradation costs. Bae and Choi provide various examples of both types of costs associated with piracy. Following their analysis we have the utility of using an unauthorized copy is given by

$$U_C(v) = (1-\alpha)\theta v - c = \theta v - (\alpha\theta v + c) \quad (2)$$

where c and $\alpha\theta v$ denote the constant reproduction costs and the type-dependent degradation costs, respectively. It is also available for consumers not to use the creative work, and the utility of no use is normalized to zero. Consumers maximize their utility by choosing their best choice.

Given three options available to consumers, we define two marginal consumers as $\tilde{v}_{(B,C)}$ and $\tilde{v}_{(C,N)}$; the first one is assumed to be indifferent between buying an original and making an unauthorized copy, and the second one is defined as the marginal consumer who is indifferent between making an illegal copy or no use. Given the definitions of the two marginal consumers, we represent them as follows:

$$\theta\tilde{v}_{(B,C)} - p \equiv (1-\alpha)\theta\tilde{v}_{(B,C)} - c \Rightarrow \tilde{v}_{(B,C)} = \frac{p-c}{\alpha\theta} \quad (3),$$

$$\text{and } (1-\alpha)\theta\tilde{v}_{(C,N)} - c \equiv 0 \Rightarrow \tilde{v}_{(C,N)} = \frac{c}{(1-\alpha)\theta} \quad (4).$$

With the configuration of the two marginal consumers, we restrict our attention to the parameter regions in which the piracy constraint is binding, that is,

$$\tilde{v}_{(C,N)} \le \tilde{v}_{(B,C)} \Rightarrow p \ge \frac{c}{1-\alpha} \quad (5),$$

which means both the reproduction costs and the degradation costs are not too high so that some consumers find that the copying option is more attractive than the buying option.

We now turn to the monopolist's optimal pricing problem when $0 < c \le \dfrac{\alpha(1-\alpha)}{1+\alpha}$. One of the options for the monopolist is to accommodate piracy in which the monopolist sets a high price and tolerates copying. In this case, the monopolist's objective becomes

$$Max\ R = p\left(1-\tilde{v}_{(B,C)}\right) = p\left(1-\frac{p-c}{\alpha\theta}\right) \tag{6}$$

The first order condition $\dfrac{\partial R}{\partial p} = \left(1-\tilde{v}_{(B,C)}\right) + p\left(-\dfrac{\partial \tilde{v}_{(B,C)}}{\partial p}\right) = 0$ yields the following equilibrium values: $\left\{p^* = \dfrac{\alpha\theta + c}{2}, \tilde{v}^*_{(B,C)} = \dfrac{\alpha\theta - c}{2\alpha\theta}, R^* = \dfrac{(\alpha\theta + c)^2}{4\alpha\theta}\right\}$ (7).

With $q^* = 1-\tilde{v}^*_{(B,C)}\left(p^*(\alpha,c),\alpha,c\right)$ we have the opposite effects of different types of piracy protection on the equilibrium demand for the original, while the same effect on the creator's revenue;

$$\frac{\partial q^*}{\partial \alpha} = -\left(\underset{(+)}{\frac{\partial \tilde{v}^*_{(B,C)}}{\partial p}}\underset{(+)}{\frac{\partial p^*}{\partial \alpha}} + \underset{(-)}{\frac{\partial \tilde{v}^*_{(B,C)}}{\partial \alpha}}\right) = -\frac{c}{2\alpha^2\theta} < 0 \text{ (8a)},\ \frac{\partial q^*}{\partial c} = -\left(\underset{(+)}{\frac{\partial \tilde{v}^*_{(B,C)}}{\partial p}}\underset{(+)}{\frac{\partial p^*}{\partial c}} + \underset{(-)}{\frac{\partial \tilde{v}^*_{(B,C)}}{\partial c}}\right) = \frac{1}{2\alpha\theta} > 0 \quad \text{(8b)}.$$

$$\frac{\partial R^*}{\partial \alpha} = \frac{(\alpha\theta + c)(\alpha\theta - c)}{4\alpha^2\theta} > 0 \text{ (9a), and } \frac{\partial R^*}{\partial c} = \frac{\alpha\theta + c}{2\alpha\theta} > 0 \text{ (9b).}$$

The social welfare can be derived from the sum of the monopolist's revenue and the consumer surplus:

$$SW(p^*) = R(p^*) + CS(p^*) = p^*\left(1-\tilde{v}_{(B,C)}\right) + \int_{\tilde{v}_{(B,C)}}^{1}\left(\theta v - p^*\right)F'(v)\,dv + \int_{\tilde{v}_{(C,N)}}^{\tilde{v}_{(B,C)}}\left((1-\alpha)\theta v - c\right)F'(v)\,dv$$

$$= \frac{\theta}{2}\left(1-\tilde{v}^2_{(B,C)}\right) + \int_{\tilde{v}_{(C,N)}}^{\tilde{v}_{(B,C)}}\left((1-\alpha)\theta v - c\right)F'(v)\,dv \tag{10}$$

We examine the effect of an increase in copyright protection on social welfare as

$$\frac{\partial SW(p^*)}{\partial \alpha} = \underbrace{-\left[\theta\tilde{v}_{(B,C)} - \left((1-\alpha)\theta\tilde{v}_{(B,C)} - c\right)\right]\frac{\partial \tilde{v}_{(B,C)}}{\partial \alpha}}_{\text{demand switch (-)}} \underbrace{-\int_{\tilde{v}_{(C,N)}}^{\tilde{v}_{(B,C)}}\theta v\,dv}_{\text{copy cost increase (-)}}$$

$$=\frac{1}{8}\left(-\frac{4c}{\alpha}+\frac{c^2\left(\alpha\left(2-5\alpha\right)-1\right)}{\alpha^2\left(1-\alpha\right)^2\theta}+\theta\right)<0^{7} \quad (11)$$

and $$\frac{\partial SW\left(p^*\right)}{\partial c}=\underbrace{-\left[\theta\tilde{v}_{(B,C)}-\left(\left(1-\alpha\right)\theta\tilde{v}_{(B,C)}-c\right)\right]\frac{\partial\tilde{v}_{(B,C)}}{\partial c}}_{\text{demand switch (+)}}\underbrace{-\left[\tilde{v}_{(B,C)}-\tilde{v}_{(C,N)}\right]}_{\text{copy cost increase (-)}}$$

$$=-\frac{1}{4}+\frac{\left(3+\alpha\right)c}{4\alpha\left(1-\alpha\right)\theta} \quad (12).$$

To determine the sign of $\frac{\partial SW\left(p^*\right)}{\partial c}$, let $\hat{c}$ be the critical value, which satisfies $\frac{\partial SW\left(p^*\right)}{\partial c}=0$ and we have $\hat{c}=\frac{\alpha\left(1-\alpha\right)\theta}{\alpha+3}$. Hence, if $c<\hat{c}$, we have $\frac{\partial SW\left(p^*\right)}{\partial c}<0$. Otherwise, we observe $\frac{\partial SW\left(p^*\right)}{\partial c}\geq 0$.

2.2. The long-run Analysis: matching between creators and investors

In the second stage, we now formalize the matching process between creators and investors, which can be considered as the long run analysis. We have a group of risk-neutral heterogeneous creators whose mass equals a unity. Every creator has a potential creative project, but they need funding from an outside investor. Creators are different regarding their ability to create, which is denoted as a_j. It can be considered as heterogeneous creator's ability to generate creative work and is uniformly distributed as $a_j \sim U\left[0,1\right]$. When creator *j* completes his/her work, the gross return on his/her creative work is dependent upon the degree of piracy protection, which equals $R^*\left(\alpha,c\right)$ in equation (7). All projects require the same fixed capital cost *K,* which should be borrowed from an outside investor, and creator's efforts *L*. When the project is complete, the investor receives

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[7] Since we have parameter region for the short run equilibrium as $c\leq\frac{\alpha\left(1-\alpha\right)}{1+\alpha}$, or equivalently $\frac{1}{2\theta}\left(\theta-c-\sqrt{c^2-6\theta c+\theta^2}\right)\leq\alpha\leq\frac{1}{2\theta}\left(\theta-c+\sqrt{c^2-6\theta c+\theta^2}\right)$, we can verify that $\frac{\partial SW\left(p^*\right)}{\partial\alpha}<0$.

$\left(1+r\right)B$ as the return of his fixed investment *B (=K)* with the repayment of *r*. Putting together we have creator *j*'s profit as

$$\pi_C\left(r;a_j\right)=a_j\left(R-\left(1+r\right)B\right)-L \tag{13}$$

Before we proceed, we make the following assumption to have a meaningful analysis.

Assumption 1. We assume that only creators with a successful project apply for a loan, which is $\pi_C\left(r;a_j\right)=a_j\left(R-\left(1+r\right)B\right)-L\geq 0$.

As a benchmark case, we consider a simple matching process with full information. After randomly matching with a creator, the investor can observe the creator's ability a_j and the profit maximization problem becomes

$$\underset{r}{Max}\,\pi_I\left(r\right)=a_j\left(1+r\right)B-\left(1+\rho\right)B \text{ s.t. } \pi_C\left(r;a_j\right)=a_j\left(R-\left(1+r\right)B\right)-L\geq 0 \qquad (14),$$

where the opportunity cost of his/her investment is denoted as $\left(1+\rho\right)$. The constraint represents the participation constraint for creator *j*. It is easily verified that the first order condition is $\frac{\partial\pi_I\left(r\right)}{\partial r}=a_jB>0$, which represents the expected marginal return in term of increasing *r* and is positive for all a_j. The investor maximizes his expected profit by choosing $r^*\left(a_j\right)=\frac{R-B}{B}-\frac{L}{a_jB}$ so that the creator's participation constraint is binding. Implementing perfect price discrimination the investor stops offering to finance to the marginal creator whose ability satisfies the zero profit condition such as

$$\pi_I\left(r\right)=a^*\left(1+r\left(a^*\right)\right)B-\left(1+\rho\right)B=a^*R-\left(1+\rho\right)B-L=0 \qquad (15),$$

which yields $a^*=\frac{\left(1+\rho\right)B+L}{R}$ and the corresponding equilibrium repayment as $r^*\left(a_j\right)\equiv r^*=\frac{\left(1+\rho\right)\left(R-B\right)-L}{\left(1+\rho\right)B+L}$.

Before we proceed to the asymmetric information case, we can derive the social optimum related to the previous abovementioned matching process. Given the creator's ability a_j, the social welfare function can be defined as

$$W(a_j) = \pi_I(r) + \pi_C(r) = a_j R - (1+\rho)B - L \qquad (16).$$

The social planner will finance projects until their expected returns are higher than the cost in which the socially marginal type, whose participation is the same as doing nothing, is $a^S_{(O,N)} = \frac{(1+\rho)B + L}{R}$[8]. It is a textbook example of social optimum, and the perfect price discriminated outcome is the same. Therefore, we have $a^S_{(O,N)} = a^*$, which means that any creator whose ability, $a_j \geq a^*$ should join the creative process.

Now we turn to our main interest the investment process with information asymmetry. According to Assumption 1, we find the marginal creator who is indifferent between producing creative work and not participating in the creative process such as $\tilde{a}_{(O,N)} = \frac{L}{R-(1+r)B}$ and show $\frac{\partial \tilde{a}_{(O,N)}}{\partial r} > 0$. Investor *k* matched with a creator but he is not able to observe the creator's true ability. So investor *k* can use *r* as a screening device knowing that the probability of accepting a loan contract with *(B, r)* is $\Pr\left(a_j \geq \tilde{a}_{(O,N)}\right) = 1 - \tilde{a}_{(O,N)}$. The investor maximizes his/her expected profits:

$$\max_r \pi_I(r) = \left(1 - \tilde{a}_{(O,N)}\right)(1+r)B - (1+\rho)B \qquad (17)$$

The first order condition with respect to *r* becomes $\frac{\partial \pi_I(r)}{\partial r} = -\frac{\partial \tilde{a}_{(O,N)}}{\partial r}(1+r)B + \left(1 - \tilde{a}_{(O,N)}\right)B = 0$. The marginal effects consist of two parts; the first term represents a negative effect on the revenue since increasing *r* reduces chances to match with a creator whose value is above $\tilde{a}_{(O,N)}$, while the second term indicates a positive effect on the expected marginal revenue with *r*. We call the first negative effect as 'asymmetric information effects' and the second positive effect as 'traditional effect.' The equilibrium rate of return for the investment is $\frac{R - B - \sqrt{LR}}{B} \equiv \tilde{r}^*$; the marginal creator is $\tilde{a}^*_{(O,N)} = \sqrt{\frac{L}{R}}$; and $\pi^*_I = \left(\sqrt{R} - \sqrt{L}\right)^2 - (1+\rho)B$. We now compare the optimal choice of the investor with the social optimum in Lemma 1 and Figure 1.

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[8] The subscript (O,N) denotes indifference between two options producing an original *(O)* and doing nothing *(N)*.

Lemma 1. We have overinvestment of $\left(a^S_{(O,N)} - \tilde{a}^*_{(O,N)}\right)$ since $\tilde{a}^*_{(O,N)} < a^S_{(O,N)}$ if $R < \frac{\left((1+\rho)B + L\right)^2}{L} \equiv R_1$. Otherwise, we have underinvestment of $\left(\tilde{a}^*_{(O,N)} - a^S_{(O,N)}\right)$ since $\tilde{a}^*_{(O,N)} \geq a^S_{(O,N)}$ if $R \geq R_1$.

Proof. To prove Lemma 1, we first proceed to prove $\tilde{a}^*_{(O,N)} < a^S_{(O,N)}$ if $R < R_1$, while $\tilde{a}^*_{(O,N)} \geq a^S_{(O,N)}$ if $R \geq R_1$. When we treat the marginal creator type $\tilde{a}_{(O,N)}$ as the control variable under incomplete information, the investor's object becomes

$$\pi_I\left(\tilde{a}_{(O,N)}\right) = \left(1 - \tilde{a}_{(O,N)}\right)\left(\frac{\tilde{a}_{(O,N)}R - L}{\tilde{a}_{(O,N)}B}\right)B - (1+\rho)B.$$

The first order condition is given by $-\left(\frac{\tilde{a}_{(O,N)}R - L}{\tilde{a}_{(O,N)}}\right) + \left(1 - \tilde{a}_{(O,N)}\right)\frac{L}{\left[\tilde{a}_{(O,N)}\right]^2} = -R + \frac{L}{\left[\tilde{a}_{(O,N)}\right]^2}$, which can be evaluated at $a^S_{(O,N)}$: $-R + \frac{L}{\left[a^S_{(O,N)}\right]^2} < 0$ if $R < R_1$. Hence $\tilde{a}^*_{(O,N)} < a^S_{(O,N)}$ when $R < R_1$. Similarly, we can show that $-R + \frac{L}{\left[a^S_{(O,N)}\right]^2} \geq 0$ if $R \geq R_1$, which proves $\tilde{a}^*_{(O,N)} \geq a^S_{(O,N)}$ when $R \geq R_1$. For the second part, we will prove the conditions for efficient investment under asymmetric information. From the zero profit condition of the marginal creator and the zero welfare condition, $\pi_C\left(\tilde{a}^*_{(O,N)}\right) = \tilde{a}^*_{(O,N)}\left(R - \left(1+\tilde{r}^*\right)B\right) - L = 0$ and $W\left(a^S_{(O,N)}\right) = a^S_{(O,N)}R - (1+\rho)B - L = 0$ respectively, these equations can be added together to yield the following $\underbrace{\tilde{a}^*_{(O,N)}R - (1+\rho)B - L}_{W\left(\tilde{a}^*_{(O,N)}\right)} + a_s R - \tilde{a}^*_{(O,N)}\left(1+\tilde{r}^*\right)B - L = 0 \Leftrightarrow W\left(\tilde{a}^*_{(O,N)}\right) = R\left(\tilde{a}^*_{(O,N)} - a^S_{(O,N)}\right)$. It is easily verified that $W\left(\tilde{a}^*_{(O,N)}\right) < 0$ with $\tilde{a}^*_{(O,N)} < a^S_{(O,N)}$. Otherwise, we have $W\left(\tilde{a}^*_{(O,N)}\right) \geq 0$. ■

As we observe from Figure 1 when the creator's revenue is low, only the portion of $a_j \geq a^S_{(O,N)}$ should produce creative works, so the portion of the investments $\left(a^S_{(O,N)} - \tilde{a}^*_{(O,N)}\right)$ are socially inefficient but undertaken. Asymmetric information benefits creators whose ability is below the social optimum. In contrast, the creators with efficient ability are blocked to produce their artistic works due to asymmetric information when $\tilde{a}^*_{(O,N)} \geq a_S$, so the portion of the investments $\left(a_S - \tilde{a}^*_{(O,N)}\right)$ are socially efficient but not undertaken.

Lemma 2. With asymmetric information, the equilibrium rate of the repayment also depends on the level of *R*. We have $\tilde{r}^* < r^*$ if $R < R_1$. Otherwise, we have $\tilde{r}^* \geq r^*$ if $R \geq R_1$.

Proof. From the zero profit condition, $\pi_C\left(\tilde{a}^*_{(O,N)}\right) = \tilde{a}^*_{(O,N)}\left(R - \left(1+\tilde{r}^*\right)B\right) - L = 0$, when $\tilde{a}^*_{(O,N)} < a^S_{(O,N)}$, we have $\tilde{a}^*_{(O,N)}\left(R - \left(1+r^*\right)B\right) - L < 0 \Leftrightarrow \tilde{a}^*_{(O,N)}\left(\tilde{r}^* - r^*\right) < 0$, which proves $\tilde{r}^* < r^*$ when $R < R_1$. Similarly, when $\tilde{a}^*_{(O,N)} \geq a^S_{(O,N)}$, we have $\tilde{a}^*_{(O,N)}\left(R - \left(1+r^*\right)B\right) - L \geq 0$ $\Leftrightarrow \tilde{a}^*_{(O,N)}\left(\tilde{r}^* - r^*\right) \geq 0$, which proves $\tilde{r}^* \geq r^*$ when $R \geq R_1$. ■

The intuition behind lemma 1 and 2 is as follows. Since the investor under full information chooses $a^S_{(O,N)}$, which is the lowest boundary to invest and decreases in *R*, i.e., $\frac{\partial a^S_{(O,N)}}{\partial R} < 0$. From the slightly modified version of the social optimum $a^S_{(O,N)}R = \left(1+\rho\right)B + L$, we observe that LHS representing the expected return equals RHS indicating the fixed cost of creation. With the fixed relation, there exists a one-to-one negative relationship between $a^S_{(O,N)}$ and *R*. It means that a low return on investment (a low level of *R*) requires high-ability creators (a high level of $a^S_{(O,N)}$). As the return improves, the low-ability creators can join the production of creative works. Under asymmetric information, the investor should balance the negative effect due to information asymmetry and the traditional positive effect. When $R < R_1$ the investor should charge a relatively lower repayment compared to the full information case, i.e., $\tilde{r}^* < r^*$ due to the dominant negative effect. However, the situation is reversed when $R \geq R_1$, in which the positive effect dominates so that $\tilde{r}^* \geq r^*$.

Proposition1. When there exists asymmetric information on creator's ability, the effect of an increase in copyright protection is dependent upon the level of the return on investment *(R)*; an increase in copyright protection decreases socially inefficient overinvestment at lower returns, while it increases socially inefficient underinvestment at higher returns.

Proof. We define the overinvestment function as $OI(R) = a^S_{(O,N)} - \tilde{a}^*_{(O,N)}$ when $R < R_1$ and the underinvestment function as $UI(R) = \tilde{a}^*_{(O,N)} - a^S_{(O,N)}$ when $R \geq R_1$. We can easily verify that

$$\frac{\partial OI(R)}{\partial R} = \frac{\sqrt{LR} - 2\left((1+\rho)B + L\right)}{2R^2} = \frac{\sqrt{LR} - 2\sqrt{LR_1}}{2R^2} < 0 \text{ and}$$

$$\frac{\partial UI(R)}{\partial R} = -\frac{\sqrt{LR} - 2\left((1+\rho)B + L\right)}{2R^2} = -\frac{\sqrt{LR} - 2\sqrt{LR_1}}{2R^2} > 0. \qquad \blacksquare$$

The intuition of Proposition 1 is straightforward. In the full information case, we establish the traditional results from the previous theoretical analysis; an increase in copyright protection reduces welfare loss due to underproduction. Since with the socially optimal level of investment, creators whose ability is above $a^S_{(O,N)}$ should participate in producing new creative works and $\frac{\partial a^S_{(O,N)}}{\partial c} = \underbrace{\frac{\partial a^S_{(O,N)}}{\partial R}}_{(-)} \underbrace{\frac{\partial R}{\partial c}}_{(+)} < 0$, we establish a positive relationship between the level of investment and piracy protection. Contrary to the full information case, the effect of increases in copyright protection is different depending on the level of return. When $R < R_1$, stronger protection has two positive effects: first, it increases the level of investment (i.e., $\frac{\partial \tilde{a}^*_{(O,N)}}{\partial c} = \underbrace{\frac{\partial \tilde{a}^*_{(O,N)}}{\partial R}}_{(-)} \underbrace{\frac{\partial R}{\partial c}}_{(+)} < 0$) and reduces overinvestment as well (i.e., $\frac{\partial OI(R)}{\partial c} = \underbrace{\frac{\partial OI(R)}{\partial R}}_{(-)} \underbrace{\frac{\partial R}{\partial c}}_{(+)} < 0$). When $R \geq R_1$, stronger protection still increases the level of investment (i.e., $\frac{\partial \tilde{a}^*_{(O,N)}}{\partial c} = \underbrace{\frac{\partial \tilde{a}^*_{(O,N)}}{\partial R}}_{(-)} \underbrace{\frac{\partial R}{\partial c}}_{(+)} < 0$) but the gap between the social optimum and the actual investment increases (i.e., $\frac{\partial UI(R)}{\partial c} = \underbrace{\frac{\partial UI(R)}{\partial R}}_{(+)} \underbrace{\frac{\partial R}{\partial c}}_{(+)} > 0$).

3. Extended Model

Up to now, the creators do their best to produce their creative works. However, there can be significant differences in the level of their efforts they put if investors are assumed to have incomplete monitoring technology. Incorporating this aspect we introduce another deliberate action of creators to create an imitative work, which is overly similar to existing original works regarding ideas, expressions, and essential inputs. We assume that creators still need investment from an investor even when they produce an imitative work. In order to secure investment from an investor, creators with an imitative work still pretend to produce an original creation so that we consider pooling equilibrium. The expected profit of creator *j* who creates an imitative work is then given by

$$\pi_C\left(r;a_j\right) = a_j\left(1-\mu\right)\left(R-\left(1+r\right)B\right)-\delta L \tag{18}$$

While he does not put his full effort, which reduces his effort to δL, it will decrease the revenue by $\left(1-\mu\right)$. We can think of this situation as after creators finish their creative works they have a chance to be detected by the authority or the owners of the infringed previous works as an imitative work, which becomes no appeal to consumers. With incomplete monitoring, imitative works can be considered as creative with the probability of $\left(1-\mu\right)$.

We again consider the socially efficient case as a benchmark. With full information, a social planner can assign creators to three different options according to their ability; create an original, imitate existing works, or do nothing. Given three choices welfare function becomes

$$W\left(a_j\right) = \begin{cases} W^O\left(a_j\right) = a_j R - \left(1+\rho\right)B - L & \text{if creator produces an original} \\ W^I\left(a_j\right) = a_j\left(1-\mu\right)R - \left(1+\rho\right)B - \delta L & \text{if creator imitates an original} \\ 0 & \text{if creator does nothing} \end{cases} \quad (19),$$

where the superscripts $\{O,I\}$ denote original and imitation, respectively. Given the welfare function, two socially marginal creators; first, denote $a^S_{(O,I)} = \frac{(1-\delta)L}{\mu R}$ as the social marginal type whose effect on welfare function is the same between producing and imitating an original. Second, we have another marginal social type such as $a^S_{(I,N)} = \frac{(1+\rho)B+\delta L}{(1-\mu)R}$ whose choice between imitation and doing nothing yield the same results such as $W^I(a_j)=0$. Based on two marginal social types, we put some restriction on parameters in order to make this section more interesting.

Assumption 2. We assume that, if $\mu\left[(1+\rho)B+L\right] \le (1-\delta)L$, the production of imitative works can be socially efficient for some creators, and sometimes it is more efficient than producing original works, which means $a^S_{(I,N)} \le a^S_{(O,I)}$.

Under Assumption 2, imitations can be socially efficient for all $a_j \ge a^S_{(I,N)}$ and sometimes more efficient than producing original works for all $a_j \in \left[a^S_{(I,N)}, a^S_{(O,I)}\right]$. It means that $a^S_{(O,I)}$ is the least socially efficient original creator and, at the same time, the most socially efficient imitative creator. With the presence of efficient imitation, we also easily verify that $a^S_{(I,N)} \le a^S_{(O,N)} \le a^S_{(O,I)}$ if Assumption 2 holds.

In the extended model, we now consider the investment process. Let $\tilde{a}_{(O,I)} = \frac{(1-\delta)L}{\mu\left(R-(1+r)B\right)}$ denote the marginal type of creators who is indifferent between working on his/her original idea and copying someone else's. Let $\tilde{a}_{(I,N)} = \frac{\delta L}{(1-\mu)\left(R-(1+r)B\right)}$ again denote the marginal type of creators who is indifferent between imitating other original works and doing nothing. With the configuration of the two marginal creators, we restrict our attention to the parameter region as in the following assumption; the cost savings from imitation are not too small, and the detection rate for imitative works is not too high so that some of the creators find imitation is more attractive than the production of an original.

Assumption 3. We assume that the imitation constraint is binding, that is, $\tilde{a}_{(O,I)} \geq \tilde{a}_{(I,N)} \Rightarrow \delta + \mu \leq 1$.

If the investor maximizes his/her expected profits as

$$\underset{r}{\text{Max}}\, \pi_I(r) = \left(1 - \tilde{a}_{(O,I)}\right)(1+r)B + \left(\tilde{a}_{(O,I)} - \tilde{a}_{(I,N)}\right)(1-\mu)(1+r)B - (1+\rho)B$$

$$= \left(1 - \mu\tilde{a}_{(O,I)} - (1-\mu)\tilde{a}_{(I,N)}\right)(1+r)B - (1+\rho)B = \left(1 - \tilde{a}_{(O,N)}\right)(1+r)B - (1+\rho)B \quad (20)$$

which yields the equilibrium rate of return for investment as $r^* = \frac{R - B - \sqrt{LR}}{B}$ and the marginal types of creators as $\tilde{a}^*_{(O,I)} = \frac{1-\delta}{\mu}\sqrt{\frac{L}{R}}$ and $\tilde{a}^*_{(I,N)} = \frac{\delta}{1-\mu}\sqrt{\frac{L}{R}}$.

Lemma 3. We have $\tilde{a}^*_{(I,N)} \leq \tilde{a}^*_{(O,N)} \leq \tilde{a}^*_{(O,I)}$.

Proof. It boils down to $\frac{\delta}{1-\mu} \leq 1 \leq \frac{1-\delta}{\mu}$, which can be easily verified with $1 \geq \delta + \mu$ from Assumption 2. ■

We notice that the positive level of imitation is observed as the results of the endogenous choice of creators. Social welfare can be improved in the presence of imitation. These changes are divided into the creation of additional imitative works and the replacements for original works. First, the production level of creative works increases directly from the additional imitation activity because it allows creators to participate in the creative production who otherwise would not have produced at all. These new imitative works are given by $\tilde{a}^*_{(O,N)} - \tilde{a}^*_{(I,N)}$. Second, the indirect benefit may exist due to the existence of the imitation option. Even the equilibrium rate of repayment (r) remains the same, imitation improves the outside option for, especially, the low-ability creators who prefer the low cost (i.e., δL) investments with the low expected return (i.e., $(1-\mu)R$), which can replace the less preferred option-the high cost (i.e., L) investment with the high return (i.e., R) for the original work. These endogenous choices of the low ability creators show the substitute relationship between original creation and imitation, while it helps to increase the overall level of creative activities. Since imitation can be viewed as a water-down version of the original creation, any additional creation activities would benefit the society, especially when the society suffers from underinvestment, i.e., $\tilde{a}^{*}_{(O,N)} \geq a^{S}_{(O,N)}$. However, we need to consider a mixed effect of imitation in details in Proposition 2 and Figure 2.

Proposition 2. When imitation can be socially beneficial, some original works are replaced by imitative works, which can be welfare improving. Also, additional imitation takes place in which these activities can be welfare enhancing. We have

1) Welfare improving second-worst replacement is observed when $\tilde{a}^{*}_{(O,N)} \leq a < \min\left\{\tilde{a}^{*}_{(O,I)}, a^{S}_{(I,N)}\right\}$ and $R < R_3 \equiv \dfrac{\left((1+\rho)B+\delta L\right)^2}{(1-\delta)^2 L}$.
2) Efficient replacement takes place when $\max\left\{a^{S}_{(I,N)}, \tilde{a}^{*}_{(O,N)}\right\} \leq a < \min\left\{a^{S}_{(O,I)}, \tilde{a}^{*}_{(O,I)}\right\}$ and $R_2 \equiv \dfrac{\mu^2\left((1+\rho)B+\delta L\right)^2}{(1-\delta)^2(1-\mu)^2 L} \leq R < \dfrac{\left((1+\rho)B+L\right)^2}{L} \equiv R_6$.
3) Inefficient replacement occurs when $\max\left\{a^{S}_{(O,I)}, \tilde{a}^{*}_{(O,N)}\right\} \leq a < \tilde{a}^{*}_{(O,I)}$ and $R \geq \dfrac{\mu^2\left((1+\rho)B+L\right)^2}{(1-\delta)^2 L} \equiv R_5$.
4) Over-imitation happens when $\tilde{a}^{*}_{(I,N)} \leq a < \min\left\{\tilde{a}^{*}_{(O,N)}, a^{S}_{(I,N)}\right\}$ and $R < R_4 \equiv \dfrac{\left((1+\rho)B+\delta L\right)^2}{\delta^2 L}$.
5) Efficient imitation comes about when $\max\left\{a^{S}_{(I,N)}, \tilde{a}^{*}_{(I,N)}\right\} \leq a < \tilde{a}^{*}_{(O,N)}$ and $R \geq R_3$.

Proof. First, for second-worst replacement, we need to show that the lower boundary $\tilde{a}^{*}_{(O,N)}$ satisfies the following condition $W^I\left(\tilde{a}^{*}_{(O,N)}\right) > W^O\left(\tilde{a}^{*}_{(O,N)}\right)$ when $R < R_3$. By definition, we have $W^I\left(a^{S}_{(I,N)}\right) = 0$ and $W^O\left(a^{S}_{(O,N)}\right) = 0$. Adding them together we have $W^I\left(a^{S}_{(I,N)}\right) + W^O\left(a^{S}_{(O,N)}\right)$ $= W^O\left(a^{S}_{(I,N)}\right) + R\left(a^{S}_{(O,N)} - a^{S}_{(I,N)}\right) = 0$, which means that $W^O\left(a^{S}_{(I,N)}\right) = -R\left(a^{S}_{(O,N)} - a^{S}_{(I,N)}\right) < 0$ by

Assumption 2. Take the case where $\tilde{a}^*_{(O,N)} = a^S_{(I,N)}$ at $R = R_3$, then $W^O\left(\tilde{a}^*_{(O,N)}\right) < 0$ with $W^I\left(\tilde{a}^*_{(O,N)}\right) = 0$, which implies that $W^I\left(\tilde{a}^*_{(O,N)}\right) - W^O\left(\tilde{a}^*_{(O,N)}\right) = -\mu\tilde{a}^*_{(O,N)}R + (1-\delta)L > 0$. Since $\frac{\partial\left[W^I\left(\tilde{a}^*_{(O,N)}\right) - W^O\left(\tilde{a}^*_{(O,N)}\right)\right]}{\partial R} = -\mu\tilde{a}^*_{(O,N)} < 0$ we have $W^I\left(\tilde{a}^*_{(O,N)}\right) > W^O\left(\tilde{a}^*_{(O,N)}\right)$ when $R < R_3$. Similarly, the upper boundary $\tilde{a}^*_{(O,I)}$, when $\min\left\{\tilde{a}^*_{(O,I)}, a^S_{(I,N)}\right\} = \tilde{a}^*_{(O,I)}$, we have $W^I\left(\tilde{a}^*_{(O,I)}\right) > W^O\left(\tilde{a}^*_{(O,I)}\right)$. Second, for the efficient replacement, by definition, we have $\pi_C\left(\tilde{a}^*_{(O,I)}\right) = 0$ and $W^I\left(a^S_{(I,N)}\right) = 0$, which can be added together to yield $\pi_C\left(\tilde{a}^*_{(O,I)}\right) + W^I\left(a^S_{(I,N)}\right)$ $= W^I\left(\tilde{a}^*_{(O,I)}\right) - (1-\mu)R\left(\tilde{a}^*_{(O,I)} - a^S_{(I,N)}\right) = 0$. Therefore, $W^I\left(\tilde{a}^*_{(O,I)}\right) = (1-\mu)R\left(\tilde{a}^*_{(O,I)} - a^S_{(I,N)}\right) \geq 0$ when $R_2 \leq R$. Similarly, we have $W^O\left(\tilde{a}^*_{(O,N)}\right) = R\left(\tilde{a}^*_{(O,N)} - a^S_{(O,N)}\right) < 0$ by adding $\pi_C\left(\tilde{a}^*_{(O,N)}\right) = 0$ And $W^I\left(\tilde{a}^*_{(I,N)}\right) = 0$ together when $R < R_6$. Putting together, we show that $W^I\left(\tilde{a}^*_{(O,I)}\right) \geq 0$ and $W^O\left(\tilde{a}^*_{(O,N)}\right) < 0$ when $R_2 \leq R < R_6$. Third, for the inefficient replacement, by definition for any $a_j > a^S_{(O,I)}$, we have $W^O\left(a_j\right) > W^I\left(a^S_{(O,I)}\right)$. When $R > R_5$, we have $a^*_{(O,I)} > a^S_{(O,I)}$, which yields $W^O\left(a^*_{(O,I)}\right) > W^I\left(a^S_{(O,I)}\right)$. Forth, for over-imitation, we have by definition, $\pi_C\left(\tilde{a}^*_{(I,N)}\right) = 0$ and $W^I\left(a^S_{(I,N)}\right) = 0$, which can be added together to yield $\pi_C\left(\tilde{a}^*_{(I,N)}\right) + W^I\left(a^S_{(I,N)}\right)$ $= W^I\left(\tilde{a}^*_{(I,N)}\right) - (1-\mu)R\left(\tilde{a}^*_{(I,N)} - a^S_{(I,N)}\right) = 0$. Therefore, the lower boundary $\tilde{a}^*_{(I,N)}$ is evaluated as $W^I\left(\tilde{a}^*_{(I,N)}\right) = (1-\mu)R\left(\tilde{a}^*_{(I,N)} - a^S_{(I,N)}\right) < 0$ when $R \leq R_4$. Similarly, we can show the upper boundary $\tilde{a}^*_{(O,N)}$, when $\min\left\{\tilde{a}^*_{(O,N)}, a^S_{(I,N)}\right\} = \tilde{a}^*_{(O,N)}$, is evaluated as

$W^I\left(\tilde{a}^*_{(O,N)}\right) = (1-\mu)R\left(\tilde{a}^*_{(O,N)} - a^S_{(I,N)}\right) < 0$. Fifth, for the efficient imitation, the upper boundary $\tilde{a}^*_{(I,N)}$ is evaluated as $W^I\left(\tilde{a}^*_{(O,N)}\right) = (1-\mu)R\left(\tilde{a}^*_{(O,N)} - a^S_{(I,N)}\right) \geq 0$ when $R \geq R_3$. The lower boundary $\tilde{a}^*_{(I,N)}$, when $\max\left\{a^S_{(I,N)}, \tilde{a}^*_{(I,N)}\right\} = \tilde{a}^*_{(I,N)}$, is evaluated as

$$W^{I}\left(\tilde{a}^{*}_{(I,N)}\right)=\left(1-\mu\right)R\left(\tilde{a}^{*}_{(I,N)}-a^{S}_{(I,N)}\right)>0 .\blacksquare$$

We have three types of replacement can be observed, and the effectiveness of these replacements depends on the relative efficiency of imitative and original works. First, when copyright protection is low, both imitation and original investment are not effective so that less inefficient imitation replaces more inefficient original creation, which can be viewed as welfare enhancing. The next set of replacement happens with efficient imitation while creative works are not efficient (i.e., $a^{S}_{(I,N)} \leq a < a^{S}_{(O,I)}$), but as the creative works become efficient then, replacement becomes inefficient. Additional imitative works can have two different effects; First, since imitative works require a lower level of effort with a lower level of returns, it can be easily socially efficient compared to creative works. However, even with a lower threshold, imitative works can end up with overinvestment. Otherwise, additional imitative works can improve welfare with more production of creative works. Since equilibrium values for the repayment rate and profit of the investors remain the same, the investors are at least indifferent towards imitative works.

Proposition 3. When copyright protection against imitation increases, the portion of investments for originals is larger, i.e., $\frac{\partial \tilde{a}^{*}_{(O,I)}}{\partial \mu}<0$ and the additional imitation will decrease, i.e., $\frac{\partial \tilde{a}^{*}_{(I,N)}}{\partial \mu}>0$. Putting these effects together, the total number of creative works will decrease.

Proof. It is easily verified that $\frac{\partial \tilde{a}^{*}_{(O,I)}}{\partial \mu}=-\frac{\left(1-\delta\right)}{\mu^{2}}\sqrt{\frac{L}{R}}<0$ and $\frac{\partial \tilde{a}^{*}_{(I,N)}}{\partial \mu}=\frac{\delta}{\left(1-\mu\right)^{2}}\sqrt{\frac{L}{R}}>0$. ■

Proposition 4. When copyright protection against piracy increases, the portion of investments for originals is larger, but less imitative works are created. The overall production level of creative works will increase.

Proof. It is easily verified that $\frac{\partial \tilde{a}^{*}_{(O,I)}}{\partial \alpha}=\frac{1-\delta}{\mu}\sqrt{\frac{L}{\partial R/\partial \alpha}}<0$ and $\frac{\partial \tilde{a}^{*}_{(I,N)}}{\partial \alpha}=\frac{\delta}{1-\mu}\sqrt{\frac{L}{\partial R/\partial \alpha}}<0$. ■

From Proposition 3 and 4, we provide a theoretical framework to show that the effect of copyright protection depends crucially on the type of copyright violation. First, the effectiveness of piracy protection relies on its nature to curve consumers' incentive to make unauthorized reproduction and to enhance creators' revenue, while protection against imitation has an impact on potential creators' choice by affecting their expected revenue. In this sense, we find complementarity between two types of copyright protection with interesting policy implications. The best combination would be strong piracy protection with low imitation protection or vice versa. When piracy protection is not effective we, at least, need to have strong imitation protection to prevent inefficient imitation from entering the production process, which eventually reduces overinvestment problem. On the other hand, when piracy protection is effective, then we can have leniency in imitation protection so socially efficient imitation can fill the gap of underproduction of original creative works.

4. The Extended model with Rational Expectation

In this section, instead of a simplistic assumption on the consumer's full information on the quality of creative works, we introduce a feedback loop through which consumer's choice can affect creator's incentive to create, and vice versa. A pathway connecting their choices is a rational expectation model where consumers form their expectations about the quality of creative works. Let θ^e denote the consumer's rational belief in the quality of creative work, which must equal the equilibrium proportion of the expected portion of original creative works as rational beliefs coincide with actual values at rational expectation models. With the introduction of the expected quality equation (7) becomes

$$R^*\left(\theta^e\right) = \frac{\left(\alpha\theta^e + c\right)^2}{4\alpha\theta^e} \qquad (21).$$

It is an increasing function of θ^e since the more likely it is that consumers expect high quality works, the more they are willing to pay for the works, which is responded by a price hike. The expected quality is, similarly, an increasing function of R since the higher level of revenue the creators expect, the more original works will be produced. Therefore, the expected quality can be defined as

$$\theta^e\left(R\right) = \frac{\left(1-\tilde{a}^*_{(O,I)}\right) + \left(1-\mu\right)\left(\tilde{a}^*_{(O,I)} - \tilde{a}^*_{(I,N)}\right)}{1-\tilde{a}^*_{(I,N)}} = \frac{\left(1-\mu\right)\left(\sqrt{R}-\sqrt{L}\right)}{\left(1-\mu\right)\sqrt{R}-\delta\sqrt{L}} \qquad (22),$$

which is equal to the sum of the portion of actual original creative works $\left(1-\tilde{a}^*_{(O,I)}\right)$ and the imitative works which is considered as fair use of the original works $\left(\left(1-\mu\right)\left(\tilde{a}^*_{(O,I)} - \tilde{a}^*_{(I,N)}\right)\right)$

divided by the total creative works $\left(1-\tilde{a}^{*}_{(I,N)}\right)$. Equations (21) and (22) jointly define R and θ.

These two curves determine a unique equilibrium since we have $\theta^{e}(c) > \frac{c}{\alpha}$ if $L < \frac{c(c-\alpha)^{2}(1-\mu)^{2}}{\left(c\delta-(1-\mu)\alpha\right)^{2}}$ at the lowest level of revenue $R\left(\theta=\frac{c}{\alpha}\right)=c$, and $\theta^{e}\left(\frac{(\alpha+c)^{2}}{4\alpha}\right)<1$ if $1-\mu>\delta$ at the highest level of revenue $R(\theta=1)=\frac{(\alpha+c)^{2}}{4\alpha}$.

Proposition 5. With consumer's rational expectation on the quality of the creative works, both types of copyright protection against piracy and imitation have a positive effect on the quality and the revenue.

Proof. We can easily verify that $\frac{\partial\theta^{e}(R)}{\partial\mu}=\frac{\delta\sqrt{L}\left(\sqrt{R}-\sqrt{L}\right)}{\left(\delta\sqrt{L}-(1-\mu)\sqrt{R}\right)^{2}}>0$ and $\frac{\partial R(\theta)}{\partial\alpha}=\frac{(\alpha\theta+c)(\alpha\theta-c)}{4\alpha^{2}\theta}>0$. ■

Combining proposition 3, 4, and 5, we reconfirm the complementarity between the types of copyright protection. Even both types of protection can increase the quality and the revenue, their effectiveness is different in details; when weak piracy protection yields overproduction, strong protection against imitation is required to reduce the total number of creation. However, when strengthening piracy protection brings underproduction of creative works, weak protection against imitation encourages low ability creators to produce imitative works, which increases the total number of creation.

5. Concluding Remarks

This paper examines how the introduction of the creator's private information and two different types of copyright infringement affects consumers' piracy behavior and creators' optimal choice on their production mode of creative works. We construct a combined model of ex-post sales of creative works with an ex-ante investment process between investors and creators who have private information about their creative ability. Within the model, we incorporate two different types of copyright infringement such as end-user piracy regarding demand-side copyright violation and creators' production of imitative works as supply-side copyright infringement. In this setup, the main findings are as follows. First, we found that the equilibrium level of investment is determined by creators' realized revenues which are positively affected by the level of piracy protection. Even with the positive relationship, the presence of asymmetric information may yield an inefficient outcome compared with the full information case; overinvestment with weak protection while underinvestment with strong protection. In both cases strengthening piracy protection increases the expected number of creative works but may improve efficiency by reducing overinvestment or cause inefficiency by increasing underproduction of creative works. Second, we analyze the effect of another type of infringement, which is determined as a result of the optimal choice of creators. In doing so, this paper provides new insight. One of the common concerns about imitative works is that it reduces efficiency when imitative works replace original creative works. We, however, found the opposite under a certain condition: overly similar works can improve efficiency when they replace inefficient original works. Third, we provide a theoretical framework to show that the effect of copyright protection depends crucially on the type of copyright violation. In particular, depending on the strength of piracy protection, the proper adjustment of protection against imitation can have positive effects; either decreasing the total number of creation to reduce overproduction problem or increasing the total number of creation to alleviate the underproduction problem. The results in this paper thus suggest that any policy implementation of copyright protection should pay more attention to the relationship between two types of protection aiming at two different types of copyright infringement.

Our approach to the effect of two types of copyright protection on the investment process of creative works provides some insights, but there are some limitations. In our model, we analyze a simplified version of consumer's expectation about the quality of creative works. We assume that consumers have perfect information about the quality before they use creative works. We can extend our analysis into the case where creative goods can be 'experience goods' as in Peitz and Waelbroeck (2006). In this case, since consumers do not know the exact quality of a creative work they consider to buy, it enables us to investigate the direct effect of the presence of imitative works on the ex-post revenue and also the indirect effect on the expected revenue of original works. It allows us to analyze the effect of consumer's sampling effect on the process mentioned above. This could be a future task for our research.

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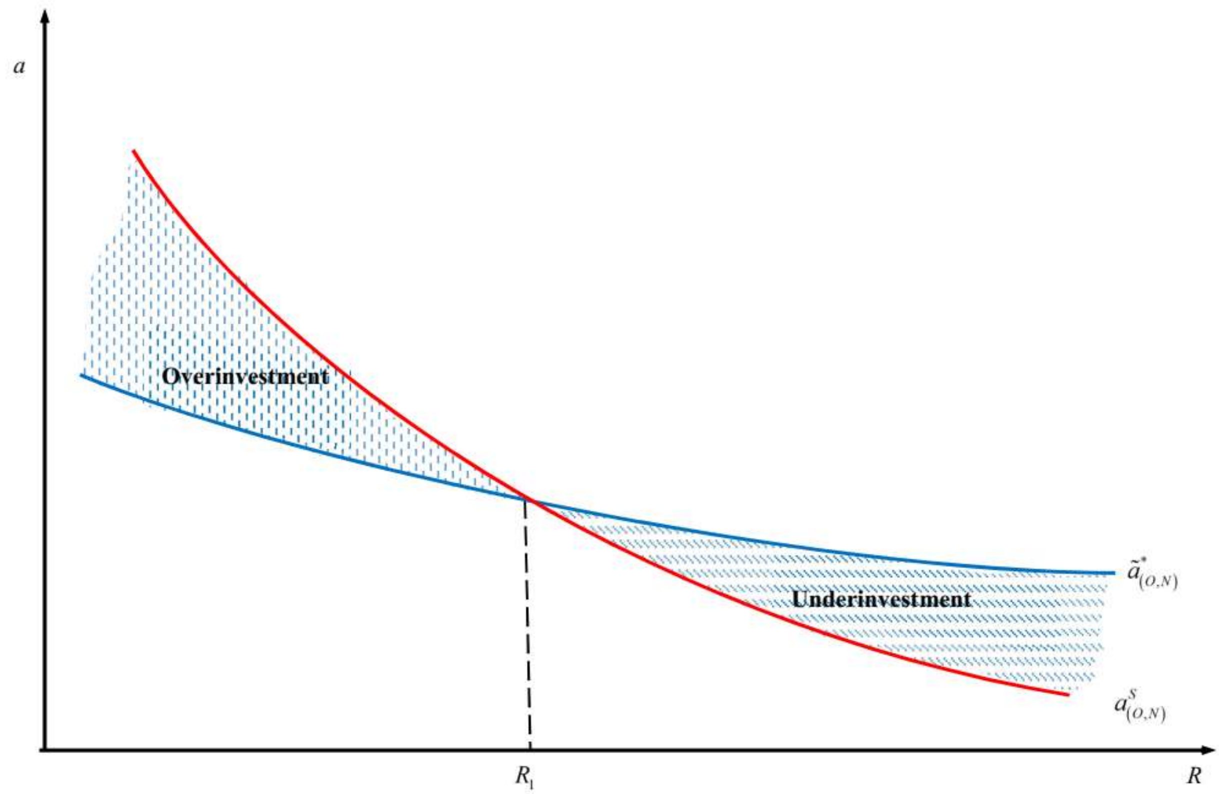

Figure 1: comparison between the optimal choice of investor and social optimum

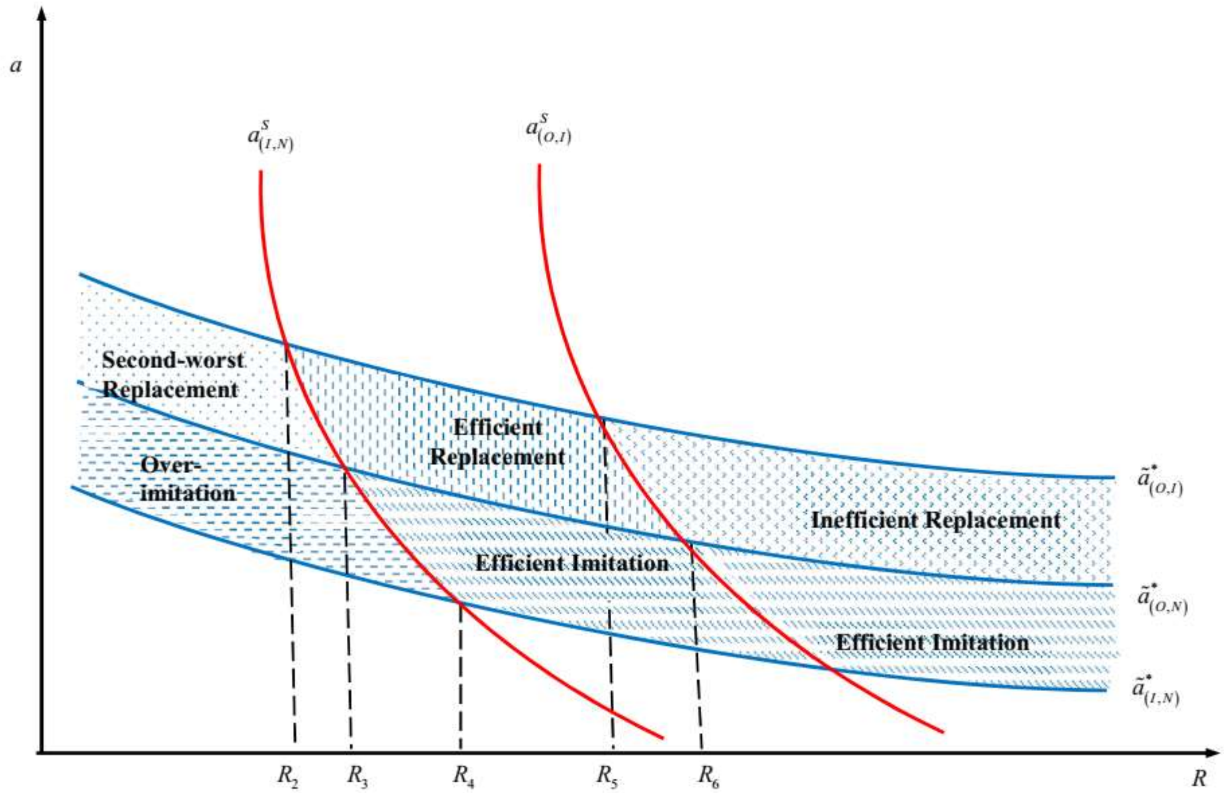

Figure 2: Equilibrium configuration with the presence of imitation