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ANALYSIS OF ADVERTISEMENT BASED BUSINESS MODEL UNDER TECHNOLOGICAL ADVANCEMENTS IN FAIR USE PERSONAL RECORDING SERVICES: A LAW AND ECONOMICS APPROACH

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Abstract

Recent technological advancements such as cloud based digital video recording services and advertisement-skipping services are threatening copyright holders’ business models more than ever. This paper introduces an economic model to analyze court rulings on the personal fair use of video recording technologies. Although personal video recorders might have been beneficial for copyright holders in the past, newer and more innovative information technologies have the potential to restrict copyright holders’ usual distribution channels, namely live airing and video on demand. By linking a law and economics approach with the characteristics of information technology, this paper provides a new perspective to explain the effects of copyright law on the business strategies of copyright holders under the threat of new kinds of information technologies. The court may have to consider adjusting the boundaries of fair use according to match such rapid technological development. Business managers should also be aware that this combination of legal rulings and information technology may create either benefits or disruptions.

Keywords: information technology, copyright law, fair use, video on demand, time shifting
1 INTRODUCTION

In March 2012, Dish Network Corp. (www.dish.com), a satellite TV provider, introduced an Auto-hop feature that allows users to automatically skip commercials when playing recorded TV content using its Hopper DVR (digital video recorder)\(^1\). TV networks such as Fox, CBS, and NBC who holds the copyright of the broadcasted contents considered the service to be a threat to their business models, which they argued to be supported by advertising, and filed lawsuits against Dish in May 2012 for copyright infringement\(^2\). The court subsequently denied Fox’s request for a preliminary injunction against Auto-hop in November 2012.

Copyright holders of TV contents have both legal barriers and technological barriers that can protect their profit and incentives to create, against PRSs since Betamax. Legal barriers are set by the court, by deciding what PRS is a fair use and what is not. Technological barriers can be categorized into three different factors which can deter viewers from using PRSs: quality loss when copying, the cost of copying (Miceli and Adelstein, 2005), and embedded advertising. Copyright holders have two major sources of income depending on the platform, namely indirect advertisement fees from live broadcasting and direct service fees from video on demand (VOD) services. Quality loss and the expensive cost of private copying help copyright holders by discouraging potential viewers from choosing a personal video recorder over their services. Embedded advertising forces viewers to watch advertisements even when the content is recorded, which allows copyright holders to convert such exposure into advertising revenue. However, recent advancements in information technology have challenged such barriers. DVRs have removed quality loss from personal recordings, while cloud based DVRs theoretically have a similar cost structure to that of VOD services. Moreover, the Auto-hop feature removes embedded advertisements, while bringing up another legal dispute over fair use doctrine. As such barriers are being removed by information technology, it is clear that both lawmakers and managers of copyright holders are facing newer and different challenges. Therefore, it is imperative to analyze the legal, economic, and technological conditions that affect the interests of copyright holders and lawmakers in order to help them make better decisions. However, to the best of the author’s knowledge, no studies have yet linked these newer personal recording devices armed with innovative information technologies such as cloud based DVR and Auto-hop with a law and economics approach to elaborate on the implications for lawmakers and copyright holders.

This paper suggests an economic model that captures disruptions from advancements of PRS technologies, from Betamax to cloud DVR and Auto-hop. The model shows the economic value of the fair use of TV content, the consequences of court decisions, and copyright holders’ strategies according to changes of PRS technologies. Research objectives are: 1) to review and compare how advancements of PRS technologies have changed TV content copyright holders’ profit, strategies, and social welfare under previous court rulings. 2) to explain how the newest PRS technologies can disrupt the balance between protecting social welfare and copyright holders’ incentives according to court’s expected decisions.

2 LITERATURE REVIEW

2.1 Fair use doctrine and related information technologies

The fair use doctrine is one of the most controversial topics in the law and economics field. The Copyright Act established the concept of fair use, which allows for unauthorized copying if it improves the original work, including criticism, scholarship, news reporting, and education purposes.


However, such purposes should not substantially impair the copyright holder’s incentives to create the work, in this case the creation of TV content (Miceli and Adelstein, 2005).

The degree of protection to be applied has always been disputed. Scholars such as Liebowitz (1985) and Boldrin and Levine (2002) have argued that a copyright holder can charge a higher price for the content to include the indirect benefits derived from unauthorized copies if it can price discriminate. However, some studies suggest that improvements in copying technology imply that the level of copyright protection may have to be increased (Adelstein and Peretz, 1985; Klein et al., 2002).

From these arguments, understanding the performance and characteristics of the technologies used in fair use is essential to balancing the costs and benefits of the fair use ruling (Novos and Waldman, 1984; Johnson, 1985; Besen, 1986). While Miceli and Adelstein (2005) claimed that the optimal level of fair use is determined by technology level, implying that the court may have to adjust its rulings as the performance and characteristics of technologies evolve. A copyright holder has two types of protection for their creations: legal and technological. Legal protection such as copyright laws safeguards incentives to create, while technological protection offers copyright holders a much better quality and cost structure when copying (Miceli and Adelstein, 2005). Therefore, legal and technological protection should work together to guarantee a copyright holder’s incentives without hampering social welfare.

2.2 Platform strategies and competitive fair use services

Copyright holders of TV contents like TV networks are often modeled as platform providers in a two-sided market, since they often operate their own distribution channels such as TV broadcasting and VOD services. The copyright holder usually creates content and serve two different groups. One group of users is content viewers and the other is advertisers. By heavily subsidizing the viewers’ side, copyright holders derive better profits with the advertisers’ side through network effects (Armstrong, 2006). Many studies have investigated platform providers’ strategies under different settings. For instance, various business models such as those including credit cards, broadband, videogames, media, and streaming services adopt similar strategies in order to maximize the benefits generated through network effects (Rochet and Tirole, 2003). However, a copyright holder’s strategy under direct competition with PRSs is not fully addressed.

Other than live airing, copyright holders have another means of distributing their content. In the past, this was usually by releasing official versions of the content on physical media such as VHS or DVD. Since 1999, however, inexpensive Internet broadband connections have facilitated the development of VOD. Compared with official DVD releases, VOD has lower marginal production and distribution costs (Shapiro and Varian, 1999) and can be directly served from the copyright holder and/or sanctioned intermediaries such as Netflix and Amazon. VOD services are usually considered to operate under a revenue-sharing model because they offer copyrighted materials for profit purposes. Economides and Tåg (2012) extended Armstrong’s (2006) model to explain the pricing- and revenue-sharing issues between VOD platform providers and copyright holders.

For copyright holders, VOD is in direct competition with PRSs, as it has both time shifting and space shifting features, while indirect advertisement revenue can be turned into direct pricing. However, the fact that copyright holders have lost the legal battle until cloud DVR suggest that the copyright holders’ business model need to be re-examined under new technological and legal circumstances.

3 MODEL AND ANALYSIS

Suppose a group of viewers who want to watch TV content. Each viewer has a different ideal watching time, denoted as $t_i$, uniformly distributed over $[0,1]$. In other words, transportation cost $t_i$ incurs if viewer $i$ watches the content at a time that deviates from his or her ideal watching time. The
content is broadcasted live at $t=0$. A viewer receives utility $U_0$ ($0 < U_0 \leq 1$) if he or she watches the content at the ideal time. We assume that $U_0$ does not decrease as time passes. The content has embedded advertisements, which incurs fixed nuisance cost of $C_F$ to viewers ($C_F < U_0$).

If a viewer watches the content and the embedded advertisements, the copyright holder charges the advertiser an advertisement fee denoted as $f$. This advertisement fee can be interpreted as advertisers’ willingness to pay or valuation for a single exposure of their advertisements. The valuation of the advertisement for the advertiser does not exceed the maximum possible utility from watching the content for a viewer ($f < 1$). In addition, although the content is not substitutable for viewers, for advertisers it is assumed that there exists similar content that has available advertisement slots. Therefore, the advertisement fee $f$ is assumed to be fixed by the market.

### 3.1 Case 1: Live TV only

In this case, it is assumed that no PRSs are available. Before Betamax was introduced in 1982, a viewer had to watch the content live or give up watching it at all if the transportation cost was too high. Therefore, a viewer’s utility function is defined as:

$$u_i = U_0 - C_F - t_i$$

(1)

If $u_i \geq 0$, viewer $i$ watches the content live. Otherwise, he or she gives up watching. The number of live viewers, denoted as $\alpha$, is:

$$\alpha = U_0 - C_F$$

The copyright holder’s profit function thus becomes:

$$\pi_{CP,1} = f\alpha = f(U_0 - C_F)$$

(2)

To derive social welfare, aggregated viewer’s welfare is expressed as:

$$\pi_{V,1} = \int_0^\alpha (U_0 - C_F - t)dt = 1/2(U_0 - C_F)^2$$

(3)

Assuming that the advertisers get the exactly same marginal benefits as the marginal advertisement fee, the social welfare becomes:

$$\pi_{S,1} = (U_0 - C_F)(f + 1/2(U_0 - C_F))$$

(4)

This case is the baseline of the following analysis. As more technologically advanced fair use PRSs are introduced to the market, more parameters and decisions must be modeled.

### 3.2 Case 2: Betamax (imperfect recording technology)

Betamax allowed viewers to record TV content onto magnetic tapes, which naturally degraded picture quality. Relative quality loss is denoted as $\sigma$ ($0 < \sigma < 1$), and the viewer now has two choices: Watch live or record and watch later. The viewer still has to watch the embedded advertisements, even with recordings. The fact that automatic advertisement skipping services such as Auto-hop are under legal dispute also suggests that copyright holders benefit from recorded advertisements in their revenues. We therefore assume that until automatic advertisement skipping services arrive, viewers watch embedded advertisements in their personal recordings in order to examine the impact of technological innovations clearly. Further, PRSs are ruled to be fair use, and viewers incur marginal recording cost $C_R$ if they decide to record and play later. PRS providers are assumed to be under perfect competition, therefore $C_R$ is set by the market.

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3 The contents considered in this paper represent movies and TV series, which are often watched years later.
4 We follow Gabszewicz et al.’s (2001) assumptions that there is a limit on the amount of advertising embedded in content without harming it and that the viewers are indifferent to marginal changes in this amount.
When a viewer watches recorded content at his or her ideal time, deviated from the original airing, it is assumed that advertising effectiveness decreases as time passes after the initial airing. Even though we assume that the utility from watching the content does not decrease over time, the value of embedded advertisements does. In this model, advertising effectiveness thus decreases after its initial live airing and eventually becomes zero when the viewer that has the most distant ideal watching time \( t = 1 \) watches the content. It is further assumed that advertising effectiveness is fully known to both the advertiser and the copyright holder and that an advertisement fee is collected according to total delivered advertisement effectiveness.

A viewer’s choice is described by the following expressions, where \( u_{i,L} \) is the utility function when the viewer watches the content live and \( u_{i,R} \) is when the viewer records the content and watches it at his or her ideal time:

\[
\begin{align*}
    u_{i,L} &= U_0 - C_F - t_i, \\
    u_{i,R} &= (1 - \sigma)U_0 - C_F - C_R
\end{align*}
\]  

(5)

In order to make any viewer choose recording services \( u_{i,R} \geq 0 \), the maximum allowed quality loss is derived as:

\[
\sigma_{\text{MAX}} = 1 - \frac{C_R + C_F}{U_0}
\]

In other words, if \( \sigma > \sigma_{\text{MAX}} \), the recording service does not appeal to viewers at all. A viewer chooses to watch live when \( u_{i,L} \geq u_{i,R} \); otherwise, he or she records the content and watches it later. The number of live viewers \( \alpha \) is derived as:

\[
\alpha = \sigma U_0 + C_R \quad 0 \leq \sigma \leq \sigma_{\text{MAX}}
\]

The profit function of the copyright holder becomes:

\[
\pi_{CP,2} = f\alpha + f \int_0^\alpha (1 - t)dt
\]

(6)

Because the effectiveness of recorded advertisements declines after \( \alpha \), the advertisement fee reduces accordingly. When \( \sigma = \sigma_{\text{MAX}} \), which may represent the performance of the first PRSs introduced into the market, the profit function can be simplified to

\[
\pi_{CP,2,\sigma_{\text{MAX}}} = \frac{1}{2}(1 + (U_0 - C_F)^2) f
\]

(7)

It is clear that \( \pi_{CP,2,\sigma_{\text{MAX}}} > \pi_{CP,1} \). Thus, the copyright holder may enjoy additional profits from the recorded advertisements embedded in the content. Analysis suggests that even though copyright holders sued Sony for copyright infringement when Betamax was introduced, they may actually benefit from fair use PRSs.

As the performance of PRSs increases \( (\sigma \text{ reduces to zero}) \), the copyright holder’s profit decreases, since:

\[
\frac{d}{d\sigma} \pi_{CP,2} = fU_0(C_R - C_F + \sigma U_0 + 1) > 0
\]

(8)

Our model is consistent with Miceli and Adelstein’s (2005) findings; in other words, as the quality of copied material under fair use increases, the copyright holder becomes worse off.

**Proposition 1:** The copyright holder is better off with PRSs if its quality loss is at the allowed maximum; however, the copyright holder’s profit decreases as quality loss decreases.

\[\text{As advertisements often have time-sensitive content, such as temporary discount campaigns (Bitran and Mondschein, 1997) and advertisers want to replace old advertisements with new ones if a competitor launches a new campaign (Sohn and Choi, 2001).}\]
When DVRs became available, the copyright holder’s profit function becomes:

$$\pi_{CP,2,\sigma=0} = f \frac{1}{2}(C_R^2 + 1)$$  \hspace{1cm} (9)$$

Since $\sigma=0$. This profit function is dependent on the marginal cost of personal recording. Although copyright holders may still cover the fixed cost of content creation if the cost of personal recording remains high, the threat is clear since the copyright holder could be worse off following the introduction of DVRs.

To derive social welfare in this case, it is assumed that DVR is provided at the cost under perfect competition. For DVR, the number of live viewers is:

$$R = C\alpha$$

The aggregated viewers’ welfare and social welfare is derived as:

$$\pi_{V,2,\sigma=0} = \int_0^\sigma (U_0 - C_F - t)dt + \int_\sigma^1 (U_0 - C_F - C_R)dt$$  \hspace{1cm} (10)$$

$$\pi_{S,2,\sigma=0} = \pi_{CP,2,\sigma=0} + \pi_{V,2,\sigma=0}$$  \hspace{1cm} (11)$$

Comparing the social welfare with when VTR’s quality loss was the maximum yields:

$$\pi_{S,2,\sigma=0} - \pi_{S,2,\sigma_{MAX}} = 1/2(U_0 - C_F - C_R)(2-(f+1)(U_0 + C_R - C_F))$$  \hspace{1cm} (12)$$

Since $f < 1$ is assumed, the analysis suggests that if marginal recording cost is high enough ($U_0-C_F > 1-C_R$), loss of advertisement revenue may surpasses gain of viewer’s benefits from technological advancement, reducing overall social welfare. It is unlikely that the court can block technological advancement of personal recording services, however as Liebowitz (1981,1982,1984,1985) and Gorden (1982) suggested, technological improvement may hamper social welfare as it can make previous business models obsolete. By ruling Betamax technology as fair use, court may increased both copyright holder’s profit and social welfare, therefore serving the purpose of the fair use doctrine: better use of copyrighted material and protect copyright holders’ incentives.

### 3.3 Case 3: Expensive DVR vs. Inexpensive VOD

In this model, VOD services generate revenues for the copyright holder directly. Although many VOD services such as Netflix and Amazon are exist as distribution intermediaries, they must still be legally sanctioned by copyright holders in contrast to fair use PRSs, and therefore revenue sharing with the copyright holder is assumed⁶.

A viewer now has three options: watch the content live, record and play later, or buy VOD. VOD is assumed to be provided without embedded advertisements; however, a price set by the copyright holder is directly charged to viewers. From a viewer’s perspective, because VOD and DVR provide the same picture quality at different prices, both services are direct competitors. However, VOD requires direct payment, while DVRs incur the marginal cost of recording and the nuisance cost of embedded advertisements.

Traditional DVRs (i.e., before cloud DVR) had a different cost structure to that of VOD. When viewers used a traditional DVR, the recording service provider usually had to install the device, generating relatively large installation costs. Content was recorded on the local hard drives of traditional DVRs, which means that if more than one viewer wanted to record the same content, it may be duplicated among viewers. Further, hard drive size was another limitation of traditional DVRs.

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⁶ We also argue that official DVD releases have the same business model as that of VOD releases, only with different launch timings. Copyright holders usually release official DVDs after a full season has ended, while VOD content is often available after just 24 hours.
Therefore, in this section VOD is modeled as being more competitive than traditional DVR, because VOD does not require such costs, which may reflect the early stages of the DVR and VOD battle.

The copyright holder decides both the price and the launch time of VOD, denoted as $P_V$ and $t_V$, respectively. The marginal cost for the VOD service is denoted as $C_V$. In this section, the DVR is assumed to be a recording service that has a higher marginal recording cost relative to the cost of using VOD services, which satisfies:

$$C_R > \frac{1}{2}(P_v + t_v - C_F)$$  \hspace{1cm} (13)

The viewer who pays the highest cost for choosing VOD over live TV has a transportation cost of $\frac{1}{2}(P_v + t_v - C_F)$. Therefore, if the marginal cost of recording exceeds the cost of using VOD services ($P_v + (t_v - \frac{1}{2}(P_v + t_v - C_F)) < C_R + C_F$), no viewers choose DVR since a viewer simply selects the lowest curve available.

A viewer whose ideal time is close to the live airing would choose to watch the content live, because of the relatively small transportation cost incurred. As the transportation cost increases both using DVR and buying VOD become cost effective, such viewers give up watching live and choose to watch the content at the ideal time. In this case, the marginal cost of recording ($C_R + C_F$) is somewhat higher than the sum of the fee for VOD ($P_v$) and the VOD transportation cost because of the lateness of launch ($t_i - t_V$, $t_i < t_V$). This condition removes the option to use DVR technology. Therefore, a viewer’s utility functions are now defined as:

$$u_{i,L} = U_0 - C_r - t_i$$
$$u_{i,R} = U_0 - C_r - C_R$$
$$u_{i,V} = U_0 - P_v - (t_v - t_i) \quad \text{when} \quad (t_v \geq t_i)$$
$$u_{i,V} = U_0 - P_v \quad \text{when} \quad (t_v < t_i)$$

where $u_{i,V}$ are utility functions when the viewer watches the content via VOD. The number of live viewers ($\alpha$) is derived as:

$$\alpha = \frac{1}{2}(P_v + t_v - C_F)$$

In this case, because no viewers choose DVR over VOD, the profit function of the copyright holder becomes:

$$\pi_{cp,v}(P_v, t_v) = f \alpha + \int_{t_i}^{t_V} (P_v - C_v)dt$$  \hspace{1cm} (15)

where $C_v$ is the marginal cost of the VOD service.

The copyright holder can freely set the price of VOD and its launch timing as long as the condition stated in expression (13) holds. To find the optimal VOD price and launch timing, first- and second-order conditions are derived as:

$$\frac{\partial \pi_{cp}}{\partial P_v} = \frac{1}{2}(C_r + C_v - 2P_v + f - t_v + 2) \quad \frac{\partial^2 \pi_{cp}}{\partial P_v^2} < 0$$
$$\frac{\partial \pi_{cp}}{\partial t_v} = \frac{1}{2}(f - (P_v - C_v)) \quad \frac{\partial^2 \pi_{cp}}{\partial t_v^2} \bigg|_{t_i} > 0$$

The second derivative of launch timing at given VOD price is negative. Therefore the best launch timing for the copyright holder is launch immediately or do not launch at all. For both cases, the optimal prices of VOD are determined from the first order conditions:

$$\hat{P}_v \bigg|_{t_i=0} = \frac{1}{3}(2C_F + C_v + f + 2) \quad \hat{P}_v \bigg|_{t_i=1} = \frac{1}{2}(C_F + C_v + f + 1)$$  \hspace{1cm} (17)

Comparison of profit of the copyright holder for both cases yields:
\[ \pi_{CP,3}(\hat{P}_V |_{t=0, t_{V,0}}) - \pi_{CP,3}(\hat{P}_V |_{t=1, t_{V,1}}) = \frac{7}{72}(1 - f + C_f - C_v)^2 > 0 \] 

Therefore, if DVR is expensive, immediate launch of VOD is the best for the copyright holder and the optimal VOD price is set to:

\[ \hat{P}_V |_{t=0} = 1/3(2C_f + C_v + f + 2) \] 

If VOD services have better cost structure than personal recording services, the copyright holder should launch the VOD immediately and the optimal VOD price exists to maximize the profit, balancing indirect advertisement fee and direct VOD revenue.

**Proposition 2:** If DVR has expensive marginal recording cost for viewers \((C_R > 1/2(P_V + t_v - C_f))\), it is best for the copyright holder to launch VOD immediately and optimal VOD price exists \((\hat{P}_V = 1/3(2C_f + C_v + f + 2))\).

If personal recording services have relatively worse cost structure due to installation cost, duplicated local storage and upgrade costs, the copyright holder may able to enjoy both advertisement fee and VOD revenue by setting optimal VOD price and launch timing.

To simplify comparison of the copyright holder’s profit between the case 2 and this case, let the quality loss as zero \((\sigma = 0)\) and the marginal cost of serving VOD is negligible \((C_v \ll C_r, C_v = 0)\).

\[ \pi_{CP,3-2} = \pi_{CP,3,t=0} - \pi_{CP,2,t=0} \]

\[ \frac{\partial \pi_{CP,3-2}}{\partial C_f} = \frac{1}{9}(4 - 2f + C_f(4 - f) + f^2) \geq 0; \quad \frac{\partial \pi_{CP,3-2}}{\partial f} = \frac{C_f^2}{18} - \frac{2}{9}C_f(1 - f) - \frac{f^2}{6} - \frac{1}{6} \leq 0 \]

\[ \pi_{CP,3-2} |_{t=1, t_f=0} = 0 \]

Therefore the copyright holder gets more profit than the case 2, when the value of the embedded advertisement is smaller than the maximum possible utility from the content \((f < 1)\) and the marginal cost of serving VOD is negligible \((C_v = 0)\). This clearly shows that the copyright holder is enjoying the newly erected technological barrier, VOD, and taking advantage of relatively efficient cost structure of VOD in comparison with traditional fair use PRSs.

Social welfare is also increases in this case, because both the viewers and the copyright holder get benefits from more efficient technology. The aggregated viewers’ welfare and social welfare in this case are derived as:

\[ \pi_{V,3} = \int_0^\alpha (U_0 - C_f - t)dt + \int_1^\beta (U_0 - \hat{P}_V)dt \]

\[ \pi_{S,3} = \pi_{CP,3} + \pi_{V,3} \]

Again, assuming \(f < 1\) and \(C_v = 0\), the comparison of social welfare between this case and DVR-only case simplifies to:

\[ \pi_{S,3} - \pi_{S,2,t=0} = \frac{1}{18}(1 - f - C_f)(5 + C_f(5 - f) + f^2) \geq 0 \]

The results shows that even when the copyright holder is taking advantage from VOD’s better cost structure and enjoying monopolistic position over the time-shifting services, the social welfare can be better off since VOD technology works better for both viewers and the copyright holders. The court still allowed PRSs as fair use, however, VOD serves as a better fair use technology for the viewers. In this case the technology worked well for both viewers and the copyright holders, for viewers can enjoy copyrighted materials better and it also protected copyright holder’s incentives for creation, without the court’s intervention to balance fair use.
3.4 Case 4: Cloud DVR vs. VOD

Cloud DVR (often referred to as Remote Storage DVR or network DVR) services store personal video recordings in a central server and play content over a broadband network. Therefore, it is assumed that the marginal service cost for PRSs is significantly lowered and can match the price of VOD services.

From a legal perspective, Cloud DVR works in the same way as does a traditional VCR, which has been ruled to be fair use. However, from a business perspective, Cloud DVR works in the same way as does VOD. The differences in two perspectives yield different results relative to the previous cases. In this case, the marginal cost of recording is low enough to threaten the VOD price and does not satisfy the condition specified in expression (13), which means that:

\[ C_R \leq 1/2(P_v + t_v - C_F) \quad (24) \]

Although a viewer’s number of available options do not change, setting the price of VOD and its launch timing becomes more complicated for the copyright holder. A viewer is assumed to choose VOD over cloud DVR when the perceived cost is the same. If the price of VOD is higher than the marginal cost of recording \( P_v > C_R + C_F \), no viewers will choose VOD over cloud DVR. However, if the price of VOD is lower than the marginal cost of recording \( P_v < C_R + C_F \), the launch timing is fast enough to satisfy expression (13), and we return to the previous case. Moreover, if the price of VOD is lower than the marginal cost of recording \( P_v < C_R + C_F \) and the launch timing is slow enough to satisfy inequality (24), the copyright holder’s profit is worse off than when setting the price of VOD to be the same as the marginal cost of recording. Therefore, the price of VOD is fixed at the marginal cost of recording in this case \( P_v = C_R + C_F \).

Since the price of VOD is fixed, advertising is relatively more valuable to the copyright holder; therefore, it may be possible to delay the VOD launch to maximize advertising revenue, even if the advertisements are recorded. The number of live viewers in this case is derived as:

\[ \alpha = C_R \]

Because \( P_v = C_R + C_F \), the copyright holder’s profit function becomes:

\[ \pi_{CP,3} = f \alpha + f \int_{t_v}^{\alpha} (1-t)dt + f \int_{t_v}^{1} (P_v - C_V)dt \quad (25) \]

The optimal launch timing \( \left( t_v \right) \) is decided by the first-order condition because the second-order derivative is negative:

\[ \frac{d\pi_{CP}}{dt_v} = f(1-t_v) + C_V - C_R - C_F \quad (26) \]

In the previous case, it was preferable for the copyright holder to set the launch timing to be immediate and set the optimal VOD price. However, control over the VOD price diminishes in this case and only the launch timing remains. If the advertisement fee is high enough, then the copyright holder should delay launch timing in order to benefit from the recorded advertisements.

Proposition 3: If DVR has a competitive marginal recording cost for viewers \( C_R \leq 1/2(P_v + t_v - C_F) \), it is preferable for the copyright holder to fix the VOD price at the marginal cost of personal recording \( P_v = C_R + C_F \) and set the optimal VOD launch timing \( (t_v = 1 - (C_R + C_F - C_V / f)) \).

\[ \text{For example, new could DVR services such as Boxee TV introduced unlimited amount of recordings for a usual monthly fee.} \]
As information technology advances and upgrades fair use PRSs, the copyright holder’s control over its own copyrighted material diminishes and embedded advertisements are important to revenue generation\(^8\).

As cloud DVR becomes cheaper, the copyright holder’s profit decreases, because:

\[
\pi_{CP,\delta_t} = \frac{f}{2} (C_R^2 + 1) + \frac{1}{2f} (C_R + C_F - C_V)^2 \quad \text{and} \quad \frac{d\pi_{CP,\delta_t}}{dC_R} = fC_R + \frac{C_R + C_F - C_V}{f} > 0
\]

If the cost of cloud DVR continuously decreases, it will eventually become the same as the cost of serving VOD, since the cost structure is the same. We further assume that cloud DVR and VOD have the same cost structure \((C_V=C_R)\), to simplify the analysis of social welfare.

The aggregated viewers’ welfare and social welfare in this case are derived as:

\[
\pi_{V,4} = f \left\{ \int_0^\alpha (U_0 - C_F - r)dt + \int_\alpha^b (U_0 - C_R - C_F)dt + \int_b^1 (U_0 - P_V)dt \right\}
\]

\[
\pi_{S,4} = \pi_{CP,4} + \pi_{V,4}
\]

As the marginal recording cost decreases, the social welfare and the copyright holder’s profit may show opposite direction.

\[
\frac{d}{dC_R} \pi_{S,4} = C_R (1 + f) - 1; \quad \frac{d}{dC_R} \pi_{CP,4} = C_Rf + \frac{C_F}{f}
\]

The social welfare increases as the marginal recording cost decreases, once the marginal recording cost gone below a certain level \((C_R \leq 1/(1+f))\). If the embedded advertisements are valuable for society, losing them by cloud DVR may not be so attractive. Otherwise, inexpensive cloud DVR is good for society because it increases the viewer’s welfare, since competition is good for society. However, the copyright holder’s profit only decreases as the marginal recording cost decreases and it may not protect incentives for creation eventually. Therefore, comparing the copyright holder’s profit with that of case 2 yields:

\[
\pi_{CP,4} - \pi_{CP,2,\delta t=0} = \frac{C_F^2}{2f} - \frac{f(C_R^2 - C_V^2)}{2}
\]

The above expression should be positive in order to protect incentives for the copyright holder. The profit loss from competition, represented by the second term, should be small enough to preserve copyright holder’s incentives.

The importance of introduction of cloud DVR technology is that for the first time allowing PRS technology as a fair use may fail to achieve its goal: protecting copyright holder’s incentive and maintain social welfare. Unlike previous cases, the fair use doctrine must be used with greater caution in this case, since with cloud DVR there is a possibility that allowing the new PRS as a fair use may fail to protect the copyright holder’s incentives for creation even the social welfare can increase by new technologies. The court already allowed cloud DVR as a fair use, however the court may have to watch closely as the marginal recording cost of cloud DVR is likely to decrease and the decision may have to be reviewed.

\(^8\) According to CNET, Fox Networks recently increased the limits on web access to its shows from 24 hours to eight days. It is hard to say that this adjustment reflects the threat from cloud DVR, however, delaying the VOD launch may suggest that copyright holders are receiving insufficient advertisement revenues and taking the relevant actions to protect them.
3.5 Case 5: Non-free Auto-Hop vs. VOD

In this case, a new parameter is introduced to model automatic advertisement skipping \((k, 0 \leq k \leq 1)\). If \(k=0\), Auto-hop is ruled to be fair use and all advertisements in the content are skipped. It is assumed that for now to automatically skip advertisement the viewers must pay additional fee which is exactly same amount as the nuisance cost, and servicing Auto-hop requires certain amount of cost for the PRS provider\(^9\).

Viewers’ utility functions do not change, since they pay the same cost for watching embedded advertisements and for using the Auto-hop service. The copyright holder’s profit function thus becomes:

\[
\pi_{CP,5} = f\alpha + kf\int_{1}^{t_{v}} (1-t)dt + \int_{1}^{t_{v}} (P_{V} - C_{V})dt
\]

(32)

If \(0 < k < 1\), the optimal launch timing is derived as:

\[
\frac{d\pi_{CP}}{dt_{v}} = fK(1-t_{v}) + C_{V} - C_{R} - C_{F}, \quad \hat{t}_{v} = 1 - \frac{C_{R} + C_{F} - C_{V}}{fk}
\]

(33)

which is similar to the previous case. If \(k\) decreases, the launch timing should be hastened because of loss of advertisement exposure in the recorded content.

When \(k=0\), the first-order derivative becomes:

\[
\frac{d\pi_{CP}}{dt_{v}} = C_{V} - (C_{R} + C_{F})
\]

(34)

The first-order derivative is negative because the marginal cost of producing VOD assumed not to exceed the marginal cost of personal recording. This means that if Auto-hop is ruled to be fair use, the copyright holder must launch VOD immediately after the initial airing.

**Proposition 4:** If DVR has an inexpensive marginal recording cost for viewers \((C_{R} \leq 1/2(P_{V} + t_{v} - C_{F}))\) and automatic advertisement skipping is ruled to be fair use, the copyright holder must fix the VOD price at the marginal cost of personal recording \((P_{V} = C_{R} + C_{F})\) and launch VOD immediately after the initial airing.

If the court decides that Auto-hop is fair use in the current series of lawsuits, the copyright holder has little control over its content’s redistribution. The price of VOD is fixed at the cost of marginal recording and the optimal launch timing is set to be immediate because embedded advertisements cannot be exploited anymore. Comparing the copyright holder’s profit with the previous case yields:

\[
\pi_{CP,5} - \pi_{CP,4} = -1/2 f(C_{F} - f + C_{K})^2 \leq 0
\]

(35)

Also if it is assumed that auto-hop service is provided at the cost, the social welfare decreases as introduction of auto-hop, since the comparison shows:

\[
\pi_{V,5} = \int_{0}^{t_{v}} (U_{o} - C_{F} - t)dt + \int_{1}^{t_{v}} (U_{o} - C_{F} - C_{R})dt
\]

\[
\pi_{S,5} = \pi_{CP,5} + \pi_{V,5}
\]

\[
\pi_{S,5} - \pi_{S,4} = -1/2 f(C_{F} - f + C_{R})^2 \leq 0
\]

(36)

The difference in social welfare is same with that of the copyright holder’s profit, since the viewers’ welfare did not change. Because it is assumed that Auto-hop service still incurs certain cost, the PRS

---

\(^9\) While Dish is arguing that Auto-hop feature is provided free of charge, understandable because it is just a function from included software, however it still only work with Dish’s Hopper DVR, which costs about $4 more than standard DVR.
providers cannot have profit from providing Auto-hop. The technological advancement pushes both recording service providers and the copyright holder, both parties loses opportunities of making a profit. By allowing Auto-hop as a fair use, the court may fail to preserve both the copyright holder’s incentives and social welfare.

3.6 Case 6: Free Auto-Hop vs. VOD

If Auto-hop service is fully integrated into cloud DVR technologies, which we assume that happen soon enough if Auto-hop is ruled as a fair use, then Auto-hop does not require any specific hardware or operating system therefore can be provided with no marginal cost. In this case, the viewers’ utility functions when using PRS changes to:

\[ u_{i,R} = U_0 - C_R \]  

Since the copyright holder should set the price of VOD at the marginal cost of recording less the nuisance cost. The number of live viewers (α) becomes:

\[ α = C_R - C_F \]

Because the embedded advertisements are gone, the viewers are more likely to use time-shifting services.

The comparison of the copyright holder’s profit in this case with non-free Auto-hop service yields:

\[
\begin{align*}
\pi_{CP,6} &= α + \int_α^1 (C_R - C_F)dt \\
\pi_{CP,6} - \pi_{CP,5} &= -C_F (f + 1 - C_R)
\end{align*}
\]

Again, the profit of the copyright holder further decreases as Auto-hop is provided free since the cost of the recording is smaller than the maximum possible utility from the content. The chance of preserving fixed cost for creation becomes slimmer. For the social welfare the comparison becomes:

\[ \pi_{S,6} - \pi_{S,5} = \frac{1}{2} C_F (C_F - 2f) \]  

Because the viewers are enjoying advertisement-free time shifting services, gain from reduced nuisance cost clearly benefits the viewers. However, for society, the gain from reduced nuisance cost should much higher than the loss from advertisement revenues (\( C_F > 2f \)).

Proposition 5: If Auto-hop service is provided as free of charge, the copyright holder’s profit reduces \( \pi_{CP,6} - \pi_{CP,5} = -C_F (f + 1 - C_R) < 0 \) and the social welfare can be better off only if the nuisance cost of watching advertisements is much larger than the advertisement fee (\( C_F > 2f \)).

Although there is still a chance that free of charge Auto-hop service can be beneficial to the society, however it is unlikely since the requirement is quite unrealistic. The removal of viewers’ nuisance cost can be argued as “substantial noninfringing use\(^{10}\)”, especially for Dish. The model suggests that if the society gains more benefits from removed nuisance costs than loss of copyright holder’s profit, Auto hop may be ruled as a fair use. The court should investigate possible development of de-embedding technology and consider how such developments can affect both the copyright holder’s business model and the social welfare.

4 CONCLUSION

This paper examined the history of the technological development of PRSs, which are pushing the limit of definition of personal fair use, and investigated the relative strategies for copyright holders

\(^{10}\) http://en.wikipedia.org/wiki/Sony_Corp._of_America_v._Universal_City_Studios,_Inc.#The_majority_opinion
from a law and economics perspective. The presented model linked the economic perspective of fair use with the characteristics of the information technologies used in both fair use PRSs and VOD services sanctioned by the copyright holder. Law and economics approaches have thus far not yet captured the recent radical development in information technology in this field, while the MIS literature did not fully considered the threat from fair use rulings. We therefore suggest that this paper is a valuable addition to the current body of knowledge by bridging both perspectives and suggesting new approaches when analyzing copyright holder’ strategies.

The presented analysis showed that technological development of PRS has greatly affected both copyright holder’s profit and social welfare. The following table summarized the findings.

<table>
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<tr>
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<td>Likely to Increase</td>
<td>Increase</td>
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<tr>
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Table 1. Summary of analysis results

We suggest that for cloud DVR, the court may have to investigate the price competition between PRS and VOD to make better assignment of fair use doctrine. For Auto-hop services, The court may have to compare the cost of serving Auto-hop feature and viewers aggregated nuisance costs from advertisement, to decide whether to allow Auto-hop as fair use or not. Miceli and Adelstein’s (2006) findings suggest that the cost of personal recordings can affect copyright holder’s benefits and in this paper, such considerations extended further with embedded advertisements and countermeasures like VOD. Copyright holders chose VOD over embedded advertisements in recorded contents when cost of PRS is high, and delayed VOD launch to utilize embedded advertisements more when cost of PRS become lower. Finally Auto-hop removed both ways of countermeasures against PRS from copyright holders.

This paper has several limitations and directions for future research. The model only considered time-invariant content such as movies or TV series. For time-sensitive content, VOD should function better than PRSs, thus favoring the copyright holder. Further, although the cost of designating what content should be recorded is represented in the marginal cost of recording, such a simplification may not be enough to offer implications to lawyers. Future research might look to introduce additional behavior models to consider such arguments. Viewers’ recordings may have complementary value for live broadcasts, in the case that a viewer expects to watch the content repeatedly in the future. By implementing parameters that capture heterogeneity in complementarities in viewers’ valuation, the extended model may produce additional implications. Making the advertisement fee as endogenous decision leads to two-sided market extension of the suggested model, and it may change the dynamics of interactions between copyright holder, viewers and PRS providers.

References