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Optimal Copyright Protection: Civil Law vs. Criminal Law

by

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Abstract

We consider optimal copyright protection strategies from the government and producer perspectives. Our model assumes that the government sets the penalty for infringement, and that the producer is responsible for monitoring illegal activity. We find that depending on the production cost of the goods, the government should set copyright penalties either to zero or to a level that makes the producer's profit zero. We also show that the social surplus is greater under a civil law scheme than a criminal law scheme when the production cost of the goods is high. On the other hand, it is better to apply penalties under criminal law when the production cost is low.

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1 Introduction

With the emergence of new computer technologies, illegal copies of copyrighted goods are becoming increasingly easy to create and obtain. According to the Japanese Association of Copyrights for Computer Software (ACCS, 2004), about 16.1 million music files worldwide are exchanged annually by peer-to-peer software such as Napster and Gnutella, and 92% of these files are exchanged without the copyright holder's permission. The illegal use of copyrighted goods has also increased in other media markets. England's International Federation of the Phonographic Industry (IFPI, 2006) reports that the global traffic in pirated products amounted to US$4.5 billion in 2005. More than one-third of all music discs purchased globally are illegal copies. The U.S.A. Business Software Alliance (BSA, 2006) estimates that in 2005, the illegal software market caused about US$34 billion in damages. Similarly, the Motion Picture Association of America (MPAA, 2006) reports that damages in 2005 due to movie piracy reached US$6.1 billion. Illegal copies decrease the producer's profit. Copyrights act to protect this profit, which in turn maintains the incentive for producing creative works. Copyrights essentially grant the right holders exclusive use of their goods, and can be used to legally force others not to use copyrighted goods without permission.

A person whose copyright is violated can pursue legal relief, but the burden is placed on copyright holders to actively enforce their rights. If a right holder discovers illegal copies of his work on the market, he can enforce two penalties. First, the right holder can demand financial compensation for damages under civil law. In the U.S.A. there are two types of compensation: actual damages (to profits), and statutory damages. Actual damages are quantifiable losses suffered by the copyright holder as a result of the infringement. Statutory damages are proportional to the number of works copied. In the U.S.A., statutory damages range from $750 to $150,000 per work (U.S.C. §504(c)). A second option is for the right holder to punish offending parties under criminal law. The maximum criminal penalty for copyright infringement in the U.S.A. is $500,000 in fines, five years in prison, or both (U.S.C.

§506).

As mentioned above, the government and the right holders have different roles in protecting a copyright. It is the producer's responsibility both to monitor illegal use and assume the cost of monitoring. The government's role is to decide the size of the civil and/or criminal penalty imposed when an infringement is brought to its attention. The purpose of this paper is partly to determine which of the two copyright protection schemes is optimal under this division of roles.

The number of criminal cases involving illegal copies has steadily increased along with the number of copyright infringements. One high-profile example is Japan's filing of criminal charges against the programmer of the "Winny" peer-to-peer file sharing software. The European Commission has proposed a law that could allow criminal charges to be pressed against businesses using software believed to infringe upon another company's intellectual property. However, it is not clear how these criminal penalties will affect the public welfare. This paper considers the optimal level of the penalty, and whether criminal law or civil law should be used to protect copyrights.

There are two sides of the issue to be considered. With respect to the optimal penalty, note that any copyright protection policy has two contradictory objectives. One the one hand, it has to reward producers and provide a reasonable incentive to create new works. On the other hand, copyright protection that is too effective will grant producers monopolistic power and damage the social surplus. This tension amounts to a trade-off problem which must be solved when designing an optimal copyright protection scheme. The second matter to consider is which penalty scheme is more desirable from the social point of view. If the penalties are enforced under civil law, then illegal users will have to pay damages to compensate the producer. Under criminal law, the *government* collects the penalty. Increasing either penalty tends to prevent illegal use and reduce the surplus of illegal copies. A high penalty thus decreases the producer's monitoring cost. On the other hand, producers will tend to set a higher price when the penalty for infringement is high. It is thus not clear what the optimal penalty level should be.

The producer's strategy, which consists of its pricing and monitoring policies, depends on the penalty scheme. As mentioned above, a copyright holder can prevent copyright infringements under either kind of penalty. The main difference between the two legal schemes is who obtains the compensation; producers recover damages under civil law but not under criminal law.

We obtain the following results. First, we find that government should set the penalty to either zero or to a level such that the producer's profit from infringement becomes zero. Next, we compare the two copyright protection schemes. We show that in terms of the social surplus, civil law is preferable to criminal law when the cost of development is high. When the cost of development is low, however, it is better to apply criminal law.

The literature on copyright protection can be divided into two groups, which will be reviewed and related to the present work in turn. The first group considers optimal government policies, and includes the works of Novos and Waldman (1984), Johnson (1985), Conner and Rumlet (1991), and Yoon (2002). Novos and Waldman (1984) and Yoon (2002) consider the social impact of increasing the marginal cost of illegal copies through government policy. Yoon (2002) also discusses the effect of copyright protection on society, concluding that there are only three optimal solutions: (i) no protection, (ii) a level of penalty such that the producer's profit is zero, and (iii) full protection. Johnson (1985) studies the effect of imposing a tax on copying and granting a subsidy for original purchases, and shows that illegal copies are harmful to the social surplus. Conner and Rumlet (1991), on the other hand, show that not protecting copyrights at all could be the best policy in an environment with positive network externality.

The present paper differs from the above works on several points. First, we take into account the fact that the government and the producer play different roles in protecting the copyright. Second, previous research implements government policy as an increase in the marginal cost of making illegal copies. This paper assumes only that the government sets and imposes a penalty on illegal users.

A second group of researchers considers the actions taken by right holders to prevent illegal use and other forms of non-governmental protection. Yooki and Scotchmer (2004), for example, analyze joint initiatives taken by the business community to develop new technology preventing illegal copies. Arai (2005) discusses copyright protection measures taken by associations of original producers. These authors do not consider actions taken by the government in their work, however. This paper is concerned with both the right holder and the government.

The paper is organized as follows. Section 2 sets up the basic model. Section 3 considers the optimal producer strategy under a civil penalty. Section 4 considers the optimal producer strategy under criminal law. Section 5 then discusses which protection scheme is better from a social point of view. Section 6 concludes. All proofs are given in the Appendix.

2 The Model

We consider a monopolistic market for copyrighted goods such as compact discs, videos, computer software, etc. The consumer valuations v_i of the goods are uniformly distributed on the interval $[0, 1]$. Each consumer wants to buy at most one unit. If consumer i buys the original good at its retail price p, his utility is given by $v_i - p$. Consumers also have the option of making illegal copies at no cost. As illegal copies are generally of lower quality than the original goods, the consumer's valuation of the copy is given by αv_i. The constant α $(0 < \alpha < 1)$ represents depreciation of the item's quality. To prevent illegal use, the producer can monitor consumer activity. The producer's monitoring cost function is given by $c(s) = ks^2 (k > 0)$, where s is the probability of detecting a given illegal user. We assume that k is high enough that the cost is significant. When an illegal use is detected, the consumer is punished by a penalty g set by the government. We present a multi-stage game model to consider the optimal copyright protection scheme in this monopolistic market. The three stages of the game have the following rules:

1. The government chooses a penalty level $g \geq 0$.
2. The producer decides whether or not to produce the goods at a fixed cost $F > 0$. If the producer decides to produce the goods, he chooses a price p and a monitoring probability s.
3. Consumers decide whether they will buy the original product, make an illegal copy, or do nothing.

We consider both civil law penalties and criminal law penalties. Under civil law, the producer obtains the penalty paid by illegal users as a part of their profit. Under criminal law, the government collects the penalty. The government's goal is to maximize a social surplus function (the consumer and producer surplus) by setting the penalty for illegal use at the correct level. We analyze the subgame perfect equilibrium by backward induction. First let us consider the consumers' behavior.

Lemma 1

Given a penalty g, price p and monitoring probability s, the optimal choice of consumers is not to obtain the good if and only if

$$v_i < p, v_i < \frac{sg}{\alpha}.$$

Consumers will make a illegal copy if and only if

$$v_i \geq \frac{sg}{\alpha}, v_i < \frac{p - sg}{1 - \alpha},$$

and will buy the original good if and only if

$$v_i \geq p, v_i \geq \frac{p - sg}{1 - \alpha}.$$

A consumer's behavior thus depends on his valuation of the good, the price, the quality of an illegal copy, and the expected penalty. In the first case, consumers will ignore a good when their valuation of the original is lower than the price p *and* their valuation of the illegal copy is lower than the expected penalty sg. In the second case, the utility of making illegal copies is positive and higher than the utility of purchasing original goods. In the third case, consumers prefer original goods to illegal copies because the utility of purchase is positive and higher. Producers choose the price p and monitoring rate s at the second stage. We consider their strategy in the next section.

3 Civil law penalty

We define the producer's strategy as $S = \{(p, s)\,|p \geq 0, 1 \geq s \geq 0\}$, where p is the price and s is the monitoring probability. For convenience of analysis, we divide the strategy space S into two sub-classes: $S_1 \ni \{(p, s)\,|s < \alpha p/g\}$ and $S_2 \ni \{(p, s)\,|s \geq \alpha p/g\}$.

For every strategy $(p, s) \in S_1$, it holds that $sg/\alpha < p < (p - sg)/(1 - \alpha)$. When the producer employs a strategy in sub-class S_1, Lemma 1 predicts the consumer behavior illustrated in Figure 1.

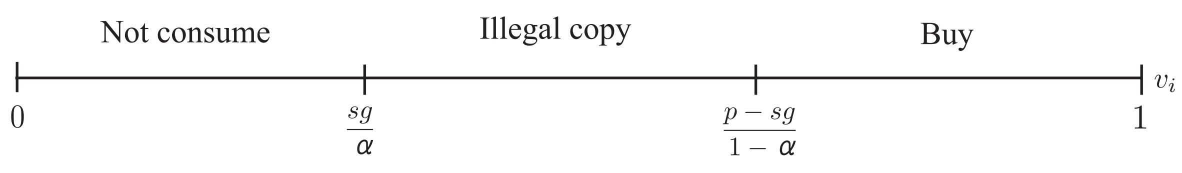

Figure 1: Consumer behavior under strategies in sub-class S_1

Consumers with valuations larger than $(p - sg)/(1 - \alpha)$ buy the original goods, those with valuations between sg/α and $(p-sg)/(1-\alpha)$ make illegal copies, and those with valuations less than sg/α do not consume. The demand for goods D_o and the demand for illegal copies D_c are thus given by

$$D_o = 1 - \frac{p-sg}{1-\alpha}, \; D_c = \frac{p-sg}{1-\alpha} - \frac{sg}{\alpha}. \tag{1}$$

From Equation (1), we also obtain the producer's profit π as

$$\pi_1 = p(1 - \frac{p-sg}{1-\alpha}) + sg(\frac{p-sg}{1-\alpha} - \frac{sg}{\alpha}) - ks^2 - F.$$

The first term in this equation represents sales, and the second term represents penalties collected from illegal users. The next lemma shows the optimal output in sub-class S_1 under civil law.

Lemma 2

Assume that the producer's strategy is restricted to sub-class S_1. When goods are to be produced, the profit of the producer under civil law is maximized by the choice

$$p_1^* = \frac{1}{2} - \frac{k\alpha^2}{2(g^2+k\alpha)}, \; s_1^* = \frac{\alpha g}{2(g^2+k\alpha)}.$$

Under this strategy, the profit of the producer is

$$\pi_1^* = \frac{1}{4} - \frac{k\alpha^2}{4(g^2+k\alpha)} - F. \tag{2}$$

When π_1^* is negative, no goods will be produced.

For every strategy $(p,s) \in S_2$, it holds that $(p-sg)/(1-\alpha) \leq p \leq sg/\alpha$. When the producer employs a strategy in sub-class S_2, Lemma 1 predicts the consumer behavior illustrated in Figure 2.

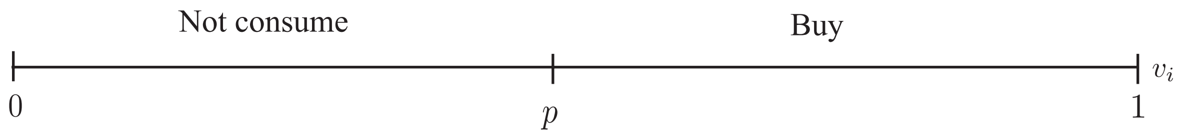

Figure 2: Consumer behavior under strategies in sub-class S_2

Consumers whose valuation is greater than p will buy the original goods, while those with valuations less than p do not consume the goods at all. The demand for goods D_o and the demand for illegal copies D_c are thus given by

$$D_o = 1 - p,\ \ D_c = 0. \tag{3}$$

From (3), we obtain the producer's profit

$$\pi_2 = p(1-p) - ks^2 - F.$$

The original producer will maximize his profit subject to $s \geq \alpha p/g$. The next lemma shows the optimal output in S_2 under civil law.

Lemma 3

Assume that the producer's strategy is restricted to sub-class S_2. When goods are to be produced, the profit of the producer under civil law is maximized by the choice

$$p_2^* = \frac{g^2}{2(g^2 + k\alpha^2)},\ \ s_2^* = \frac{\alpha g}{2(g^2 + k\alpha^2)}.$$

Under this strategy, the profit is

$$\pi_2^* = \frac{g^2}{4(g^2 + k\alpha^2)} - F. \tag{4}$$

When π_2^* is negative, no goods will be produced.

The iso-profit curves of the strategy space are depicted in Figure 3. The straight lines are loci of strategies that maximize profit with respect to price and monitoring rate in the sub-class S_1. It follows that the producer's profit in sub-class S_1 is maximized at their intersection A. In sub-class S_2, the maximum profit is obtained at the intersection of $s = \alpha p/g$ and $\partial\pi_1/\partial p = 0$. The next proposition shows that the larger optimal profit is in S_1.

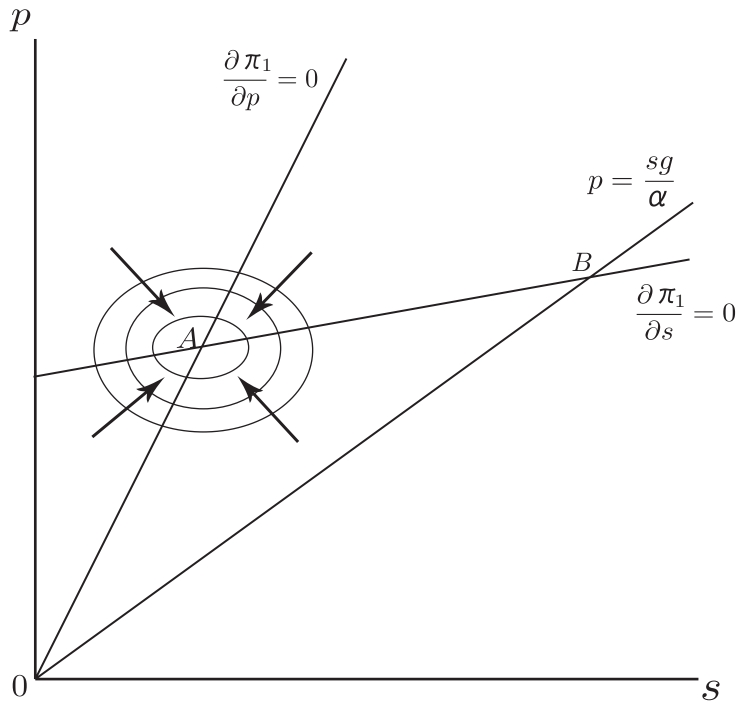

Figure 3: Iso-profit curves under civil law

Proposition 1

The profit of the producer under civil law (over the whole strategy space S) is maximized by the choice

$$p_1^* = \frac{1}{2} - \frac{k\alpha^2}{2(g^2 + k\alpha)}, \quad s_1^* = \frac{\alpha g}{2(g^2 + k\alpha)},$$

where illegal copies may exist.

This proposition shows that the producer will choose a strategy in S_1. Choosing a strategy in S_1 greatly increases the circulation of the work, so the profit from illegal users can easily outweigh the cost of monitoring. Essentially, the producer accepts that fewer consumers will pay for the good in exchange for the profit to be obtained from all the consumers infringing the copyright.

We now consider the optimal penalty level against illegal users under civil law. The government chooses the penalty to maximize the social surplus, which is defined as the sum of the producer surplus and the consumer surplus. If the producer chooses not to create goods, the social surplus is zero. Otherwise the social surplus is given by

$$SW(g) = \frac{1}{4} - \frac{k\alpha^2}{4(g^2+k\alpha)} - F + \int_{\frac{g^2}{2(g^2+k\alpha)}}^{\frac{1}{2}} (\alpha v - \frac{ag^2}{2(g^2+k\alpha)})dv + \int_{\frac{1}{2}}^{1} (v - \frac{1}{2} + \frac{k\alpha^2}{2(g^2+ka)})dv \tag{5}$$

$$= \frac{3+\alpha}{8} - \frac{\alpha g^2(g^2+2k\alpha)}{8(g^2+k\alpha)^2} - F$$

The first term represents the profit of the producer. The second and third terms represent the consumer surplus due to illegal copies and legal purchases respectively. The next lemma considers how changes in the civil law penalty affect the social surplus.

Lemma 4

(1) If $0 \le F < (1-\alpha)/4$, *then*

$$\frac{\partial SW(g)}{\partial g} < 0.$$

(2) If $(1-\alpha)/4 \le F < 1/4$, *then*

$$SW(g) = 0 \text{ for } 0 \le g \le \sqrt{\frac{k\alpha(4F+\alpha-1)}{1-4F}},$$

$$\frac{\partial SW(g)}{\partial g} < 0 \text{ for } g > \sqrt{\frac{k\alpha(4F+\alpha-1)}{1-4F}}.$$

(3) If $1/4 \le F$, *then* $SW(g) = 0$ *for all* g.

The interpretation of this lemma is clear. The social surplus is a decreasing function of the penalty, because the number of participating consumers decreases as the penalty increases. The producer's profit is an increasing function of the penalty, because he can afford to decrease the monitoring cost as the penalty increases. When the penalty is low and the production cost is high, the producer may decide not to create the goods at all. In such cases the social surplus will be zero. The next proposition defines the optimal civil law penalty in the same three cost regimes.

Proposition 2

The optimal civil law penalty g^* is given by

$$g^* = 0 \textit{ for } 0 \leq F < \frac{1-\alpha}{4},$$

$$g^* = \sqrt{\frac{k\alpha(4F+\alpha-1)}{1-4F}} \quad \textit{for} \quad \frac{1-\alpha}{4} \leq F < \frac{1}{4},$$

$$g^* \in [0, \infty) \textit{ for } \frac{1}{4} \leq F.$$

As discussed in Lemma 4, the government desires to maximize the social surplus by setting the civil law penalty as low as possible. The original producer may decide not to create goods if the penalty is too low, however, because his profit is an increasing function of g. In the first case $(0 \leq F < (1-\alpha)/4)$ the cost is low enough that the government can set the penalty to zero. In the second case, setting the penalty to zero will result in a negative profit for the producer. The government thus gives the producer an incentive to create goods by imposing a penalty. The level of the penalty is set just high enough to result in a non-negative profit. In the third regime, the producer will never create goods because the production cost is too high.

4 Criminal law penalty

In this section, we consider the case of a criminal penalty. The right holder does not profit from a criminal penalty, but the government does. We again consider the previously defined sub-classes of strategies S_1 and S_2. The consumer behavior and the producer profit in S_2 are of course the same under criminal law since there is no illegal activity. We thus consider only strategies in sub-class S_1.

The demand for goods D_o and the demand for illegal copies D_c are given by

$$D_o = 1 - \frac{p - sg}{1 - \alpha},$$

$$D_c = \frac{p - sg}{1 - \alpha} - \frac{sg}{\alpha}.$$

From Lemma 1, we can obtain the producer's profit as

$$\pi_1 = p(1 - \frac{p - sg}{1 - \alpha}) - ks^2 - F.$$

The first term represents sales, and the second term is the monitoring cost. We see that by applying criminal law, the producer's profit has changed for strategies in S_1. The next lemma gives the optimal strategy for a given criminal penalty.

Lemma 5 *When the producer's strategy is restricted to sub-class S_1, his profit is maximized by the choice*

$$p_1^* = \frac{4k(1-\alpha)^2}{8k(1-\alpha) - 2g^2},\ s_1^* = \frac{2g(1-\alpha)}{8k(1-\alpha) - 2g^2}$$

for $g \leq \sqrt{2k\alpha(1-\alpha)}$, and by the choice

$$p_1^* = \frac{g^2}{2(g^2 + k\alpha^2)},\ s_1^* = \frac{\alpha g}{2(g^2 + k\alpha^2)}$$

for $g > \sqrt{2k\alpha(1-\alpha)}$. *The optimal profit is thus given by*

$$\pi_1^* = \frac{k(1-\alpha)^2}{4k(1-\alpha)-g^2} - F \text{ for } g \leq \sqrt{2k\alpha(1-\alpha)},$$

and by

$$\pi_1^* = \frac{g^2}{4(g^2+k\alpha^2)} - F \text{ for } g > \sqrt{2k\alpha(1-\alpha)}.$$

When the profit π_1^* *is negative, no goods are produced.*

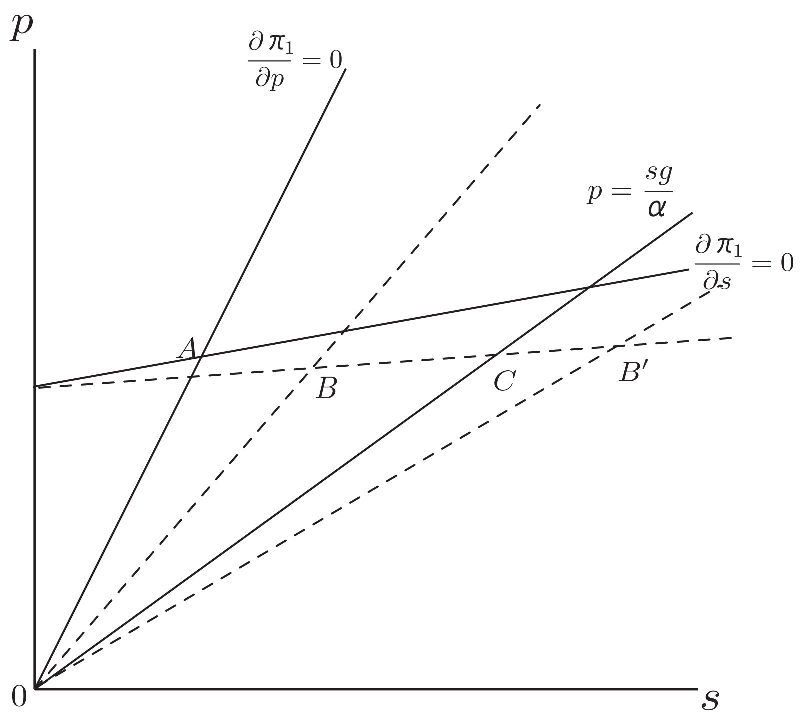

Figure 4: Iso-profit curves under criminal law

The optimal strategy within S_1 is an interior solution when $g \leq \sqrt{2k\alpha(1-\alpha)}$. Figure 4 illustrates the relationships of Lemma 5. The dashed curve $\partial\pi_1/\partial p = 0$ has a flatter slope under a criminal penalty than the solid curve under a civil penalty. The dashed curve $\partial\pi_1/\partial s = 0$ also slopes become flatter under a criminal penalty. The maximum profit under a criminal penalty thus moves to point B, the intersection of $\partial\pi_1/\partial p = 0$ and $\partial\pi_1/\partial s = 0$.

If the penalty g is larger than $\sqrt{2k\alpha(1-\alpha)}$, however, the producer simply sets the price as $p = sg/\alpha$. In this case the slope of $\partial\pi_1/\partial p = 0$ is flatter than that of $p = sg/\alpha$. The intersection of $\partial\pi_1/\partial p = 0$ and $p = sg/\alpha$ is B'. Then the optimal solution in S_1 becomes a corner solution, and producer's profit is maximized at point C, the intersection of $\partial\pi^1/\partial p = 0$ and $p = sg/\alpha$. We show this in our next proposition.

Proposition 3

When the entire strategy space S is considered, the profit of the producer under criminal law is maximized by the choice

$$p_1^* = \frac{4k(1-\alpha)^2}{8k(1-\alpha)-2g^2},\ s_1^* = \frac{2g(1-\alpha)}{8k(1-\alpha)-2g^2}$$

for $g \leq \sqrt{2k\alpha(1-\alpha)}$ and by

$$p_2^* = \frac{g^2}{2(g^2+k\alpha^2)},\ s_2^* = \frac{\alpha g}{2(g^2+k\alpha^2)}$$

for $g > \sqrt{2k\alpha(1-\alpha)}$.

Again, this proposition can be interpreted in a straightforward manner. When $g < \sqrt{2k\alpha(1-\alpha)}$, the producer chooses a strategy in S_1 because it is too costly to monitor illegal use. If g exceeds this limit, the producer chooses a strategy that shuts out all illegal users from the market since they cannot obtain the penalty under criminal law.

When no goods are produced, of course, the social surplus is zero. Otherwise the social surplus also depends on the magnitude of g as follows: If $g \leq \sqrt{2k\alpha(1-\alpha)}$,

$$\begin{aligned} SW(g) &= \frac{k(1-\alpha)^2}{4k-4k\alpha-g^2} - F \\ &\quad + \int_{\frac{4k(1-\alpha)-2g^2}{8k(1-\alpha)-2g^2}}^{1} \left(v - \frac{4k(1-\alpha)^2}{8k(1-\alpha)-2g^2}\right)dv + \int_{\frac{2g^2(1-\alpha)}{8k\alpha(1-\alpha)-2\alpha g^2}}^{\frac{4k(1-\alpha)-2g^2}{8k(1-\alpha)-2g^2}} \alpha v dv \\ &= \frac{(2\alpha g^4 - g^4 + 12\alpha k^2 - 6\alpha g^2 k - 20\alpha^2 k^2 + 4\alpha^3 k^2 + 4\alpha^4 k^2 + 4\alpha^2 g^2 k + 2\alpha^3 g^2 k)}{2\alpha\left(4\alpha k - 4k + g^2\right)^2} - F \end{aligned} \tag{6}$$

The first term is the optimal profit of the producer, and the second term is the surplus of consumers buying the goods. The third term sums the surplus of consumers making illegal copies and the penalty collected by the government. As the penalty is a transfer from illegal users to the government, it cancels out when calculating the social surplus.

When g is high, the social surplus function $SW(g)$ is as follows: If $g > \sqrt{2k\alpha(1-\alpha)}$,

$$\begin{aligned} SW(g) &= \frac{g^2}{4\left(g^2+\alpha^2 k\right)} - F + \int_{\frac{g^2}{2(g^2+\alpha^2 k)}}^{1} (v - \frac{g^2}{2(g^2+\alpha^2 k)})dv \\ &= \frac{3g^4 + 4\alpha^4 k^2 + 6\alpha^2 g^2 k}{8\left(g^2+\alpha^2 k\right)^2} - F \end{aligned} \tag{7}$$

In this case, the producer's choice of price and monitoring probability shuts out all illegal users. The social surplus is thus the sum of the profit of original goods and the surplus of consumers who buy the goods. The first term is the optimal profit of producer, and the second term is the surplus of consumers buying the goods. The next lemma shows the impact of a criminal penalty on the social surplus.

Lemma 6

A penalty paid to the government affects the social surplus as follows:

(1) If $0 \le F < (1-\alpha)/4$, *then*

$$\frac{\partial SW(g)}{\partial g} < 0.$$

(2) If $(1-\alpha)/4 \le F < (1-\alpha)/2(2-\alpha)$, *then*

$$SW(g) = 0 \textit{ for } 0 \le g \le \sqrt{\frac{k(1-\alpha)(4F+\alpha-1)}{F}},$$

$$\frac{\partial SW(g)}{\partial g} < 0 \textit{ for } g > \sqrt{\frac{k(1-\alpha)(4F+\alpha-1)}{F}}.$$

(3) If $(1-\alpha)/2(2-\alpha) \le F < 1/4$*, then*

$$SW(g) = 0 \text{ for } 0 \le g \le \sqrt{\frac{4Fk\alpha^2}{1-4F}},$$

$$\frac{\partial SW(g)}{\partial g} < 0 \text{ for } g > \sqrt{\frac{4Fk\alpha^2}{1-4F}}.$$

(4) If $1/4 \le F$*, then* $SW(g) = 0$ *for all* g*.*

This result can be interpreted in the same manner as Lemma 4. The following proposition discusses the optimal criminal penalty.

Proposition 4

The optimal criminal law penalty g *is given by*

$$g^* = 0 \text{ for } 0 \le F < \frac{1-\alpha}{4},$$

$$g^* = \sqrt{\frac{k(1-\alpha)(1-\alpha-4F)}{F}} \text{ for } \frac{1-\alpha}{4} \le F < \frac{1-\alpha}{2(2-\alpha)},$$

$$g^* = \sqrt{\frac{4Fk\alpha^2}{1-4F}} \text{ for } \frac{1-\alpha}{2(2-\alpha)} \le F < \frac{1}{4}, \text{ and}$$

$$g^* \in [0, \infty) \text{ for } \frac{1}{4} \le F.$$

This result can be interpreted in the same manner as Proposition 2. The government wants to set the criminal law penalty as low as possible to maximize the social surplus. However, the government has to set a high enough penalty to prevent the producer's profit from being negative. In the cost is low ($0 \le F < (1-\alpha)/4$) then the government can afford to set the penalty to zero. In the second and the third case, goods will not be created if the government sets the penalty to zero. Instead the government sets a penalty just high enough to prevent the producer's profit from being negative. In the last case, the producer does not create goods at any penalty level because the production cost is too high.

5 Discussion

In this section we compare the civil law and criminal law penalty schemes. It is not immediately clear from the above analysis which protection scheme is better from the point of view of society, but we are now ready to find the optimal copyright protection scheme. The next proposition compares the producer's optimal profits under each protection scheme.

Proposition 5

The producer's profit is larger under a civil penalty than under a criminal penalty.

This clearly supports our intuition, as the producer can profit from the penalties imposed on illegal users under civil law. According to Propositions 2 and 4, the government will set the civil penalty either to zero or to a level that makes the producer's profit zero. Therefore, the criminal law penalty has to be larger than the civil law penalty in order to cover production costs. In the U.S.A. Copyright Act, the allowed statutory damages range from $750 to $150,000 per work. Under criminal law, on the other hand, the first copyright infringement is punishable by up to $500,000. This example supports our proposition. Next, we consider the optimal copyright protection scheme.

Proposition 6

From the point of view of society, a criminal law scheme is better when the production cost is in the range $0 \leq F < 5(1-\alpha)/4(5-2\alpha)$. *Otherwise, a civil law scheme is better.*

This proposition can be interpreted as follows. When the production cost is low, the penalty set by the government is also low. The producer thus has little incentive to monitor illegal activity under criminal law because he does not profit from the penalty. It follows that under criminal law, more consumers will be using the goods. The criminal law scheme is therefore better than the civil law scheme when the production cost is low.

When production cost is high, on the other hand, the producer has an incentive to absorb the cost of monitoring and remove all illegal copies from the market. Under criminal law, the producer monitors illegal use excessively and reduces the number of consumers using the goods. The government can thus increase the social surplus by adopting a civil law penalty. This will give the producer an important incentive to profit from illegal use by assuming a more moderate monitoring strategy. Goods with a high production cost should therefore be protected under civil law. Movies and video games are examples of goods with a high production cost that should be protected by civil law, and music discs are an example of low-cost goods that should be protected by criminal law.

We end this section by pointing out some of the key assumptions in this work. First, criminal law penalties and civil law penalties are distinguished simply by changing the agent who obtains the penalty. However, there are many other differences between these penalty schemes. For instance, under criminal law illegal users may be punished by imprisonment. The threat of such punishment may also have a negative effect on illegal activity in the long run, but such non-monetary effects are not treated in our model. Another difference is that under civil law, the right holder can profit by claiming compensation for his actual damages. The calculation of actual damages would be based on the number of sales, not on the number of works copied. We do not include such actual damages in this model. Finally, note that in the real world illegal activity may be punished by both criminal penalties and civil penalties. This model does not consider a dual punishment scenario.

We could also use the model presented here to calculate the equilibrium output in other situations. For example, we have assumed that consumer valuations v_i are uniformly distributed on the interval $[0, 1]$. If this assumption is violated, the resulting consumer behavior could change drastically. The result of such a model depends on several additional assumptions, and will be the topic of future research.

6 Conclusion

In this paper we determine the optimal copyright protection scheme under a model where (a) the government sets a penalty to maximize the social surplus, (b) producers must monitor illegal activity, and (c) only civil penalties are paid to the producer. We obtain the following results.

First, we show that the optimal penalty level is always either zero or that which sets the producer's profit to zero. A zero penalty may be imposed when the cost of production is low enough that profits can be made even in the presence of illegal activity. When the cost of production is higher, the government must set a positive penalty to keep the producer's profit from falling below zero. To maximize the social surplus, however, the government wants to set the penalty as low as possible. It follows that the penalty imposed will be that which sets the producer's profit to zero.

Second, we compare the two copyright protection schemes. In real situations, copyright infringement is often punished under both civil law and criminal law. It is important to show which scheme does a better job of protecting the copyright. We show that when the development cost is high, civil law schemes are better from the point of view of society (i.e., the producer's optimal strategy under civil law leads to more consumers using the goods). When the development cost is low, on the other hand, it is better to apply criminal law.

Our analysis suggests that changes should be made in the direction of modern copyright policy. Recently, the punishments for copyright infringement have become severe. The government should perhaps reduce these penalties to a point where the private gain of producers is much smaller, but not negative. Copyright infringements are typically punished by civil penalties. We point out that goods with a low development cost are better protected by criminal law. The government can increase the overall social surplus by adapting the penalty scheme to the development cost of the product.

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7 Appendix

Proof of Lemma 1

In this lemma, we consider the optimal consumer behavior. In the first case, when consumers use the original product they obtain a higher utility than when making an illegal copy or not using it at all. We therefore obtain the equations

$$v_i - p \geq \alpha v_i - sg, \;\; v_i - p \geq 0.$$

In the second case, when consumers make illegal copies they obtain a higher utility than when buying the original product or not using it at all. We therefore obtain the equations

$$\alpha v_i - sg > v_i - p, \; \alpha v_i - sg \geq 0.$$

Finally, there is the case of consumers who choose not to consume the product because the utilities of buying and copying are both negative. We obtain the equations

$$0 > v_i - p, \; 0 > \alpha v_i - sg.$$

The lemma follows from these equations. Q.E.D.

Proof of Lemma 2

The optimal price p^* and the optimal monitoring probability s^* are the solution to

$$\max_{p,s} \pi = p(1 - \frac{p - sg}{1-\alpha}) + sg(\frac{p - sg}{1-\alpha} - \frac{sg}{\alpha}) - ks^2 - F.$$
$$s.t. \quad s < \frac{\alpha p}{g}$$
$$p \geq 0$$
$$1 \geq s \geq 0$$

We define the Lagrangian

$$L(p, s) = p(1 - \frac{p - sg}{1-\alpha}) + sg(\frac{p - sg}{1-\alpha} - \frac{sg}{\alpha}) - ks^2 - F + \lambda_1(\frac{\alpha p}{g} - s) + \lambda_2(1 - s).$$

The Kuhn-Tucker conditions are

$$\frac{\partial L(p^*, s^*)}{\partial p} = 1 - \frac{2p - sg}{1-\alpha} + \frac{sg}{1-\alpha} + \frac{\alpha\lambda_1}{g} \leq 0, \ p \geq 0, \ p^*\frac{\partial L(p^*, s^*)}{\partial p} = 0,$$

$$\frac{\partial L(p^*, s^*)}{\partial s} = \frac{pg}{1-\alpha} + \frac{pg - 2sg^2}{1-\alpha} - \frac{2sg^2}{\alpha} - 2ks - \lambda_1 - \lambda_2 \leq 0, \ s \geq 0, \ s^*\frac{\partial L(p^*, s^*)}{\partial s} = 0,$$
$$\frac{\partial L(p^*, s^*)}{\partial \lambda_1} = \frac{\alpha p}{g} - s > 0, \ \lambda_1 \geq 0, \ \lambda_1\frac{\partial L(p^*, s^*)}{\partial \lambda_1} = 0,$$
$$\frac{\partial L(p^*, s^*)}{\partial \lambda_2} = 1 - s \geq 0, \ \lambda_2 \geq 0, \ \lambda_2\frac{\partial L(p^*, s^*)}{\partial \lambda_2} = 0.$$

We can consider the case $p^* > 0, s^* > 0$, $\lambda_1 = 0$ and $\lambda_2 = 0$, because we assume that k is large. From these equations, we obtain

$$p_1^* = \frac{1}{2} - \frac{k\alpha^2}{2(g^2 + k\alpha)}, s_1^* = \frac{\alpha g}{2(g^2 + k\alpha)}.$$

The optimal profit in S_1 is thus given by

$$\pi_1^* = \frac{1}{4} - \frac{k\alpha^2}{4(g^2 + k\alpha)} - F.$$

The producer decides to produce the goods, if his profit is not negative. Q.E.D.

Proof of Lemma 3

The optimal price p^* and the optimal monitoring probability s^* are the solution to

$$\max_{p,s} \pi_2 = p(1-p) - ks^2 - F$$
$$s.t. \, 1 \geq s \geq \frac{\alpha p}{g}$$
$$p \geq 0$$

Profit in the S_2 sub-class is a decreasing function of s, so the producer wants to set $s = \alpha p/g$. We obtain

$$p_2^* = \frac{g^2}{2(g^2 + k\alpha^2)}, s_2^* = \frac{\alpha g}{2(g^2 + k\alpha^2)}.$$

The optimal profit in sub-class S_2 is thus given by

$$\pi_2^* = \frac{g^2}{4(g^2 + k\alpha^2)} - F.$$

The producer decides to produce the goods, if his profit is not negative. Q.E.D.

Proof of Proposition 1

We compare the optimal profits obtained in S_1 and S_2 in order to prove this proposition.

$$\pi_1^* - \pi_2^* = \frac{1}{4} - \frac{k\alpha^2}{4(g^2 + k\alpha)} - \frac{g^2}{4(g^2 + k\alpha^2)} = \frac{(1-\alpha)\, k^2\alpha^3}{4\, (g^2 + k\alpha^2)\, (k\alpha + g^2)} > 0$$

We can show that the producer's profit is larger in strategy space S_1. Q.E.D.

Proof of Lemma 4

The social surplus when goods are produced is given by

$$SW(g) = \frac{3+\alpha}{8} - \frac{\alpha g^2(g^2+2k\alpha)}{8(g^2+k\alpha)^2} - F.$$

We thus obtain

$$\frac{\partial SW(g)}{\partial g} = -\frac{k^2 g a^3}{2\left(ak+g^2\right)^3} < 0.$$

The social surplus is a decreasing function of the penalty g when goods are produced. Goods will not be produced, however, if the profit is negative. The producer's profit depends on the magnitudes of g and F, and is an increasing function of g.

In the case of $0 \leq F < (1-\alpha)/4$, the production cost is smaller than the minimum profit $\pi^*(0) = (1-\alpha)/4$. In this case the producer will create goods for all g. In the second case, the production cost is larger than the minimum profit of the producer. If the penalty is so low that the producer's profit is negative, the producer will not create any goods. In the last case, the production cost is larger than the maximum profit of the producer. In this case, no goods will be produced for any value of g. Q.E.D.

Proof of Proposition 2

From Lemma 4, the social surplus is a decreasing function of the penalty if goods are being produced. In the first case the government should choose $g = 0$ because the producer will create goods even if there is no penalty. In the second case the penalty should be chosen at the minimum level that provides an incentive for the producer to work. In the last case, the producer can not produce the goods for any g. The government's optimal penalty is therefore unconstrained. Q.E.D.

Proof of Lemma 5

The optimal price p^* and the optimal monitoring probability s^* are the solution to

$$\max_{p,s} \pi = p(1 - \frac{p - sg}{1-\alpha}) - ks^2 - F.$$

$$s.t. \quad s < \frac{\alpha p}{g}$$

$$0 \le s \le 1$$

$$p \ge 0$$

We define the Lagrangian as

$$L(p, s) = p(1 - \frac{p - sg}{1-\alpha}) - ks^2 - F + \lambda_1(\frac{\alpha p}{g} - s) + \lambda_2(1 - s).$$

The Kuhn-Tucker conditions are

$$\frac{\partial L(p^*, s^*)}{\partial p} = 1 - \frac{2p - sg}{1-\alpha} + \frac{\alpha\lambda_1}{g} \le 0,\ p \ge 0,\ p^* \frac{\partial L(p^*, s^*)}{\partial p} = 0,$$

$$\frac{\partial L(p^*, s^*)}{\partial s} = \frac{pg}{1-\alpha} - 2ks - \lambda_1 - \lambda_2 \le 0,\ s \ge 0,\ s^* \frac{\partial L(p^*, s^*)}{\partial s} = 0,$$

$$\frac{\partial L(p^*, s^*)}{\partial \lambda_1} = \frac{\alpha p}{g} - s > 0,\ \lambda_1 \ge 0,\ \lambda_1 \frac{\partial L(p^*, s^*)}{\partial \lambda_1} = 0,$$

$$\frac{\partial L(p^*, s^*)}{\partial \lambda_2} = 1 - s \ge 0,\ \lambda_2 \ge 0,\ \lambda_2 \frac{\partial L(p^*, s^*)}{\partial \lambda_2} = 0.$$

We consider the case $p^* > 0, s^* > 0,\ \lambda_1 = 0$ and $\lambda_2 = 0$ because we assume that k is large. We thus obtain

$$p_1^* = \frac{4k(1-\alpha)^2}{8k(1-\alpha) - 2g^2}, s_1^* = \frac{2g(1-\alpha)}{8k(1-\alpha) - 2g^2}.$$

The optimal price and monitoring probability satisfy the condition $s < \alpha p/g$ when $g < \sqrt{2k\alpha(1-\alpha)}$. The optimal profit of the producer when $g < \sqrt{2k\alpha(1-\alpha)}$ is given by

$$\pi_1^* = \frac{k(1-\alpha)^2}{4k(1-\alpha) - g^2} - F.$$

We can also consider the case $p^* > 0, s^* > 0$, $\lambda_1 > 0$ and $\lambda_2 = 0$ when $g \geq \sqrt{2k\alpha(1-\alpha)}$. In this case, the optimal price and monitoring rate are given by

$$p_1^* = \frac{g^2}{2(g^2 + k\alpha^2)}, s_1^* = \frac{\alpha g}{2(g^2 + k\alpha^2)}$$

which is equivalent to the optimal strategy of S_2. The optimal profit of the producer when $g \geq \sqrt{2k\alpha(1-\alpha)}$ is thus given by

$$\pi_1^* = \frac{g^2}{4(g^2 + k\alpha^2)} - F.$$

Q.E.D.

Proof of Proposition 3

We compare the maximum profit in S_1 to that in S_2 under a criminal penalty in order to prove this proposition.

$$\pi_1^* - \pi_2^* = \frac{k(1-\alpha)^2}{4k(1-\alpha) - g^2} - \frac{g^2}{4(g^2 + k\alpha^2)} = \frac{\left(g^2 - 2k\alpha + 2k\alpha^2\right)^2}{4\left(g^2 + k\alpha^2\right)\left(4k - 4k\alpha - g^2\right)}.$$

This equation is positive when $g \leq \sqrt{2k\alpha(1-\alpha)}$, and negative otherwise. The producer thus chooses the optimal strategy in S_1 when $g \leq \sqrt{2k\alpha(1-\alpha)}$, otherwise he chooses the optimal strategy in S_2. Q.E.D.

Proof of Lemma 6

The social surplus when goods are produced is given by

$$SW_1(g) = \frac{(2ag^4 - g^4 + 12ak^2 - 6ag^2k - 20a^2k^2 + 4a^3k^2 + 4a^4k^2 + 4a^2g^2k + 2a^3g^2k)}{2\alpha\left(4ak - 4k + g^2\right)^2} - F$$
$$\text{for} \quad g \leq \sqrt{2k\alpha(1-\alpha)}, \text{ and}$$

$$SW_2(g) = \frac{3g^4 + 4a^4k^2 + 6a^2g^2k}{8\left(g^2 + a^2k\right)^2} - F \quad \text{for} \quad g > \sqrt{2k\alpha(1-\alpha)}.$$

We obtain

$$\frac{\partial SW_1(g)}{\partial g} = \frac{2\left(a-1\right)^2\left(4-a\right)g^3k}{a\left(4ak - 4k + g^2\right)^3}, \tag{8}$$

$$\frac{\partial SW_2(g)}{\partial g} = -\frac{k^2ga^4}{2\left(g^2 + a^2k\right)^3} < 0.$$

Equation (8) is negative for $g \leq \sqrt{2k\alpha(1-\alpha)}$. The social surplus is thus a decreasing function of g when goods are produced. The producer will not create any goods if his profit is negative. The profit depends on the magnitudes of g and F, and is an increasing function of g.

In the case of $0 \leq F < (1-\alpha)/4$, the monitoring cost is smaller than the minimum producer's profit $\pi^*(0) = (1-\alpha)/4$. The producer will create goods for any value of g in this case. In the second and third cases, the production cost is larger than the minimum profit of the producer. The producer chooses the strategy in S_1 for F smaller than $\pi_1^*(\sqrt{2k\alpha(1-\alpha)}) = (1-\alpha)/2(2-\alpha)$, which is the maximum profit in S_1. No goods will be produced if the penalty is so low that the producer's profit is negative. The producer chooses the strategy in S_2 for $(1-\alpha)/2(2-\alpha) \leq F$. In the last case, the production cost is larger than the maximum profit and no goods will be produced for any value of g. Q.E.D.

Proof of Proposition 4

From Lemma 6, the social surplus is a decreasing function of the penalty g when goods are produced. In the first case, the government chooses the minimum penalty $g = 0$ because the producer will create goods for any value of g. In the second and third cases, the penalty is chosen at the minimum level that provides incentive for the producer to work. In the last case, the producer cannot afford to create goods for any value of g. The government's optimal penalty is therefore unconstrained. Q.E.D.

Proof of Proposition 5

We compare the producer's profit under each penalty scheme. First, we compare the optimal profit in S_1 under civil law (π_1^v) to the optimal profit in S_1 under criminal law (π_1^r).

$$\pi_1^v - \pi_1^r = \frac{1}{4} - \frac{k\alpha^2}{4(g^2 + k\alpha)} - \frac{k(1-\alpha)^2}{4k(1-\alpha) - g^2} = \frac{(g^2 - 3k\alpha + 3k\alpha^2)\, g^2}{4\,(k\alpha + g^2)\,(4k\alpha - 4k + g^2)} \tag{9}$$

This equation is positive when $g \leq \sqrt{2k\alpha(1-\alpha)}$.

Next, we compare the optimal profit in S_1 under civil law (π_1^v) to the optimal profit in S_2 under criminal law (π_2^r).

$$\pi_1^v - \pi_2^r = \frac{1}{4} - \frac{k\alpha^2}{4(g^2 + k\alpha)} - \frac{g^2}{4(g^2 + k\alpha^2)} = \frac{(1-\alpha)\, k^2\alpha^3}{4\,(g^2 + k\alpha^2)\,(k\alpha + g^2)} > 0 \tag{10}$$

From Equations (9) and (10), it can be shown that the profit under civil law is always larger than that under criminal law. Q.E.D.

Proof of Proposition 6

We compare the social surplus under each penalty scheme. We obtain the social surplus under the optimal civil law protection scheme by substituting g^* into Equation (5):

$$SW = 0 \text{ for } 0 \leq F < \frac{1-\alpha}{4},$$

$$SW = \frac{(3a - 8F + 16F^2 + 1)}{8a} \text{ for } \frac{1-\alpha}{4} \leq F < \frac{1}{4}, \tag{11}$$

$$SW = 0 \text{ for } \frac{1}{4} \leq F.$$

We then obtain the social surplus under the optimal criminal law protection scheme by substituting g^* into Equations (6) and (7):

$$SW = 0 \text{ for } 0 \leq F < \frac{1-\alpha}{4},$$

$$SW = \frac{(8F + 3a - 10Fa - 16F^2 - 2a^2 + 2Fa^2 + 4F^2a - 1)}{2a(1-a)} \tag{12}$$
$$\text{for } \frac{1-\alpha}{4} \leq F < \frac{1-\alpha}{2(2-\alpha)},$$

$$SW = \frac{1}{2}\left(4F^2 - 2F + 1\right) \text{ for } \frac{1-\alpha}{2(2-\alpha)} \leq F < \frac{1}{4}, \tag{13}$$
$$SW = 0 \text{ for } \frac{1}{4} \leq F.$$

We compare Equations (11) and (12) for $(1-\alpha)/4 \leq F < (1-\alpha)/2(2-\alpha)$:

$$\frac{(3a - 8F + 16F^2 + 1)}{8a} - \frac{(8F + 3a - 10Fa - 16F^2 - 2a^2 + 2Fa^2 + 4F^2a - 1)}{2a(1-a)}$$
$$= -\frac{(4F + \alpha - 1)(8F\alpha - 5\alpha - 20F + 5)}{8(1-\alpha)\alpha}$$

This equation is negative when F is less than $5(1-\alpha)/4(5-2\alpha)$.

We compare Equations (11) and (13) for $(1-\alpha)/2(2-\alpha) \leq F < 1/4$:

$$\frac{(3a - 8F + 16F^2 + 1)}{8a} - \frac{1}{2}\left(4F^2 - 2F + 1\right) = \frac{(4F-1)^2}{8\alpha(1-\alpha)} > 0$$

We thus prove that the criminal law scheme is better than the civil law scheme for $0 \leq F < 5(1-\alpha)/4(5-2\alpha)$. On the other hand, the civil law scheme is better than the criminal law scheme for $5(1-\alpha)/4(5-2\alpha) \leq F$. Q.E.D.