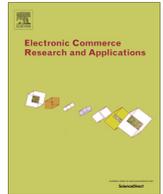




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Analysis of an advertisement based business model under technological advancements in fair use personal recording services



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ABSTRACT

In 1982, Betamax, the world's first personal recording service was ruled as a fair use in court. Although the copyright holders of TV content claimed that Betamax was an infringement of copyright, the court determined that the benefits of personal recording services were significant and that the copyright holder's profits could be protected because the original service was of better quality and had a better cost structure. It also ruled that the loss from manual advertisement skip was minimal. However, recent advancements in information technology have allowed new kinds of personal recording services such as a cloud DVR that provides unlimited storage and flawless quality, and an Auto-hop feature that automatically removes embedded advertisements. This paper introduces a microeconomic model for reviewing the copyright holder's business model and social welfare under the court's decision in relation to newer personal recording services powered by information technologies. Before cloud DVR existed, applying fair use to personal recording services increased social welfare while protecting the copyright holder's profits; however, after the introduction of cloud DVR, it may no longer do so.

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1. Introduction

Innovations in information technology have greatly helped content providers with low copy and distribution costs (Shapiro and Varian 1999, Davenport 2013). Ironically, the same information technologies are now threatening content providers' major business models by automatically removing advertisements from content. In March 2012, Dish Network Corp., a satellite TV provider, introduced an Auto-hop feature that allows users to automatically skip commercials when playing TV content recorded with its Hopper Digital Video Recorder (Bauder 2012). TV networks such as Fox, CBS, and NBC who hold the copyright of the broadcasted content considered the service a threat to their business models, which they claim are supported by advertising, and filed against Dish in May 2012 for copyright infringement (Jeffery 2012). According to CBS spokesperson Shannon Jacobs, "this service takes existing network content and modifies it in a manner that is unauthorized and illegal." In response, Dish CEO Joe Clayton pointed out that about 50% of viewers had already been skipping advertisements with VCR and DVR technology while watching their recorded content. Since the VCR and DVR technologies were already ruled as personal fair use under copyright law, he claimed

that Auto-hop is only a "slightly complicated version of a fast-forward button." The court subsequently denied Fox's request for a preliminary injunction against Auto-hop in November 2012 (Flint 2012), which was confirmed by the U.S. Court of Appeals in July 2013. The court also came to the same conclusion for ABC Television's request on September 2013 (Jeffrey 2013). Disney finally settled with Dish, who agreed to "postpone" enabling the Auto-hop feature for selected Disney digital content (Palmeri and Moritz 2014).

The Auto-hop legal dispute is not the first battle between fair use personal recording services (PRS hereafter) and TV content copyright holders. When Cablevision Systems Corporation launched its cloud based digital video recording service (cloud DVR hereafter), which stores personal recordings in central server storages and plays them back via Internet streaming, in March 2006, copyright holders sued Cablevision for copyright infringement, but ultimately lost the case (Albanesius 2008). The Supreme Court agreed with Cablevision's argument that their cloud DVR should be treated the same way as customer-owned fair use devices such as a Betamax, because only its storage location differs. The fair use doctrine of copyright law, which has thus far been applied to PRS, should protect both social welfare and the copyright holder's incentives by allowing some personal copies to be free of copyright infringements (Cooter and Ulen 2011). When Betamax first entered the market in 1982, a similar legal dispute between Sony Corporation of America and Universal Studios went to court and the service

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was eventually ruled to be a fair use. The court ruled that the copyright holders' monetary incentives could still be protected, because the risk of zapping the advertisements embedded in the TV content was minimal (*Sony Corp v. Universal City Studios* 1984). From the copyright holders' viewpoint, applying fair use doctrine to PRS is done in order to achieve better social welfare at the expense of potential profit, however minimal it may be.

It was not until around the year 2000 that copyright holders finally acquired another major technology with the potential to greatly extend their business model to the realm of fair use: video on demand (VOD hereafter). VOD allowed copyright holders to provide their content via digital streaming and it did not require any specific hardware or storage medium, gaining higher ground against PRS such as DVR, because earlier versions of DVR still required individual hardware, individual installation, upgrade costs and were limited in storage size (*Bertolucci* 2009). The cost structure difference between VOD and early DVR was significant. It followed the traditional law and economics assumptions that state that the producer has a better cost structure when copying and distributing the copyrighted materials (*Novos and Waldman* 1984). Because of VOD technology, the copyright holder's business model was extended and protected against PRS by two important technological barriers: (1) The copyright holder can provide time-shifted material with better cost structure; and (2) The copyright holder may still generate revenue from the advertisements embedded in the recorded content.

However, recent developments in information technology are removing the two technological barriers that justified the fair use doctrine applied thus far on PRS. Theoretically, cloud DVR has the same cost structure as the copyright holder's most advanced form of time-shifted content, VOD, and Auto-hop is surgically removing embedded advertisements from TV content. Both of the copyright holders' business models are being threatened by new information technologies and are now dependent solely on legal protection. Cloud DVR is again determined to be a fair use because the court could not find any legal difference between it and the previous fair use PRS. In addition, Auto-hop is currently the subject of a fierce legal debate, as some law professors recently urged the court to give up fighting technological evolution with the law, which would save needless legal costs (*Gershman* 2013). *Table 1* shows the development of PRS and related court rulings.

Therefore, it is imperative to generate economic implications for both lawmakers and business managers, because information technologies that are applied to PRS have made rapid advancements in the last few years to the point where these are now threatening the copyright holders' business model and social welfare. While some previous Information Systems (IS hereafter) papers focused on business implications from information technologies used on PRS and piracy of digital content (*Chellappa and Shivendu* 2005, *Regner et al.* 2009, *Margolina et al.* 2011), these relatively newer information technologies and their interactions with fair use doctrine are not yet fully addressed. This paper aims to provide a link between law and economics research and IS research on new technological development regarding the fair use doctrine and PRS. It suggests a microeconomic model that describes the interaction between both business models in conjunction with technological characteristics of PRS.

The research objectives are: (1) Review previous court rulings on PRS to date, to examine social welfare and copyright holder's profits, taking into consideration the technological advancements of PRS and copyright holder's business models, and (2) Generate economic implications for the court over the Auto-hop legal dispute. In *Section 2*, the related literature is reviewed. *Section 3* presents and analyzes the economic model. In the final section, the limitations of the paper and future research opportunities are suggested.

2. Literature review

Once PRS was allowed as a fair use, the copyright holders of TV content gained two additional business models that could contribute to their profit. The first is by directly selling copyrighted content to potential viewers with PRS. The second is by exposing viewers to advertisements that are embedded in the private recordings. In this section, through a review of related literature, it is explained how the new PRS is different from descriptions in previous literature, and why a link is needed between law and economics research and IS research. The summary of the literature regarding the economic analysis of fair use and advertisement based strategies is in the *Appendix*.

For the first business model, the competition between original and private copy was enabled by the fair use doctrine, drawing much attention in the fields of law and economics. Before Betamax, there were no practical means to distribute TV content apart from live broadcasting, which in turn imposed strict time and space constraints on viewers. Once the potential viewers have access to PRS, the copyright holders can produce their own version of time-shifted content in the appropriate medium and compete with the viewer's own personal recordings. *Klein and others* (2002) pointed out that the new time-shifting market can be beneficial to the copyright holders. Moreover, in terms of competition, it has usually been assumed that the copyright holder who is the producer of the content is protected by technological barriers that allow better quality and cost structure compared to an personal copy (*Novos and Waldman* 1984). At this point, 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. *Johnson* (1985) showed that if the cost of private copying is too low, reducing the scope of the fair use doctrine might be necessary. *Besen* (1986) even argued that consumers do not benefit from inefficient private copying in the long run. *Liebowitz* (1981, 1982, 1985) investigated how a technology may change the application of fair use for photocopying, while *Gordon* (1982) analyzed how time-shifting technology such as Betamax may hamper market structure. *Miceli and Adelstein* (2005) claimed that the optimal level of fair use is determined by the level of technology, implying that courts may have to adjust their rulings as the performance and characteristics of technologies evolve (*Adelstein and Peretz* 1985, *Klein and others* 2002).

However, when PRS moved from using analog tapes to the digital medium, the quality difference between the original and personal recordings was at first removed. Subsequently, cloud DVR eliminated the difference in cost structure, because viewers no longer had the need for specific devices installed in their homes,

Table 1
Historical development of PRS and related court rulings.

Private recording	Year introduced	Quality	Time shifting feature	Space shifting feature	Advertisement removal feature	Court decision
TV only		Original	No	No	No	
Betamax VCR	1982	Limited	Yes	No	No	Fair use
DVR	1999	Perfect	Yes	No	No	Fair use (assumed)
Cloud DVR	2006	Perfect	Yes	Yes	No	Fair use
Auto-hop	2012	Perfect	Yes	Yes	Yes	Under debate

with unlimited storage for recordings. New PRS has nullified the assumptions that favored copyright holders in previous economic research. Since the court determined cloud DVR as a fair use, the technological and legal barriers that protected the first business model no longer exist.

For the other business model, it has thus far been assumed that the advertisements are somewhat securely embedded in the TV content. Advertisement based business models are intensively researched and often explained as a two-sided market strategy. The copyright holder usually creates content and serves two different groups. One group of users is made up of content viewers and the other is of advertisers. By heavily subsidizing the viewers' side, copyright holders derive better profits from 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, video games, media, and streaming services adopt similar strategies in order to maximize the benefits generated through network effects (Rochet and Tirole 2003). Chellappa and Shivendu (2005) suggested that for digital content, unlike physical goods, sampling is not always beneficial for underestimated experience goods. Choi (2010) suggests various implications for copyright holders under different circumstances, such as single versus multi-homing. Anderson and Coate (2005) investigated the advertisement pricing strategy and Gabszewicz and others (2001) suggested that securing the maximum number of viewers is crucial to the advertisement based content broadcasting business models. These studies focused on the participating players' strategies and implicitly assumed that the payment scheme, including advertising, is secure from a third party manipulation. About copyright infringements in digital contents, Regner and others (2009) found that sometimes newcomer artists give up copyright protections such as digital rights management in order to gain more exposure initially. Margolina and others (2011) investigated economic feasibility of protecting digital media rights. Since these studies investigated copyright protections on digital contents in general, specific exceptions like the fair use doctrine are not fully considered. The possibility of PRS intentionally removing embedded advertisements under the fair use doctrine in the two sided market model is not yet fully considered in the related studies, although it is a very real threat to the second business model, as the court acknowledged the risks of "zapping" the embedded advertisements when using Betamax (Sony Corp v. Universal City Studios 1984).

For copyright holders, the two business models should interact with each other in the face of threat from newer and advanced fair use PRS. If the technological barriers that supported one business model collapse, the copyright holders may cling to the other model and even survive because of it. The ultimate goal of fair use doctrine could still be realized if the contribution to society of newer technologies is institutionally allowed while protection for the copyright holders' business models is maintained. Linking and analyzing the two business models under specific court rulings for technological innovations of PRS is therefore important, given that information technology is rapidly advancing and changing the characteristics and performance of PRS.

3. Model and analysis

Suppose there is a group of viewers who want to watch TV content. Each viewer has a different ideal watching time. Viewer i 's ideal watching time is denoted as t_i , which is uniformly distributed from the time of a live broadcast until a time in the reasonable future, for example, a couple of years later, and normalized to $[0,1]$. Each viewer's ideal watching time t_i is also interpreted as

either transportation cost or time shifting cost, since the difference between the viewer's ideal watching time and the time of a live broadcast represents the amount of rescheduling costs such as taxi fares that are paid to get home early. A viewer receives utility U_0 ($0 < U_0 \leq 1$) if she watches the content at his or her ideal time. We further assume that the target content is non-time-sensitive, and hence U_0 does not decrease as time passes, in order to clearly define the incentives of using PRS and see the effects from them.¹ The content has embedded advertisements, which incur a nuisance cost of C_F to viewers ($C_F < U_0$). We follow Gabszewicz and others' (2001) assumptions that a limit exists on the amount of advertisement that can be embedded in content without harming it and that viewers are indifferent to variable changes in this amount. Furthermore, some countries regulate the advertising time in TV content, such as the Prime Time Access Rule from FCC (Anderson 2005). The existence of such regulations suggests that while TV copyright holders want to embed more advertisements, society would rather there be less. Therefore, we assume that the copyright holder always embeds the maximum allowed amount of advertisement, which is fixed in this model.

If a viewer watches the content and the embedded advertisements, the copyright holder charges the advertiser an advertisement fee denoted as f . Although the content is not substitutable for viewers, for advertisers it is assumed that various works with similar content exist and have advertisement slots available. Therefore, the advertisement fee can be interpreted either as the advertisers' willingness to pay or as a valuation of a single exposure of their advertisement. Therefore, we suggest that once the content is determined, the advertisement fee f incurred from the content is determined and fixed by the market, since all advertisers that are attracted by the same content should have the same willingness to pay for the content's advertisement slot.

3.1. Stage 1: Live TV only (Before 1982)

At this stage, it is assumed that no PRS is available. Before the introduction of Betamax in 1982, a viewer had to choose between either watching the content live or giving up watching it all together if the transportation cost was too high. Viewer i 's utility function when watching live is defined as

$$u_{i,L} = U_0 - C_F - t_i. \quad (1)$$

If $u_{i,L} > 0$, viewer i watches the content live. Otherwise, he or she gives up watching. Since t_i is uniformly distributed over $[0,1]$, the number of live viewers, denoted as α , is derived as

$$\alpha = \int_0^{U_0 - C_F} dt = U_0 - C_F.$$

The copyright holder's profit function of stage 1 thus becomes

$$\pi_{CP,1} = f\alpha = f(U_0 - C_F). \quad (2)$$

Aggregated viewer's welfare of stage 1 is expressed as

$$\pi_{V,1} = \int_0^\alpha (U_0 - C_F - t) dt = \frac{1}{2}(U_0 - C_F)^2. \quad (3)$$

Assuming that the advertisers get the exact same benefits as the advertisement fee, the social welfare of stage 1 becomes

$$\pi_{S,1} = \pi_{V,1} + \pi_{CP,1} = (U_0 - C_F) \left(f + \frac{1}{2}(U_0 - C_F) \right). \quad (4)$$

¹ Amazon offers a full season bundle after a TV show season ends, which means that some movies and TV series are watched by its viewers a few years later than its original air date. We suggest that the content modeled in this paper is of this type, which does not have significant network values from viewers' friends or plot twists.

Stage 1 is the baseline of the following analysis. As more technologically advanced fair use PRS are introduced to the market, more parameters and decisions are modeled in the following stages.

3.2. Stage 2: From Betamax to DVR (1982–1999)

Betamax allowed viewers to record TV content onto magnetic tapes on which picture quality would gradually deteriorate due to the characteristics of the magnetic tapes. Relative quality loss is denoted as σ ($0 < \sigma < 1$), and the viewer can choose either to watch live or to record and watch later. The viewer still has to watch the embedded advertisements, even with recordings. Although a related survey suggests that approximately 50% of viewers manually skip embedded advertisements with remote controls (Jeffery 2012), the fact that the remaining half do not fast-forward advertisements suggests that the cost of manual skipping is not negligible compared with the nuisance cost of watching advertisements. The fact that automatic advertisement skipping services such as Auto-hop are under legal dispute of significant scale also suggests that copyright holders are concerned about revenues from embedded advertisements in personal recordings. We therefore assume that unless automatic advertisement skipping services are available, viewers will watch embedded advertisements in their personal recordings without any adjustment. This assumption has been made in order to clearly examine the impact of technological innovations. Furthermore, since PRS in this stage is ruled to be a fair use, viewers incur a variable recording cost C_R if they decide to record and play content later. PRS providers are assumed to be under perfect competition; therefore, C_R is set by the market.

When a viewer watches a recorded content at his or her ideal time, which deviates from the original airing time, it is assumed that after the initial airing the advertising effectiveness gradually decreases as time passes. Even though we assume that the utility from watching the content does not decrease over time, the value of embedded advertisements does decrease. It does so because advertisements often include time-sensitive content such as temporary discount campaigns (Bitran and Mondschein 1997) or because they want to replace old advertisements with new ones if a competitor launches a new campaign (Sohn and Choi 2001). Advertising effectiveness therefore decreases in this model, after its initial live airing. It eventually becomes zero when the viewer with the most distant ideal watching time ($t_i = 1$) watches the content. It is further assumed that the advertising effectiveness value is fully known to both the advertiser and the copyright holder and that any advertisement fee is collected according to its total amount of delivered advertisement effectiveness, since marketing reports regarding the use of DVR are available (Nielsen 2010, 2011). Therefore, the advertisement fee collected from a viewer is a function of the time that the content is watched, $f(t) = f(1 - t)$. This means that if the content is not time sensitive and some of the viewers are willing to buy PRS to watch it later, advertisements will be delivered with diminished effectiveness to those viewers. Hence, the value of the advertisement embedded in the content should be much lower than a time-sensitive and powerful content that can draw many viewers at the time of broadcasting, such as a football match. Considering the anecdotal evidence (Smith 2012, Nielson 2011, Heldenfels 2008),² it is assumed that the value of

exposure of a single advertisement for the advertiser does not exceed the maximum possible utility from the content for the viewer ($f < U_{0,MAX} = 1$).

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 the function when the viewer records the content and watches it at his or her ideal time:

$$\begin{aligned} u_{i,L} &= U_0 - C_F - t_i, \\ u_{i,R} &= (1 - \sigma)U_0 - C_F - C_R. \end{aligned} \quad (5)$$

When a viewer buys a PRS service, the transportation cost term t_i becomes zero since the PRS enables the viewer to watch the content at his or her ideal time. In order to make any viewer choose recording services ($u_{i,R} \geq 0$), the maximum allowed quality loss is derived as

$$\sigma_{MAX} = 1 - \frac{C_R + C_F}{U_0}.$$

In other words, if $\sigma > \sigma_{MAX}$, 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 (α) is derived as

$$\alpha = \sigma U_0 + C_R, \quad (0 \leq \sigma \leq \sigma_{MAX}).$$

The profit function of the copyright holder of stage 2 becomes

$$\pi_{CP,2} = f(0)\alpha + \int_{\alpha}^1 f(t)dt = f\alpha + \int_{\alpha}^1 f(1 - t)dt. \quad (6)$$

Advertisement is in full effect for the live viewer ($f\alpha$) while for PRS users the effects of advertisement reduces as time passes ($\int_{\alpha}^1 f(1 - t)dt$). We suggest that very early commercial PRSs such as Betamax that provided barely acceptable picture quality can be modeled by setting $\sigma = \sigma_{MAX}$. At that time, the profit function of the copyright holder can be simplified to

$$\pi_{CP,2,\sigma_{MAX}} = \frac{1}{2}(1 + (U_0 - C_F)^2)f. \quad (7)$$

It is clear that $\pi_{CP,2,\sigma_{MAX}} > \pi_{CP,1}$. Thus, the copyright holder may enjoy additional profits from recorded advertisements that are embedded in the content that is exposed to additional viewers. Analysis suggests that even though copyright holders sued Sony for copyright infringement when Betamax was introduced, they may have actually benefitted from fair use PRS, since it attracts more viewers and those viewers watch the embedded advertisements. In addition, when $\sigma = \sigma_{MAX}$, the social welfare is better off than the live broadcast only case, because more viewers can now watch the content. This is consistent with one of the Klein and others (2002)'s findings, which suggests adopting Betamax actually helped the copyright holders.

$$\pi_{S,2,\sigma_{MAX}} - \pi_{S,1} = \frac{1}{2}f(1 - U_0 + C_F)^2 > 0.$$

However, as the performance of PRS increases (σ reduces to zero), the copyright holder's profit decreases, since

$$\frac{d}{d\sigma} \pi_{CP,2} = fU_0(C_R - C_F + \sigma U_0 + 1) > 0. \quad (8)$$

The result is consistent with Miceli and Adelstein's (2005) findings, which suggested that allowing fair use might increase overall demand, whereas better technology used to make personal copies might reduce the copyright holder's profit.

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

² According to news articles, the top scripted TV show (which has relatively less time sensitive content), NCIS, drew 15 million viewers in 2011 and should have a price of around \$0.025 per 30 s advertisement slot. As an average prime time show has 18 min of commercials, the total value of advertisements for the top prime time show should be around \$0.90. Considering the number is for the best prime time show and the price of web based VOD for TV series is usually set around \$2.00, the assumption ($f < U_{0,MAX} = 1$) should not deviate from the reality too much.

In 1999, quality loss was reduced to zero ($\sigma = 0$) when the first DVR (i.e., TiVo) was introduced. When DVRs became available, the copyright holder's profit function was

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

This profit function is dependent on the variable cost of personal recording (C_R). Early DVRs were limited with individual installation requirements, upgrade costs, and relatively small hard drive sizes. Therefore, the possibility to protect the copyright holders' profits under zero quality loss remains if the cost of personal recording stays high enough.

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

$$\alpha = C_R.$$

The aggregated viewers' welfare and social welfare are derived as

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

$$\pi_{S,2,\sigma=0} = \pi_{CP,2,\sigma=0} + \pi_{V,2,\sigma=0}. \quad (11)$$

Comparing social welfare with that of when the VTR's quality loss was at maximum yields

$$\pi_{S,2,\sigma=0} - \pi_{S,2,\sigma_{MAX}} = \frac{1}{2} (U_0 - C_R - C_F) (2 - (f + 1)(U_0 + C_R - C_F)). \quad (12)$$

The analysis suggests that social welfare may decrease with the commercialization of DVR if the loss of advertisement revenue is significant ($(f + 1) > 2/(U_0 + C_R - C_F)$). The higher the significance of advertisement revenue, the higher the possibility that the loss of advertisement revenue due to PRS surpasses the total gain of viewer's benefits that stem from technological advancement, thereby reducing overall social welfare.

Proposition 2. Social welfare may decrease as DVR removes quality loss, if the loss of advertisement revenue from PRS is significant ($(f + 1) > 2/(U_0 + C_R - C_F)$).

It is unlikely that the court can block the technological advancement of PRS; however, as Liebowitz (1981, 1982, 1985) and Gorden (1982) suggested, technological improvement might hamper social welfare as it can make previous business models obsolete. However, around the time DVR was introduced, advancements in information technology also benefited copyright holders. VOD services, which are naturally protected by copyright laws since no private copying is involved, were also commercialized. The following subsections examine the battle between fair use PRSs and copyright-protected VOD services.

3.3. Stage 3: Early DVR vs. VOD (2000–2005)

In this model, VOD services generate revenue for the copyright holder by charging the viewer directly. A viewer now has three options: watch the content live, record and play it later, or buy the 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. VOD requires direct payment, while DVRs incur the variable cost of recording and the nuisance cost of embedded advertisements.

Traditional DVRs (i.e., before cloud DVR) had a different cost structure than that of VODs. When viewers used a traditional

DVR, the recording service provider usually had to install the device, generating relatively large installation costs. VOD services rarely require such installation services because no special hardware is required. Moreover, the 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 could have been duplicated among viewers. By contrast, VOD stores the content centrally, which greatly reduces duplicated content and benefits from economies of scale. Furthermore, hard drive size was another limitation of traditional DVRs. A small hard drive meant that the viewer might have had to erase older content to record new programs. In addition, the picture quality of TV content is continuously increasing, from SD to 720p to 1080i to 1080p, and so on, which requires more hard drive space per program. Some reporters have even suggested that the cost incurred by installations and upgrades may be a major driver of cloud DVR innovation (Bertolucci 2009). Therefore, in this section, VOD is modeled as being more competitive than traditional DVR, which may reflect the early stages of the battle between DVR and VOD.

Although in reality, many VOD services such as Netflix and Amazon only exist as distribution intermediaries, they still must be legally sanctioned by the copyright holder and must pay for the rebroadcasting fee set by the copyright holder, in contrast to fair use PRS. Therefore, to clearly see the copyright holder's strategy against PRS rather than bargaining with redistributors, it is assumed that the copyright holder controls the price of VOD.³ In this section, the DVR is assumed to be expensive enough that users are not attracted to it at all, to clearly see the differences in the cost structure between early DVR and VOD. This assumption is expressed as

$$C_R > \frac{1}{2} (P_V + t_V - C_F), \quad (13)$$

where P_V and t_V are the price and the launch timing of VOD, respectively. The copyright holder decides on both the price (P_V) and the launch time of VOD (t_V) to maximize its profit. The graphical representation of the condition stated in expression (13) is presented in Fig. 1.

The maximum cost of watching the content by using the combination of live broadcasting and VOD services is expressed as the large dot in Fig. 1. The cost of using PRS always exceeds ($C_R + C_F > P_V + (t_V - 1/2(P_V + t_V - C_F))$), and hence, no viewers choose DVR over VOD.

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 of watching live increases, using DVR and buying VOD both become cost effective to a degree that viewers give up watching live and choose to watch the content at the ideal time with a better time-shifting service. At this stage, the expression (13) holds; thus, the variable cost of using PRS ($C_R + C_F$) is somewhat higher than the sum of the fee for VOD (P_V) and the transportation cost for VOD incurred from the delay of the launch ($t_i - t_V$, $t_i < t_V$).

Therefore, a viewer has three options. The utility functions for those options are now defined as

$$\begin{aligned} u_{i,L} &= U_0 - C_F - t_i, \\ u_{i,R} &= U_0 - C_F - C_R, \\ u_{i,V} &= U_0 - P_V - (t_V - t_i) \quad (t_V \geq t_i), \\ u_{i,V} &= U_0 - P_V \quad (t_V < t_i), \end{aligned} \quad (14)$$

³ 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 h, because launching an official DVD every week may not be cost-effective for copyright holders. As VOD virtually removed variable costs of production and distribution, it can directly compete with PRS immediately after the initial airing.

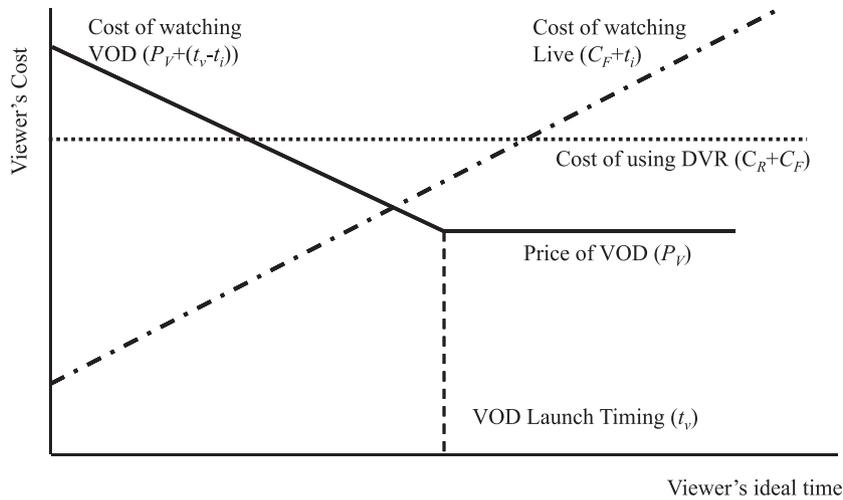


Fig. 1. Viewers' choices when PRSs are more expensive than VOD services.

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

$$\alpha = \frac{1}{2}(P_V + t_V - C_F).$$

At this stage, no viewers choose DVR over VOD. Therefore, viewers who give up live immediately switch to VOD. The profit function of the copyright holder becomes

$$\pi_{CP,3}(P_V, t_V) = f\alpha + \int_{\alpha}^1 (P_V - C_V)dt, \tag{15}$$

where C_V is the variable cost of the VOD service, such as copying and distribution cost, which is usually very small for digital media (Shapiro and Varian 1999).

The copyright holder can freely set the price of VOD (P_V) and its launch timing (t_V). To find the optimal VOD price and launch timing, first- and second-order conditions and the determinant of the Hessian matrix are derived as

$$\begin{aligned} \frac{\partial \pi_{CP}}{\partial P_V} &= \frac{1}{2}(C_F + C_V - 2P_V + f - t_V + 2); & \frac{\partial \pi_{CP}}{\partial t_V} &= \frac{1}{2}(f - (P_V - C_V)), \\ H(\pi_{CP})(P_V, t_V) &= -\frac{1}{4}. \\ \frac{\partial^2 \pi_{CP}}{\partial P_V^2} &< 0; & \frac{\partial^2 \pi_{CP}}{\partial t_V^2} |_{P_V=\hat{P}_V} &> 0. \end{aligned} \tag{16}$$

Since the Hessian matrix is negative for all possible P_V and t_V , the second derivative of VOD price is strictly negative, the optimal price of VOD (\hat{P}_V) exists for any given t_V . Applying the optimal VOD price, the second derivative of launch timing at a given VOD price is strictly positive. Therefore, the optimal launch timing for the copyright holder should be one of the ends of its possible range ($t_V = 0$ or $t_V = 1$). In other words, the choice is either to launch immediately after the broadcasting or to not launch at all. Therefore, a comparison between both cases is required in order to derive the optimal strategy for the copyright holder. The optimal price of VOD for both optimal candidate launch timings ($t_V = 0$ and $t_V = 1$) are derived as

$$\begin{aligned} \hat{P}_V|_{t_V=0} &= \frac{1}{3}(2C_F + C_V + f + 2), \\ \hat{P}_V|_{t_V=1} &= \frac{1}{2}(C_F + C_V + f + 1). \end{aligned} \tag{17}$$

A comparison of the copyright holder's profit for both cases yields

$$\pi_{CP,3}(\hat{P}_V|_{t_V=0}, t_{V,0}) - \pi_{CP,3}(\hat{P}_V|_{t_V=1}, t_{V,1}) = \frac{7}{72}(1 - f + C_F - C_V)^2 > 0. \tag{18}$$

Therefore, if DVR is expensive, as stated in the expression (13), immediate launch of VOD is the best option for the copyright holder and the optimal VOD price is set to

$$\hat{P}_V|_{t_V=0} = \frac{1}{3}(2C_F + C_V + f + 2). \tag{19}$$

If VOD services have a better cost structure than PRS, the copyright holder should launch the VOD immediately after the original air date; in this case, an optimal VOD price exists to maximize profit, which balances indirect advertisement fees and direct VOD revenue.

Proposition 3. If DVR has expensive variable recording costs for viewers ($C_R > \frac{1}{2}(P_V + t_V - C_F)$), it is best for the copyright holder to launch VOD immediately after the original air date; in this case, an optimal VOD price exists ($\hat{P}_V = \frac{1}{3}(2C_F + C_V + f + 2)$).

Prior to the introduction of VOD, the copyright holder usually released any official VHS or DVD of a TV series after a full season, because of relatively high copying and distribution costs. VOD allowed for inexpensive copying and distribution costs, allowing the copyright holder to release official versions, even on a daily basis. If PRSs have relatively worse cost structures than VOD services due to factors such as required installation costs or duplicated local storage problems or upgrade costs, the copyright holder may be able to enjoy both the advertisement fee and the VOD revenue by setting an optimal VOD price and launch timing.

To simplify the comparison of the copyright holder's profit between stage 2 and this stage, let us assume that quality loss is zero ($\sigma = 0$) and the variable cost of serving VOD is negligible ($C_V \ll C_R, C_V = 0$). Let $\pi_{CP,3-2} = \pi_{CP,3,C_V=0} - \pi_{CP,2,\sigma=0}$; then,

$$\begin{aligned} \pi_{CP,3-2}|_{C_F=0,f=1} &= 0, \\ \frac{\partial \pi_{CP,3-2}}{\partial C_F} &= \frac{1}{9}(4 - 2f + C_F(4 - f) + f^2) \geq 0, \\ \frac{\partial \pi_{CP,3-2}}{\partial f} &= -\frac{C_F^2}{18} - \frac{2}{9}C_F(1 - f) - \frac{f^2}{6} - \frac{1}{6} \leq 0. \end{aligned} \tag{20}$$

Therefore, the copyright holder enjoys relatively better profits than those of stage 2, because $\pi_{CP,3-2}$ is positive when $f < 1$ and the nuisance cost of watching the embedded advertisements is not zero ($C_F > 0$). This clearly shows that the copyright holder is enjoying the newly enhanced technological barrier, VOD, and is taking advantage of its cost structure, which is relatively more efficient than traditional fair use PRSs.

Social welfare is also increased in this case, because both viewers and the copyright holder receive benefits from the better

technology. The aggregated viewers' welfare and social welfare in this case are derived as

$$\pi_{V,3} = \int_0^\alpha (U_0 - C_F - t)dt + \int_\alpha^1 (U_0 - \hat{P}_V)dt, \tag{21}$$

$$\pi_{S,3} = \pi_{CP,3} + \pi_{V,3}. \tag{22}$$

The comparison of social welfare between this case and the DVR-only case simplifies to

$$\pi_{S,3} - \pi_{S,2,\sigma=0} = \frac{1}{18} (1 - f + C_F)(5 + C_F(5 - f) + f^2). \tag{23}$$

Expression (23) is positive if $f < 1$. The results show that even when the copyright holder is taking advantage of VOD's better cost structure and is enjoying a monopolistic position over the time-shifting services, social welfare can be better off since VOD technology works better for both the viewers and the copyright holders. Traditionally, in a photocopying or private TV recording context, originals usually had the better quality but with a higher price, meaning that users faced a trade-off between quality and price (Liebowitz 1981, 1982, 1985, Miceli and Adelstein 2005). However, VOD that equipped with new information technology practically removed the trade-off by making traditional PRS obsolete.

Proposition 4. When VOD has a better cost structure than PRS, social welfare increases since the originals (VOD) have both better quality and better price.

So far, legal decisions that allowed PRS as a fair use and advancements in information technology have worked together to protect the copyright holders' profits as well as social welfare. However, the following cases of technological changes show differing results.

3.4. Stage 4: Cloud DVR vs. VOD (2006–2012)

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. Thanks to the recent development of mobile technologies such as smartphones, a viewer can use any Internet-connected device to play the recorded content. By contrast, traditional VCRs or DVRs could only be used at the site where the device was installed, generally the viewer's home. Cloud DVR; the new and innovative PRS has enabled space shifting in addition to time shifting for viewers who suffered from significant transportation costs occurred by watching content live. Furthermore, a viewer theoretically does not need a specific device to record and play, since a record request can be submitted via the service provider's website and the requested content can be played with any device. Although Cablevision still requires a set-top box to provide additional features such as a 'local cache' and 'picture in picture', the service also enables the viewer with a function that allows playback via any device that has a screen, an internet connection and an automatic scheduling function for recording via web services.

The cost structure and features of cloud DVR services are theoretically identical to those of VOD services. Video content is stored in the central server in order to minimize duplication, and served through a broadband network. Therefore, in this stage it is assumed that the variable service cost for PRS is significantly lowered and can match the price of VOD services. For example, new DVR services such as Boxee TV introduced unlimited amount of recordings, with 1080p high definition quality, for a monthly fee of about \$10 (Roettgers 2013).

Copyright holders such as Cartoon Network, CNN, Twentieth Century Fox, Universal, Paramount, and Disney have argued that Cablevision's act of copying programs onto its servers violates reproduction rights, while transmitting the data from these servers to customers' set-top boxes infringes on the right of public performance. However, the Court of Appeals sided with Cablevision, stating, "We do not believe that a cloud DVR customer is sufficiently distinguishable from a VCR user to impose liability as a direct infringer on a different party for copies that are made automatically upon that customer's command" (Albanesius 2008). 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 between these two perspectives yield different results compared to the previous stages.

At this stage, the variable cost of personal recording is low enough to threaten VOD price and does not satisfy the condition specified in expression (13), which means that

$$C_R \leq \frac{1}{2} (P_V + t_V - C_F). \tag{24}$$

Eq. (24) represents a situation when using PRS may be more cost-effective than buying VOD. Unlike the previous stage, VOD service now faces strong competition from a better and cheaper PRS: cloud DVR. A viewer will choose cloud DVR over VOD if the cloud DVR has a smaller perceived cost. For simplicity, a viewer is assumed to choose VOD over cloud DVR when the perceived cost is the same. Although the number of available options for the viewer does not change, setting the price and launch timing of VOD becomes more complicated for the copyright holder. If the price of VOD is higher than the variable cost of recording ($P_V > C_R + C_F$), no viewer will choose VOD over cloud DVR. If the price of VOD is lower than the variable cost of recording ($P_V < C_R + C_F$); enough to satisfy expression (24), the copyright holder's profit is worse off than when he sets the price of VOD to be the same as the variable cost of recording.⁴ Therefore, the copyright holder has no choice but to set the price of VOD at the variable cost of recording at this stage ($P_V = C_R + C_F$). Fig. 2 explains that the only remaining feasible decision left for the copyright holder is the launch timing of the VOD service.

The number of live viewers at this stage is derived as

$$\alpha = C_R.$$

Because $P_V = C_R + C_F$, the copyright holder's profit function becomes

$$\pi_{CP,4} = f\alpha + f \int_\alpha^{t_V} (1 - t)dt + \int_{t_V}^1 (P_V - C_V)dt. \tag{25}$$

The optimal launch timing (t_V) is decided by the first-order condition because the second-order derivative is negative:

$$\frac{d\pi_{CP}}{dt_V} = f(1 - t_V) + C_V - C_R - C_F, \hat{t}_V = 1 - \frac{C_R + C_F - C_V}{f}. \tag{26}$$

During the previous stage, it was preferable for the copyright holder to set the launch timing to be immediately after the original air date and to set the optimal VOD price. However, control over the VOD price diminishes at this stage and only control over the launch timing remains. If the advertisement fee is high enough, the copyright holder should delay the launch timing in order to benefit from the recorded advertisements.

⁴ Let $P_V = C_R + C_F - \beta$, where $0 < \beta < C_R + C_F$. Since $C_R \leq 1/2(P_V + t_V - C_F)$, the number of live viewers (α) is fixed at C_R and $t_V - \beta > C_R$. The profit is $\pi_L = f\alpha + f \int_\alpha^{t_V - \beta} (1 - t)dt + \int_{t_V - \beta}^1 (C_R + C_F - \beta - C_V)dt$ when setting $P_V = C_R + C_F$ and hastening the launch time by β yields $\pi_H = f\alpha + f \int_\alpha^{t_V - \beta} (1 - t)dt + \int_{t_V - \beta}^1 (C_R + C_F - C_V)dt \geq \pi_L$.

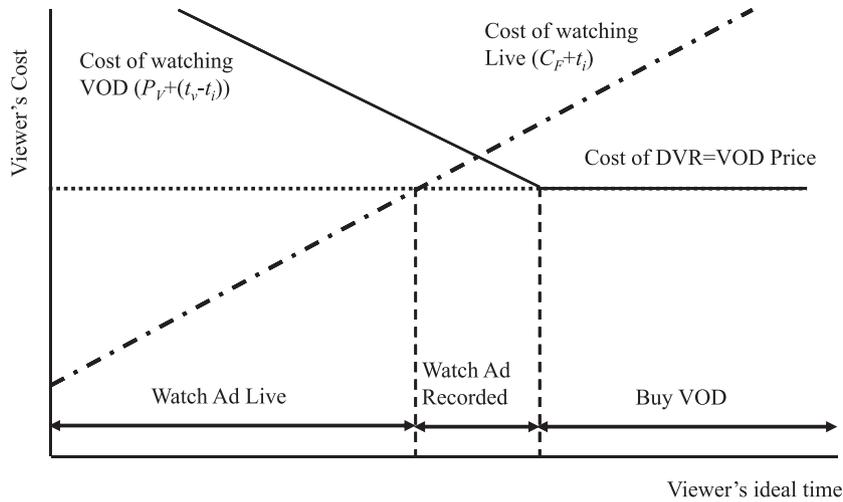


Fig. 2. Viewers' choices when PRSs are less expensive than VOD services.

Proposition 5. If cloud DVR has a competitive variable recording cost for viewers ($C_R \leq \frac{1}{2}(P_V + t_V - C_F)$), it is preferable for the copyright holder to fix the VOD price at the variable cost of personal recording ($P_V = C_R + C_F$) and set the optimal VOD launch timing ($\hat{t}_V = 1 - \frac{C_R + C_F - C_V}{f}$).

As information technology advances and upgrades fair use PRSs, the copyright holder's control over its own copyrighted material diminishes and embedded advertisements become more and more critical in generating revenue. According to CNET, Fox Networks recently delayed the web access to its shows from 24 h to eight days, with ABC soon after implementing the same policy (Sanger 2011). It is hard to say that this adjustment reflects the threat from cloud DVR, since Cablevision still offers the service at \$10.95 per month with 24 h of HD programming, while VOD services are usually offered at \$1.99 per episode. However, delaying the VOD launch may suggest that copyright holders are recently receiving insufficient advertisement revenue and are taking relevant actions to protect it.

At this stage, VOD services from the copyright holder are under threat from competitive fair use PRS. As cloud DVR becomes cheaper, the copyright holder's profit decreases, because

$$\pi_{CP, A|\hat{t}_V} = \frac{f}{2}(C_R^2 + 1) + \frac{1}{2f}(C_R + C_F - C_V)^2, \tag{27}$$

$$\frac{d\pi_{CP, A|\hat{t}_V}}{dC_R} = fC_R + \frac{C_R + C_F - C_V}{f} > 0.$$

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 at this stage are derived as

$$\pi_{V, A} = \int_0^{\hat{t}_V} (U_0 - C_F - t)dt + \int_{\hat{t}_V}^{\hat{t}_V} (U_0 - C_R - C_F)dt + \int_{\hat{t}_V}^1 (U_0 - P_V)dt, \tag{28}$$

$$\pi_{S, A} = \pi_{CP, A} + \pi_{V, A}. \tag{29}$$

As the variable recording cost decreases, social welfare and the copyright holder's profit may show opposite directions.

$$\frac{d}{dC_R} \pi_{S, A} = C_R(1 + f) - 1, \tag{30}$$

$$\frac{d}{dC_R} \pi_{CP, A} = C_R f + \frac{C_F}{f}.$$

Social welfare increases as the variable recording cost decreases, once the variable recording cost goes below a certain level ($C_R \leq 1/(1 + f)$). In other words, viewer benefits from the inexpensive cloud DVR must be large enough to compensate for the loss of advertisement value from time-shifting.

Proposition 6. Social welfare increases as the cost of cloud DVR decreases, only if the cost of using cloud DVR is low enough to cover the loss of the value of embedded advertisements from time-shifting ($C_R \leq 1/(1 + f)$).

As fair use personal recording technology advances, it increases competition, and competition is good for society. However, the copyright holder's profit monotonously decreases as the variable recording cost of PRS decreases, meaning that eventually it may not protect the copyright holder's business model at all. Now the court is clearly facing a dilemma. Before cloud DVR, allowing the use of new PRSs increased the copyright holder's profit as well as social welfare, protected copyright holder's business models while enjoying all the benefits provided by new technology. The court already determined Cablevision's cloud DVR service as a fair use PRS, since from a legal perspective only the storage location differs. From an economic perspective, if the cost of using cloud DVR falls below a certain level, there is a trade-off between protecting the copyright holder's profits for creation and social welfare. The fact that Cablevision won the legal dispute over cloud DVR suggests that the court thinks that the copyright holder's profits can be protected despite the fact that cloud DVR has the same cost structure as VOD. Therefore, comparing the copyright holder's profit with that of stage 2 yields

$$\pi_{CP, A} - \pi_{CP, 2, \sigma=0} = \frac{C_F^2}{2f} - \frac{f(C_R^2 - C_V^2)}{2}, \tag{31}$$

The above expression should be positive in order to protect the copyright holder's profit. The profit loss from competition, represented by the second term, should be small enough, suggesting that either the variable cost of serving VOD and cloud DVR is relatively high or the cost of recording with traditional DVR is relatively low. Unlike in previous stages, the fair use doctrine must be used with greater caution at this stage, 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 business models, even when social welfare increases because of the new technology.

3.5. Stage 5: Auto-hop vs. VOD (2012 – present)

The DVR provided by the Dish Network Corporation, named Hopper DVR, automatically records prime time TV content and viewers can enjoy advertisement-free content approximately eight hours later, if they agree to skip the advertising. Despite criticism from copyright holders including Fox, CBS, and NBC, Dish claims that the Auto-hop feature is simply an automated viewer behavior feature. In other words, it is a slightly more complicated version of a fast-forward button (Kenneally 2012).

At this stage, 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. If $k = 1$, Auto-hop is ruled to be a copyright infringement and the analysis does not change from the previous stage. The previous stages have so far assumed $k = 1$ in order to clarify the effect of the Auto-hop feature, although Dish is not providing cloud DVR for now. Further, it is assumed that Auto-hop is charged at a viewer's nuisance cost of watching advertisements. While Dish is arguing that the Auto-hop feature is provided free of charge, which is understandable since it is just a function included in the software, it still only works with Dish's Hopper DVR, which costs about \$4 more than any other standard DVR. This suggests that although Auto-hop service is by nature a software function, it is not yet independent from specific hardware or an operating system. Therefore, it is assumed that for now, in order to automatically skip an advertisement, viewers must pay an additional fee that is exactly the same amount as the nuisance cost (C_F), and that servicing Auto-hop requires a certain amount of cost for the PRS provider.

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

$$\pi_{CP,5} = f\alpha + kf \int_{\alpha}^{t_V} (1-t)dt + \int_{t_V}^1 (P_V - C_V)dt. \tag{32}$$

If $0 < k < 1$, the optimal launch timing is derived as

$$\begin{aligned} \frac{d\pi_{CP}}{dt_V} &= fk(1-t_V) + C_V - C_R - C_F, \\ \hat{t}_V &= 1 - \frac{C_R + C_F - C_V}{fk}, \end{aligned} \tag{33}$$

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

When $k = 0$, the first-order derivative becomes

$$\frac{d\pi_{CP}}{dt_V} = C_V - (C_R + C_F) \leq 0. \tag{34}$$

The first-order derivative is negative because the variable cost of producing VOD is assumed not to exceed the variable 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 7. If DVR has an inexpensive variable recording cost for viewers ($C_R \leq \frac{1}{2}(P_V + t_V - C_F)$) and automatic advertisement skipping is ruled to be fair use, the copyright holder must fix the VOD price at the variable 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 variable recording and the optimal launch timing is set to be immediately after initial airing because embedded advertisements cannot be exploited anymore. Furthermore, VOD is under full competition

with cloud DVRs equipped with the Auto-hop feature even though the original content is created by the copyright holder. Comparing the copyright holder's profit with the previous stage yields

$$\pi_{CP,5} - \pi_{CP,4} = -\frac{1}{2f}(C_F - f + C_Rf)^2 \leq 0. \tag{35}$$

As expected, Auto-hop significantly reduces the copyright holder's profit, even if it still requires the same amount of costs for viewers to activate the function with the nuisance costs of watching embedded advertisements (C_F).

In addition, if it is assumed that the price of auto-hop service is set to the variable cost under perfect competition, social welfare decreases with the introduction of Auto-hop, as the comparison shows

$$\begin{aligned} \pi_{V,5} &= \int_0^{\alpha} (U_0 - C_F - t)dt + \int_{\alpha}^1 (U_0 - C_F - C_R)dt, \\ \pi_{S,5} &= \pi_{CP,5} + \pi_{V,5}, \\ \pi_{S,5} - \pi_{S,4} &= -\frac{1}{2f}(C_F - f + C_Rf)^2 \leq 0. \end{aligned} \tag{36}$$

The difference in social welfare is the same as that of the copyright holder's profit, since the viewers' welfare did not change. Because it is assumed that Auto-hop service still incurs a certain cost, the recording service providers do not receive profit by providing Auto-hop. The technological advancement pushes both recording service providers and the copyright holder, and both parties lose opportunities to make profit. By allowing Auto-hop as a fair use, the court may fail to preserve both the copyright holder's monetary incentives and social welfare. However, more than two dozen law professors filed a brief with the U.S. Court of Appeals in January 2013, stating that "We urge the Court to reject Fox's attempt to engineer a sea change in copyright law and the resulting precedential conflicts it would create" (Gershman 2013). They are suggesting that the result of fair use doctrine applied on PRS has changed our lives so significantly that it has grown larger than the scope of copyright protection. Our model showed that the new information technology that powered Auto-hop featuring PRSs could harm both the copyright holder's profit and social welfare. The brief description above suggests, however, that even if the court acknowledges the possible loss of those two factors, the litigation and enforcing costs may be too much for society to bear. The functionality of copyright law applied to PRS is being threatened more than ever and the court should carefully examine the consequences of its ruling over the Auto-hop case.

It may be worthwhile to consider the case when Auto-hop is fully integrated as server software and therefore does not require any variable costs to use, a case we expect soon to be realized if Auto-hop is ruled as a fair use. In this case, the viewers' utility functions when using PRS changes to

$$u_{i,R} = U_0 - C_R. \tag{37}$$

Since the copyright holder should set the price of VOD at the variable cost of recording and less than the nuisance cost, the number of live viewers (α) becomes

$$\alpha = C_R - C_F.$$

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

The comparison of the copyright holder's profit at this stage with profit of non-free Auto-hop service stages yields

$$\begin{aligned} \pi_{CP,6} &= \alpha f + \int_{\alpha}^1 (C_R - C_V)dt, \\ \pi_{CP,6} - \pi_{CP,5} &= -C_F(f + 1 - C_R). \end{aligned} \tag{38}$$

Again, the profit of the copyright holder further decreases as Auto-hop is provided for free, since the cost of the recording is smaller than the maximum possible utility from the content. The

chance of preserving a fixed cost for creation becomes slimmer. For social welfare, the comparison becomes

$$\pi_{S,6} - \pi_{S,5} = \frac{1}{2} C_F (C_F - 2f). \tag{39}$$

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

Proposition 8. If Auto-hop service is provided free of charge, the copyright holder's profit reduces ($\pi_{CP,6} - \pi_{CP,5} = -C_F(f + 1 - C_R) < 0$) and social welfare can be better off only if the nuisance cost of watching advertisements is much larger than the value of the advertisement ($C_F > 2f$).

Although there is still a chance that free of charge Auto-hop service can be beneficial to society, it is highly unlikely, since the requirement is quite unrealistic. The model suggests that if society benefits from removed nuisance costs that are larger than the loss of the copyright holder's profit, Auto hop may be ruled as a fair use. The court should investigate the possible development of de-embedding technology and consider how such developments can affect both the copyright holder's business model and social welfare.

4. Conclusion

This paper reviewed the history of the technological development of PRSs and the related court rulings, while also investigating the strategies of copyright holders and social welfare from legal, economic, and IS perspectives. For law and economics research, this paper adds analysis and implications on how the most recent development in information technology now threatens the economic logic supporting the fair use doctrine, because PRS theoretically now possesses the same or an even better cost structure than the copyright holder. For IS research, this paper suggests that while information technology greatly supported advertisement based models with low copy and distribution costs, the same technology can now remove advertisements and threaten the very legal foundation of PRS: the fair use doctrine. We suggest that this paper is therefore a valuable addition to the current body of knowledge as it bridges both perspectives by showing how legal and technological protection for copyright holders have interacted with each other thus far. It also suggests new approaches when analyzing copyright holder' strategies and social welfare regarding the fair use doctrine and information technology.

The presented analysis showed that when the first PRS, Betamax, was introduced to the market, the copyright holder may have enjoyed additional benefits from recorded advertisements. Both the copyright holder's profit and social welfare may have increased by allowing Betamax technology as a fair use. With VOD technology, the copyright holder might have had advantages over contemporary PRSs such as traditional DVRs because of a better cost structure. As long as VOD had a better cost structure than the

traditional PRS, again both the copyright holder and social welfare were better off due to the new technology.

Cloud DVR, the new generation of PRS, removed such differences in cost structure, because it works in the same way as VOD. The copyright holder thus loses the ability to extract desirable profits from VOD and may have to delay its launch in order to maximize the revenues generated from recorded advertisements. With cloud DVR technologies, the court may fail to protect both the copyright holder's profits and social welfare, because each goes in a different direction as the price of using cloud DVR decreases. The Cablevision case suggests that the court acknowledged that the copyright holder's monetary loss from competition was not enough to hamper the incentives for creation. However, the analysis showed that the conditions drawn from the analysis are relatively tight to hold.

Finally, if Auto-hop is ruled to be fair use, the copyright holder cannot utilize embedded advertisements and must operate under full competition with PRSs using its own content. Social welfare is also likely to decrease, unless the nuisance cost of watching embedded advertisements largely surpasses the value of the advertisements. The following table is a summarization of the analysis results and suggests that the recent advancement of information technologies is now threatening the copyright holder's profits and, most likely, also social welfare, which differs from cases prior to cloud DVR. Legal actions therefore may have to be adjusted following changes in technological environments. If traditional legal perspectives remain unchanged, fair use PRS equipped with new information technology may hamper both the copyright holders' business models and social welfare. Table 2 summarizes the results.

As Downes (2009) pointed out, information technology is rapidly changing and blurring the boundaries of legal definitions such as personal fair use. Social functions such as business, law, and politics are finding it difficult to keep up with the many disputes occurring over such new technologies. Copyright holders had both legal and technological protection against personal recordings. Now when those technological protections have almost vanished, the court's responsibility to protect the incentives for content creation is greater than ever. The court may even have to investigate what options copyright holders have, including VOD services, in order to ascertain its sufficiency against these new PRSs and to protect copyright holder's business models. Copyright holders can use this paper's analysis to fortify their legal arguments. However, it may be hard to show that they did not overstep personal fair use by taking advantage of VOD's better cost structure before the introduction of cloud DVRs and Auto-hop. Therefore, the court investigating the Auto-hop lawsuits may have to consider that legal protection may be the only way to protect the copyright holder's profits, unless the fundamental purpose and scope of the copyright law is re-examined as it is suggested in the brief that has been filed with the U.S. Court of Appeals by some renowned law professors.

This paper has several limitations and also presents several possibilities for future research. The presented model only considered non-time-sensitive content. For time-sensitive content, PRS may not be required in the first place. However, we suggest that if the copyright holders are pushed too far by advanced PRSs,

Table 2
Summary of analysis results.

Available technology	Copyright holder's profit	Social welfare	Court decision	Notes
Betamax VCR	Likely to increase	Increase	Fair use	Due to increase of exposure of embedded advertisements via recording Copyright holder may freely set both price and launch timing of VOD Copyright holder must fix VOD price to match competition Copyright holder must fix both VOD price and launch timing to match competition
DVR, VOD	Increase	Increase	Fair use	
Cloud DVR, VOD	Decrease	Determined by C_R	Fair use	
Auto-hop, VOD	Decrease	Likely to decrease	Under debate	

non-time-sensitive content may turn to time-sensitive content by incorporating more time-sensitive complementary values, such as promotional Twitter events that are only available during the live airing. Investigating the causality between the threat of PRS and such exclusive live-only events can be a significant extension of this paper.

We expect that as Auto-hop removes advertisements and their effectiveness diminishes in the process, there could emerge a positive feedback due to devaluation of content embedded advertisements. Advertisers are aware that their advertisement can be removed, and therefore, the advertisement slots are devaluated. This leads to low-quality advertisements such as spam. In a reaction against it, viewers might aggressively adopt ad-removal services like Auto-hop, thereby creating positive feedback. The presented model only examined the extreme cases of ad removal ($k = 0$ and $k = 1$); however, an analysis of the results of progressing devaluation of advertisements could yield valuable insights for the future of ad removal services and copyright holders' business.

In the presented model, the PRS providers are predetermined as price-takers since they are assumed to be under perfect competition. This assumption was applied to reflect the situation of early PRS versions, such as Betamax or Tivo, which were mass produced independent hardware. However, modern PRS such as cloud DVR is tied to the media distribution service business model, therefore it could be a viable extension of this paper by considering strategic decisions for service business models of the copyright holders and PRS providers. For example, one of the important revenue sources

for copyright holders is a subscription fee from media distributors, such as cable providers. The advancement of PRS may render cable TV even less attractive for users (especially for rebroadcasts) and may also harm the copyright holder. However, such interactions are not modeled in this paper. In future research, strategic decisions such as retaliation of the copyright holders against new PRS technologies may be a valuable addition to the field.

The modeling of Auto-hop service can be extended to other advertisement removal services, such as web browser plugins or custom smartphone hacking software that removes advertisements in web content or smartphone applications. Those business models could also suffer from user side advertisement removal. Their business models and governing copyright laws may have to be changed in similar directions as suggested in this paper, as a result.

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Appendix A

A.1. Summary of literature

Context	Author (Date)	Description
Economic analysis of copyright holders' strategy regarding the fair use doctrine that applied to (traditional) PRS	Klein et al. (2002)	New time-shifting markets can be beneficial to copyright holders by increasing user base
	Novos and Waldman (1984)	The copyright holder is assumed to be protected by technological barriers which allow better quality and cost structure than the individual personal copy
	Johnson (1985)	When the cost of private copying is too low, limiting fair use may be necessary
	Besen (1986)	Even consumers do not benefit from inefficient private copying in the long run
	Liebowitz (1981, 1982, 1985)	How technology may change social welfare regarding the application of fair use for photocopying
	Gordon (1982)	Betamax technology may hamper market structure
	Miceli and Adelstein (2005)	The optimal level of fair use is determined by the level of technology, implying that the court may have to adjust its rulings as the performance and characteristics of technologies evolve
	Adelstein and Peretz (1985)	
	Economic analysis of advertisement based two-sided market strategy	Armstrong (2006)
Rochet and Tirole (2003)		Various business models such as those including credit cards, broadband, video games, media, and streaming services adopt similar strategies in order to maximize the benefits generated through network effects
Choi (2010)		Analyzed copyright holders strategies under single-homing and multi-homing
Anderson and Coate (2005)		Suboptimal pricing occurs when viewers are allowed to switch channels and explained why some countries have regulated the amount of advertising embedded in prime time schedules
Gabszewicz et al. (2001)		Viewers are sometimes assumed to be indifferent to the advertisements embedded in the content, therefore securing the maximum number of viewers is crucial

(continued on next page)

Appendix A (continued)

Context	Author (Date)	Description
	Regner et al. (2009)	Newcomer artists sometimes give up hard digital rights management to gain increased attention
	Margolina et al. (2011)	Suggested secret protection incentive-based escrow system to better digital rights management

This study investigates the ways in which information technologies have changed PRS fundamentally thus far and its effects on business environments, including the most recent cloud DVR and Auto-hop technologies. The analysis results suggest that before cloud DVR existed, applying fair use to personal recording services increased social welfare while protecting the copyright holder's profits; however, after the introduction of cloud DVR and Auto-Hop, it may no longer do so

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