Pay-per-view Broadcasting of Outstanding Events: Consequences of a Ban*

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Abstract

A regulatory ban on pay-per-view broadcasting of certain outstanding events has recently been implemented in the EU. This paper analyses the consequences of such a ban when the alternative is financing the events purely by TV-commercials. The result on total surplus is ambiguous and, hence, does not by itself justify a ban. However, a ban always increases consumer surplus and reduces the proceeds to the owner of the broadcasting rights. This is consistent with the motivation for the ban given in the EU Directive, which focuses on the welfare of the viewers.

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1 Introduction

A TV broadcast is no longer a (pure) public good, i.e. non-rival and non-excludable, because of the emergence of cable TV, scramblers, etc. that has made it possible to exclude some households from watching a broadcast. Thus, for private TV stations pay television has become an attractive alternative to television financed purely by advertising, and in general it is becoming increasingly common to charge viewers directly for watching a specific channel or a certain event. This paper concentrates only on the second type of pay television, i.e. what is called "pay-per-view" broadcasting for the following reasons. First, the consequences of having whole channels financed by pay subscription instead of pure advertising are relatively well known (see e.g. Spence and Owen, 1977; Owen and Wildman, 1992) and a ban on pay television in general is not on the practical policy agenda. Second, although pay-per-view broadcasting is rather new in Europe,[1] it will be more and more common in the future especially because of the emergence of digital broadcasting which can provide pay-per-view programs "much more easily", The Economist 20/4/96 p. 53. Finally, the new EU "Television without frontiers" Directive, which was fully implemented on the 30th of December 1998, prevents pay-per-view broadcasting of certain major (mainly sporting) events occurring on national lists made by each member state.[2]

This paper examines how such a regulatory ban on pay-per-view broadcasting affects total surplus and the distribution of this surplus between the viewers and the owners of the broadcasting rights. More specifically, we consider a television station that can acquire the sole broadcasting rights to an (outstanding) event and compare the outcome of selling the event on a pay-per-view basis (including commercials) with selling the event on a pure commercial basis. These seem to be the two available alternatives in many cases. Matters are more complicated if public television is included as an alternative, since the "efficiency loss" from having a broadcast financed through the general tax system is hard to determine.[3]

[1] E.g. the first pay-per-view broadcast in Denmark was a boxing fight between Larry Holmes and Brian Nielsen on the 24th of January 1997.

[2] Directive 97/36/EC of the European Parliament and of the Council (amending Council Directive 89/552/EEC) came into force on the 30th of July 1997 and was fully implemented into national legislation on the 30th of December 1998.

[3] Many countries use license fees. However, this works more or less as financing through the

From an economic perspective, a natural analytical starting point is to look at total surplus. Intuitively, one may anticipate from the discussion above that a ban on pay-per-view increases total surplus simply because a TV broadcast is a non-rival good (i.e. marginal costs are zero). This need not be the case: Although pay-per-view may reduce the number of viewers watching the event, it may also reduce the number of commercials which increases total surplus. Our results on total surplus are not necessarily in favour of a ban: (*i*) Two cases exist where pay-per-view yields the highest surplus, namely (a) when a broadcast cannot be financed purely by commercials, and (b) when all potential viewers watch the event. (*ii*) The comparison is ambiguous if these constraints are not binding. (*iii*) In a calibrated example a ban leads to a reduction in total surplus by at least 16%.

The distributional implications of a ban are unambiguous: consumer surplus increases and the proceeds from the property right of the event decline. Moreover, these effects can be quite large: in our calibrated example a ban almost doubles consumer surplus and halves the value of the broadcasting rights. This may justify a ban if a desired division of total surplus is impossible to achieve, or if the rents to the owner of the broadcasting rights are dissipated in wasteful effort to become a monopolist, cf. Posner (1975).

The economic consequences of pay-per-view broadcasting are relatively unexplored. The aforementioned literature on pay subscription versus advertising is not very applicable when considering outstanding events, like the UEFA Euro Cup final in football. The reason is that this literature considers the welfare effects that arise because the number of channels, the number of programs, and the program quality differ with pay subscription and advertising. These effects are not very important when considering outstanding events which lack substitutes and are few in numbers. Moreover, broadcasting hours and quality (apart from disutility from commercials) are not determined by the television station. Finally, this literature does not consider the effect on the advertising level of charging a direct price which is a driving force in our model.

One previous paper has analysed outstanding events, namely Holden (1993). Our analysis differs in two respects. First, Holden (1993) does not include any

general tax system as households having a television set have to pay whether it is used for public television or not, although one may argue that license fees do not affect behaviour on the margin unlike the general tax system.

formal analysis of the effects on total surplus. Second, Holden (1993) considers only the possibility of second degree price discrimination caused by allowing pay-per-view, i.e. the station obtains revenue first by selling the event to some viewers on a pay-per-view basis, and later by making a pure advertising broadcast of the event to other viewers. Instead, our main analysis considers the case where a later broadcast of the event has zero value to the viewers (e.g. what is the value of watching a football match when you know the result?!). We believe this to be a more natural starting point for a basic analysis of the issue. We do, however, briefly consider the effect of including second degree price discrimination. Simulations suggest that our results are unchanged when including this element.

The paper is organised as follows. The next section presents the basic model and characterises the interior solutions of having an event broadcasted by a pure advertising TV-station, a pay-per-view TV-station, and a social planner. The third section compares these outcomes. The fourth section uses specific functional forms to calibrate the model and to elaborate on the consequences of second degree price discrimination. The last section discusses the results.

2 A Basic Television Model

An agent possesses the "legal" (monopoly) rights to broadcast an outstanding event.[4] The agent is willing to sell the rights if the price Ω is at least $\tilde{\Omega} \geq 0$.[5] We assume that there are infinitely many television stations each bidding for the rights to broadcast the event as long as they expect non-negative profits. The broadcasting rights are then sold at the highest bid. The potential viewers of the event are indexed by $x \in [0, \bar{x}]$ where the viewers' willingness to pay are declining in the index. The marginal viewer's willingness to pay with no commercials is denoted by $\zeta(x)$. It is assumed that this function is not "too convex", i.e. $\zeta''(x)\, x / \zeta'(x) > -1$, which is sufficient, but not necessary, to ensure that any interior point satisfying

[4]The agent could be UEFA possessing the rights to the Euro Cup Final in football or promoter Don King owning the rights to boxing matches involving Evander Holyfield.

[5]In the case where promoter Don King owns the rights to a fight involving Evander Holyfield this could reflect the reservation price of Holyfield since ultimately he decides whether or not to fight.

the first order conditions is indeed a solution.[6] We assume that all viewers have the same disutility of commercials measured in money terms, $\eta(a)$,[7] where $\eta'(\cdot) > 0$, $\eta''(\cdot) > 0$, and a denotes the number of commercials. This seems to be a reasonable assumption if there is no systematic relationship between the reservation prices of the viewers and their disutility of commercials. Furthermore, it is convenient since it implies that the inverse demand curve facing the television station for a given level of advertising takes the following separable form: $p(x,a) \equiv \zeta(x) - \eta(a)$. We assume it is impossible to pay/subsidise a viewer to watch the event implying that any solution (x,a) fulfils $p(x,a) \geq 0$. The station sells commercials at a price per ad per viewer equal to $q(a)$ where $q'(\cdot) \leq 0$, and we assume that the station captures all commercial rents. Thus, commercial revenue per viewer equals $\psi(a) \equiv \int_0^a q(t)\,dt$, where $\psi'(\cdot) > 0$ and $\psi''(\cdot) \leq 0$. Note, that in the case of a perfectly competitive market for ads $q(a)$ is equal to the competitive market price implying that $q'(\cdot) = \psi''(\cdot) = 0$.

We consider two possible ways of selling the event: through pure advertising or pay-per-view. In the pure advertising case all revenues are obtained from selling commercials, whereas in the pay-per-view case revenues stem from commercials as well as direct payments from the viewers. For comparison, we also consider the case of a social planner seeking to maximise total surplus under the same constraints. In the following three subsections, we characterise the interior solutions of each case, and in Section 3 we compare the three cases also taking into consideration two possible constraints that may give rise to boundary solutions: (a) the equilibrium contract price must be at least equal to the reservation price of the supplier $\tilde{\Omega}$, and (b) the number of viewers cannot exceed the potential number of viewers $\bar{x}$.

2.1 Advertising

The advertising monopolist is prohibited from charging the viewers direct payments, and therefore he chooses the advertising level, a, in order to maximise profits,

$$\Pi(\Omega) = \psi(a) \cdot x - \Omega, \tag{1}$$

[6] In the appendix, it is shown that the second order conditions are satisfied for all problems under consideration.

[7] This represents the direct displeasure of being interrupted by commercials net of any possible gains, e.g. because of the informational content.

subject to the following inverse relationship between the number of viewers and the amount of advertising,

$$\zeta(x) - \eta(a) = 0. \tag{2}$$

Maximisation yields the following first order condition

$$\psi'(a) = -\frac{\eta'(a)}{\zeta'(x)\, x}\psi(a). \tag{3}$$

This equation states that the advertising monopolist chooses advertising level such that the marginal revenue per viewer of increased advertising (the LHS) equals the marginal costs (the RHS) consisting of reduced number of viewers from increased advertising multiplied by advertising revenue per viewer. An interior equilibrium (x_A, a_A, Ω_A) is characterised by (2), (3), and $\Pi(\Omega) = 0$.

2.2 Pay-per-view

The pay-per-view monopolist chooses price and advertising level in order to maximise[8]

$$\Pi(\Omega) = (\zeta(x) - \eta(a))\, x + \psi(a)\, x - \Omega, \tag{4}$$

where the first two terms represent revenues from "pay-per-view" and commercials, respectively. Note, that a solution to this problem does not yield less profit than the advertising solution. To be an interior solution, we require a strictly positive pay-per-view price, $\zeta(x_P) - \eta(a_P) > 0$, which is assumed to be fulfilled throughout the paper. The unique maximum (x_P, a_P) is then characterised by the first order conditions

$$\psi'(a) = \eta'(a), \tag{5}$$

$$\zeta(x) - \eta(a) + \zeta'(x)\, x = -\psi(a). \tag{6}$$

The first equation states that the optimal level of advertising is chosen where marginal revenue per viewer equals marginal disutility per viewer. The marginal disutility per viewer is also the marginal cost of the television station as it measures how much the station has to reduce the price per viewer for a given number of viewers. The second equation is the standard marginal revenue equals marginal

[8] We disregard any direct costs of charging the viewers. Such costs are relatively low and will probably be infinitesimal in a future with Digital Broadcasting.

costs condition of a monopolist. The LHS represents the marginal revenue from pay-per-view payments of getting one more viewer equal to the price per viewer (the first two terms) plus the loss in revenue from reducing the price in order to attract the extra viewer. The RHS represents marginal revenue from advertising of getting one more viewer, which can be interpreted as a negative marginal cost.[9] An interior equilibrium (x_P, a_P, Ω_P) is characterised by (5), (6), and $\Pi(\Omega) = 0$.

2.3 Social Planner

For comparison, we derive the outcome of a social planner choosing (x, a) to maximise total surplus defined as

$$W \equiv \int_0^x \zeta(s)\, ds - \tilde{\Omega} + [\psi(a) - \eta(a)]\, x, \tag{7}$$

where the first two terms are total surplus not including commercials and the last term is advertising surplus.[10] Maximising (7) taking into consideration the constraint $\zeta(x) - \eta(a) \geq 0$ yields a unique solution (x_S, a_S) satisfying the following conditions

$$\zeta(x) - \eta(a) = 0, \tag{8}$$

$$\psi'(a) = -\frac{\eta'(a)}{\zeta'(x)\, x}\psi(a) + \eta'(a). \tag{9}$$

The first condition states that the socially optimal pay-per-view price is zero, i.e. the marginal cost of one more viewer is zero. The second condition is identical to the advertising solution (3) except for the last term, which represents the increased disutility to the viewers of a higher advertising level. The advertising monopolist does not take this effect into account, thus creating a negative externality on the viewers. An interior solution (x_S, a_S) is characterised by (8) and (9).

[9] Thus, interior solutions always lie on the inelastic part of the demand curve provided such area exists. If not, the number of viewers equals the upper bound $\bar{x}$. This case is analysed in Section 3.

[10] In this definition, it is assumed that there exists a direct welfare gain of having commercials. One might argue that the revenue does not contribute with any surplus or even that we should add a negative term representing further negative effects, e.g. because seemingly identical products are "diversified" by commercials and thereby reducing the competitiveness among firms buying advertising time. Including such effects would, ceteris paribus, be in favour of pay-per-view.

3 Pay-per-view vs. Pure Advertising

In this section, we compare the outcomes of the two institutions. In doing so, we also consider the possibility of boundary solutions. Two natural constraints may give rise to boundary solutions: (a) the contract price cannot be below the reservation price of the supplier, i.e. $\Omega \geq \tilde{\Omega}$, and (b) the number of viewers cannot exceed the potential number of viewers, i.e. $x \leq \bar{x}$. We start by focusing on interior solutions where these constraints are not binding. It is quite intuitive that the advertising level is highest under pure advertising when comparing the pay-per-view, the advertising, and the socially optimal solution. It is, however, less clear both intuitively and analytically that the number of viewers is lowest with pay-per-view as the advertising level may be so high under pure advertising that marginal consumers prefer the pay-per-view price combined with a lower advertising level. To deal with this ambiguity, it is useful to rewrite and combine the first order conditions of the previous section to get the following relationships

$$\zeta(x_P) + \zeta'(x_P)\, x_P = -\left[\psi(a_P) - \eta(a_P)\right], \tag{10}$$

$$\zeta(x_A) + \zeta'(x_A)\, x_A = -\left[\frac{\eta'(a_A)}{\psi'(a_A)}\psi(a_A) - \eta(a_A)\right], \tag{11}$$

$$\zeta(x_S) + \zeta'(x_S)\, x_S = -\left[\frac{\eta'(a_S)}{\psi'(a_S) - \eta'(a_S)}\psi(a_S) - \eta(a_S)\right], \tag{12}$$

where (10) follows directly by isolating the terms including x in the pay-per-view equation (6); (11) is derived by rewriting and adding the advertising equations (2) and (3); (12) is derived by rewriting and adding the equations (8) and (9), which characterise the socially optimal solution. Using these equations and the equations determining the advertising level (i.e. (3), (5), and (9), respectively) it is possible to illustrate graphically the comparison of the number of viewers, x, and the advertising levels, a. This is done in panel a and b, respectively, in Figure 1.

< Figure 1 >

The pay-per-view solution is intuitively straightforward in this diagram; a_P maximises the difference between $\psi(a)$ and $\eta(a)$ and x_P is set where marginal revenue (before advertising, i.e. $\eta(a)$ is moved to the RHS) equals marginal costs. The two other solutions are more complicated because the LHS of (11) and (12) do not represent marginal revenue but the aggregate marginal willingness to pay of the viewers (before disutility of advertising). The shadow value of a change in the aggregate willingness to pay, $[\zeta(x) - \eta(a)]\,x$, is one in the case of pay-per-view (as it equals the revenue from pay-per-view payments, $p_P x_P$) but $\frac{\psi'(a_A)}{\eta'(a_A)}$ and $\frac{\psi'(a_S)-\eta'(a_S)}{\eta'(a_S)}$ in the case of advertising and in the case of the social planner, respectively. In the advertising case, it transforms the loss in aggregate willingness to pay into the loss in advertising revenue necessary to obtain an increase in the number of viewers. In the case of the social planner it transforms the loss in aggregate willingness to pay into the loss/gain in total surplus from the reduction in the advertising level necessary to obtain an increase in the number of viewers. The inverse of these shadow values occur at the RHS of (10) - (12) and are the only thing separating the equations from each other. This is used below when proving the result illustrated in Figure 1 and stated in the following proposition.

Proposition 1 *If the contract price with pure advertising is larger than or equal to the reservation price, $\Omega_A \geq \tilde{\Omega}$, and the number of viewers under pay-per-view is less than the potential number of viewers, $x_P < \bar{x}$, then: (i) Pay-per-view has fewer viewers than pure advertising which has fewer viewers than the socially optimal solution, $x_P < x_A < x_S$. (ii) Pay-per-view involves an intermediate level of commercials; less than pure advertising but more than the socially optimal solution, $a_S < a_P < a_A$. (iii) The comparison of total surplus under pay-per-view and pure advertising is ambiguous but both yield lower surplus than the socially optimal solution,* $\max(W_A, W_P) < W_S$.

Proof. Note, that $\Omega_A \geq \tilde{\Omega}$ implies $\Omega_P \geq \tilde{\Omega}$. We start by deriving the result when the constraint $x_A \leq \bar{x}$ is not binding. First, we compare the advertising solution (x_A, a_A) and the pay-per-view solution (x_P, a_P). Define $H(a) \equiv \psi(a)\frac{\eta'(a)}{\psi'(a)} - \eta(a)$ and note that $H(a)$ is increasing because of the assumptions $\eta'(\cdot) > 0, \eta''(\cdot) > 0, \psi'(\cdot) > 0$, and $\psi''(\cdot) < 0$. From equation (5) it follows that $H(a_P) = \psi(a_P) - \eta(a_P)$ which implies $H(a) > \psi(a_P) - \eta(a_P) \Leftrightarrow a > a_P$. The LHS of (10) and (11) are declining in x_P and x_A respectively, yielding the implication

$$x_P < x_A \;\Leftrightarrow\; a_P < a_A.$$

We now establish that $x_P < x_A$. Assume the opposite is true, $x_P \geq x_A$, and thus $a_P \geq a_A$. The reservation price of the marginal viewer, $p(x,a) \equiv \zeta(x) - \eta(a)$, is then characterised by $p(x_P, a_P) \leq p(x_A, a_A) = 0$, which contradicts the existence of an interior solution to the pay-per-view problem, i.e. $p(x_P, a_P) > 0$. Thus, $x_P < x_A$ and $a_P < a_A$. Now we turn to the inequality, $a_S < a_P$. The equations (5) and (9) imply that $\psi'(a_S) - \eta'(a_S) = -\frac{\eta'(a_S)}{\zeta'(x_S)x_S}\psi(a_S) > \psi'(a_P) - \eta'(a_P) = 0$. The result then follows from $\psi''(\cdot) < 0$ and $\eta''(\cdot) > 0$, which imply that $\psi'(a) - \eta'(a)$ is decreasing. The result $x_A < x_S$ follows from $a_S < a_P$ and the equations (2) and (8). The result on total surplus follows from the fact that both monopolists choose higher advertising level than the social planner, and that the social planner maximises under the same constraints as the pay-per-view monopolist. Until now we have skipped the possibility that the constraint $x_A \leq \bar{x}$ is binding. However, it is clear from Figure 1 that the results are still valid for this case as $x_P < \bar{x}$. $\square$

Thus, if an event can be financed purely by advertising and the constraint on the number of viewers is not binding with pay-pay-view then a ban on pay-per-view broadcasting will increase the number of viewers towards the socially optimal solution but also increase the advertising level further away from the socially optimal level. Therefore, the effect on total surplus becomes ambiguous. We will elaborate further on this ambiguity in the next section.

Readers familiar with the Swan invariance theorem (see e.g. Tirole, 1989, p. 102) may be puzzled by the result that the pay-per-view monopolist advertises more than the social planner: the aggregate disutility of commercials, $\eta(a)x$, acts as linear "production" costs in the profit expression, which normally results in an efficient choice of a. This does not occur in our case since it is impossible to subsidise viewers to watch an event, $p(x, a) \geq 0$. The pay-per-view advertising level would coincide with the social planner's if the social planner could spend some of the proceeds from advertising to subsidise people normally unwilling to watch the event.[11]

The above proposition included one boundary solution, namely when the advertising solution was constrained by the number of potential viewers. The following

[11] Graphically, the number of viewers, x_S, would be determined in Figure 1, panel a by setting the willingness to pay of the marginal viewer, $\zeta(x)$, equal to net marginal costs $\eta(a_P) - \psi(a_P)$. Obviously, such solution is characterised by a negative willingness to pay of the marginal viewer, $\zeta(x_S)$, implying a contract specifying that the viewer will watch the event in exhange of money. We assume that such contracts are impossible to enforce.

proposition covers the remaining possibilities.

Proposition 2 *If it is impossible to finance an event through pure advertising, $\Omega_A = 0$, or if all potential viewers watch the event under pay-per-view, $x_P = \bar{x}$, then pay-per-view yields larger total surplus than pure advertising, $W_P \geq W_A$.*

Proof. Clearly, if $\Omega_A = 0$ and $x_P \leq \bar{x}$ then one of two things may happen; *a*) pay-per-view is profitable and yields positive total surplus; *b*) pay-per-view is not profitable, and thus the event will not be broadcasted at all. If $x_P = \bar{x}$ and $\Omega_A > \tilde{\Omega}$ then $x_A = x_P = \bar{x}$. Now it follows from (7) that $W_P \geq W_A \Leftrightarrow \eta(a_A) - \eta(a_P) \geq \psi(a_A) - \psi(a_P)$. Let $\tilde{a}$ be defined by $\eta'(\tilde{a}) = \psi'(\tilde{a})$. Then two possible cases arise: *a*) If $a_A > \tilde{a}$ then $a_P = \tilde{a} < a_A$ and thus $W_P > W_A$. *b*) If $a_A = \tilde{a}$ then $a_P = a_A = \tilde{a}$ implying that $W_P = W_A$. □

The intuition of these results is straightforward: Pay-per-view can finance events unprofitable under pure advertising, thus giving some surplus instead of none. When the pay-per-view solution is constrained by the number of potential viewers, so is the advertising solution. Thus, the number of viewers is identical implying higher surplus in the case of pay-per-view because of a lower advertising level, cf. Figure 1, panel b. So far we have only considered effects on total surplus. Turning to distributional implications, we have

Corollary 1 (*i*) *Pay-per-view yields a larger contract price than pure advertising.* (*ii*) *Pure advertising yields larger consumer surplus than pay-per-view if and only if it is possible to finance the event through pure advertising.*

Proof. (*i*) This follows from the fact that the pay-per-view monopolist has one more instrument, p, when maximising profits. Thus, $\Omega_P \geq \Omega_A$. (*ii*) The consumer surplus equals

$$CS_A \equiv \int_0^{x_A} [\zeta(s) - \eta(a_A)]\, ds = \int_0^{x_A} [\zeta(s) - \zeta(x_A)]\, ds, \tag{13}$$

$$CS_P \equiv \int_0^{x_P} [\zeta(s) - \eta(a_P) - p]\, ds = \int_0^{x_P} [\zeta(s) - \zeta(x_P)]\, ds, \tag{14}$$

with pure advertising and pay-per-view, respectively. From Proposition 1 and Proposition 2, we have $x_A \geq x_P \Rightarrow CS_A \geq CS_P$ if it is possible to finance the event through pure advertising. If not then $CS_P \geq CS_A = 0$. $\square$

It is obvious that pay-per-view yields a higher contract price (i.e. transfer from the TV station to the owner of the event) than pure advertising since the pay-per-view monopolist has an additional choice variable. The second result can be seen from Figure 1. The consumer surplus under pay-per-view equals the triangle bounded by the $\zeta(x)$ - curve and the horizontal line going through point **P**. Similarly, the consumer surplus under advertising equals the triangle bounded by the $\zeta(x)$ - curve and the horizontal line going through point **A**. This result strengthens the overall conclusion in Holden (1993) which shows (using numerical examples) that pay-per-view may involve a large loss of consumer surplus.

4 A Useful Special Case

In this section, we consider a special case with specific functional forms in order to calibrate the model, so as to elaborate on the ambiguity concerning total surplus in Proposition 1 and to give an impression of the possible magnitudes of total surplus, consumer surplus, and contract price. Furthermore, we address the consequences on total surplus of second degree price discrimination, which may arise when pay-per-view is allowed.

We use the following functional forms: The willingness to pay without commercials is described by $\zeta(x) = \alpha - \beta x$, disutility of commercials by $\eta(a) = \gamma a^2$, and revenue from commercials by $\psi(a) = a$, where α, β, and γ are strictly positive parameters.

4.1 Calibration

To carry out the calibration, we start by calculating the solution of the model as a function of the parameters. For the case of advertising, we first calculate the number of viewers and the advertising level using (2) and (3) and then insert these solutions into (7), (13), and (1) in order to derive total surplus, consumer surplus, and equilibrium contract price. This yields

$$x_A = \frac{2}{3}\frac{\alpha}{\beta}, \quad a_A = \sqrt{\frac{\alpha}{3\gamma}},$$

$$W_A = \frac{2\alpha}{3\beta}\left(\frac{\alpha}{3} + \sqrt{\frac{\alpha}{3\gamma}}\right) - \tilde{\Omega}, \quad CS_A = \frac{2\alpha^2}{9\beta}, \quad \Omega_A = \frac{2\alpha}{3\beta}\sqrt{\frac{\alpha}{3\gamma}},$$

for all α, β, γ. In the case of pay-per-view, we use (6), (5), and the inverse demand function to derive number of viewers, pay-per-view price, and advertising level after which total surplus, consumer surplus, and equilibrium contract price can be derived using (7), (14), and (4). This gives

$$p = \frac{\alpha}{2} - \frac{3}{8\gamma}, \quad x_P = \frac{\alpha}{2\beta} + \frac{1}{8\beta\gamma}, \quad a_P = \frac{1}{2\gamma},$$

$$W_P = \frac{3}{8\beta}\left(\alpha + \frac{1}{4\gamma}\right)^2 - \tilde{\Omega}, \quad CS_P = \frac{1}{2\beta}\left(\frac{\alpha}{2} + \frac{1}{8\gamma}\right)^2, \quad \Omega_P = \frac{(4\alpha\gamma + 1)^2}{64\beta\gamma^2},$$

for $\gamma > 3/(4\alpha)$. The pay-per-view solution must satisfy the condition $p(x, a) > 0$ yielding the parameter restriction $\gamma > 3/(4\alpha)$. When this condition is violated the pay-per-view monopolist chooses price equal to zero and same advertising level as the advertising monopolist.

For the calibration, we use data from the first pay-per-view broadcast in Denmark, a boxing fight for the IBO Heavyweight World Champion Title between Brian Nielsen and Larry Holmes on the 24th of January 1997.[12] The fight was seen by 350 thousand viewers dispersed on 50 thousand pay-per-view subscriptions, thus giving an average of seven viewers per subscription.[13] The pay-per-view price was 250 DKK giving an average price of 36 DKK per viewer. In order to get an estimate of the number of viewers, had the fight not been financed through pay-per-view broadcasting, we use Brian Nielsen's previous defence of the title, which was financed purely by commercials. The fight took place on the 31st of May 1996 against Mike Hunter and had 458 thousand viewers. These estimates for p, x_P, and x_A, and the above parametric solutions for these variables are sufficient to calibrate the three parameters: $\alpha = 76$, $\beta = 0.00011$, and $\gamma = 0.17$. Inserting these parameters in the above equations, total surplus, consumer surplus, and equilibrium

[12] The data are obtained from Gallup Denmark, section for National TV-audience research.

[13] The seven viewers per subscription reflects that people clustered together in private homes, and that the fight was shown in many pubs, restaurants etc.

contract price measured in mill. DKK become:[14]

$$W_P = 20.5 - \tilde{\Omega}, \quad CS_P = 6.8, \quad \Omega_P = 13.7,$$

$$W_A = 17.3 - \tilde{\Omega}, \quad CS_A = 11.7, \quad \Omega_A = 5.6.$$

Thus, our calibration indicates that a ban on pay-per-view would have reduced total surplus with 16% if the reservation price of the owners of the broadcasting rights was zero. With a positive reservation price the relative loss would have been even larger, and with a reservation price above 5.6 mill. there would have been no event at all if pay-per-view was banned.[15] If the reservation price was below 5.6 mill. the distributional consequences of a ban would have been a reduction of the contract price by more than half and almost a doubling of consumer surplus.

4.2 Second Degree Price Discrimination

Until now we have not taken into consideration that pay-per-view broadcasting may admit second degree price discrimination by making it possible for the television station to broadcast two versions of the event: first a pay-per-view version (usually live) corresponding to our previous analysis, and second an advertising version (usually the day after). As mentioned in the introduction, Holden (1993) looked at the distributional implications of pay-per-view broadcasting admitting second degree price discrimination.[16] Here, we use numerical simulations based on the aforementioned specific functional forms in order to indicate whether our previous conclusions concerning total surplus would change when including the possibility of second degree price discrimination.

[14] In the analysis we have assumed that the gain to the owners of the broadcasting rights equals $\Omega - \tilde{\Omega}$. It is difficult to judge whether the television station actually captured some of these rents since we have no information on the actual price of the rights or on the salary of the fighters. Nevertheless, how the rents are divided does not influence the results on total surplus and consumer surplus.

[15] This presumes that the total revenue was equal to the Danish revenue. There may have been additional revenue stemming from the rights to broadcast the event in other countries. However, for this particular event the presumption seems reasonable since there were no live broadcasts (only summaries) of the event in the US and in other countries for that matter.

[16] Actually, Holden (1993) calls it third degree price discrimination. However, in the analysis the station cannot separate the two groups directly. It has to maximise profits subject to an incentive compatibility constraint specifying when the first group will choose the package intended for the second group. This is in fact second degree price discrimination according to the definition in Tirole (1989).

The viewers obtain lower utility from watching the second version, e.g. because the news content is gone. Following Holden (1993), we assume that the willingness to pay for the second version equals $\lambda\zeta(\cdot)$ where $\lambda \in (0,1)$. The television station chooses pay-per-view price, p, advertising level in the first version, a_1, and advertising level in the second version, a_2, in order to maximise

$$\Pi(p, a_1, a_2) = px_1 + \psi(a_1)x_1 + \psi(a_2)x_2 - \Omega,$$

subject to the incentive compatibility constraint (IC)

$$\zeta(x_1) - \eta(a_1) - p \geq \lambda\zeta(x_1) - \eta(a_2),$$

and the participation constraint (PC)

$$\lambda\zeta(x_1 + x_2) - \eta(a_2) \geq 0,$$

where x_2 denotes the number of viewers watching the second version. The IC states that the viewers watching the first version must obtain higher utility than if they were watching the second version. The PC states that only viewers obtaining positive utility watch the broadcast. This maximisation program is solved in the appendix using the specific functional forms. Let $z(\alpha, \gamma, \lambda)$ denote the total surplus under pay-per-view with second degree price discrimination relative to total surplus under pure advertising, and note that $\lambda = 0$ corresponds to our previous model without price discrimination. Thus, values of $z(\alpha, \gamma, \lambda)$ above (below) one corresponds to parameter values for which pay-per-view (advertising) yields the highest total surplus. In the appendix it is shown that $z(\alpha, \gamma, \lambda)$ is constant along any hyperbola $\gamma = \rho/\alpha$ for a given value of λ, where ρ is a positive constant. Therefore, we proceed by comparing only $z(\alpha, \gamma, \lambda)$ and $z(\alpha, \gamma, 0)$ for $\alpha = \gamma$. This yields the outcome illustrated in Figure 2 where the solid curve illustrates the value of $z(\alpha, \gamma, 0)$ whereas the dashed curves illustrate $z(\alpha, \gamma, \lambda)$ for different values of λ.

< Figure 2 >

Starting from left in Figure 2, $z(\alpha, \gamma, \lambda)$ equals one for all values of λ reflecting that the pay-per-view solution and advertising solution coincide since it is not optimal for the pay-per-view monopolist to charge a positive price. When moving to the right, all the curves have the same shape: first, advertising yields the highest total surplus and later, pay-per-view yields the highest total surplus.[17] In the figure the dashed curves are all above but close to the solid curve revealing that second degree price discrimination tends to increase the relative total surplus in favour of pay-per-view but that the effect is reasonably small. Thus, the basic conclusion is that the inclusion of second degree price discrimination does not contribute with any significant changes to the preceding results. Allowing for pay-per-view enlarges the rent capacity of the event in two ways: first, by making it possible for the television stations to charge a direct price and second, by admitting second degree price discrimination. Our example indicates that the first effect is by far the largest.

5 Discussion

The beginning of Article 3a of the new EU "Television Without Frontiers" Directive illustrates the aim of the regulatory ban on pay-per-view broadcasting of certain outstanding events: "*Each Member State may take measures in accordance with Community law to ensure that broadcasters under its jurisdiction do not broadcast on exclusive basis events which are regarded by the Members State as being of major importance for society in such a way as to deprive a substantial proportion of the public in that Member State of the possibility of following such events via live coverage or deferred coverage on free television.*" Thus, the purpose of Article 3a is to secure access for everybody to major events on live (or deferred) coverage, and to secure that viewers are not charged a direct price. This paper addresses only the second issue, i.e. whether a ban on pay-per-view can be justified given that everybody has access.[18]

The result on total surplus does not by itself justify a ban. A ban reduces total surplus if financing the event through pure advertising is impossible or if all potential viewers are watching the event under pay-per-view (Proposition 2). Otherwise, a ban may or may not reduce total surplus (Proposition 1). In our calibrated example, a ban reduces total surplus by at least 16%. The analysis

[17] The dashed curves are all above the solid horizontal line in a small region around $\alpha = \gamma = 0.85$. This occurs because the constraint $p \geq 0$ is binding in the basic pay-per-view case but not in the case with price discrimination. The dashed curves all coincide with the solid curve after some threshold because it is unprofitable to broadcast the second version. Thus, the solution coincides with the simple pay-per-view case.

[18] In a near future with digital broadcasting access will probably not be an issue anymore.

treats commercials favourable by including commercial revenue in total surplus although it may be questionable whether this revenue represents a direct welfare gain (cf. footnote 10). A less favourable treatment would make it more likely that a ban reduces total surplus. On the other hand, if the proceeds to the owner of the broadcasting rights are dissipated in efforts to become a monopolist, a ban will increase social welfare unambiguously according to Corollary 1.[19]

There may be other reasons for a ban. If a desired division of total surplus is impossible to obtain, policy makers may favour a ban out of distributional concerns. In fact, this seems to be the justification given by the policy makers in the above citation, which focuses on the welfare of the viewers rather than on economic efficiency. Our results state that a ban unambiguously increases the surplus of the viewers if it is possible to finance events purely by commercials (Corollary 1), and in our calibrated example a ban almost doubles the consumer surplus, thus indicating that the gain to the viewers may be substantial. However, note that it would be misleading to conclude from the unambiguous effect on consumer surplus that a ban on pay-per-view broadcasting in general would be desirable. Pay-per-view broadcasting of events that cannot be financed purely by advertising should of course be allowed. Therefore, it is in fact reasonable to focus only on major outstanding events, which presumably can be financed purely by advertising.

Pay-per-view television always yields the highest proceeds to the initial owner of the broadcasting rights (Corollary 1), and in our calibrated example the contract price was more than twice as high under pay-per-view. This implies that the extent of pay-per-view television, if allowed, may increase dramatically in the future where technical solutions for pay-per-view broadcasting are expected to be available at very low costs. Another implication of the strong effect on the contract price is the creation of incentives for (sporting) organisations to lobby in order not to be included on the national lists.[20] The consequence may be that not all outstanding events of major importance for society are included on the national lists.

[19] In this case total surplus is identical to consumer surplus, cf. Posner (1975).

[20] Furthermore, it seems paradoxical that (sporting) organisations may be punished economically after great success that suddenly makes their (sporting) events of national interest. That is, it is beneficial to be popular but not too popular.

A Appendix

A.1 Second Order Conditions

A.1.1 Advertising

From the definition of profits, we get the following second order condition

$$\Pi_{aa} = \psi''(a)\,x + \frac{\psi'(a)\,\eta'(a) + \psi(a)\,\eta''(a)}{\zeta'(x)} + \frac{dx}{da}\left(\psi'(a) - \psi(a)\cdot\frac{\eta'(a)\,\zeta''(x)}{(\zeta'(x))^2}\right) < 0.$$

Inserting $\frac{dx}{da}$ derived from (2) and rearranging give

$$\psi''(a)\,x^2 + \frac{\psi'(a)\,\eta'(a)\,x + \psi(a)\,\eta''(a)\,x}{\zeta'(x)} + \frac{\eta'(a)}{\zeta'(x)}\left(\psi'(a)\,x - \frac{\psi(a)\,\eta'(a)}{\zeta'(x)}\cdot\frac{\zeta''(x)\,x}{\zeta'(x)}\right) < 0.$$

This is fulfilled if

$$\psi'(a)\,x - \frac{\psi(a)\,\eta'(a)}{\zeta'(x)}\cdot\frac{\zeta''(x)\,x}{\zeta'(x)} > 0.$$

It is seen from (3) that the assumption $\frac{\zeta''(x)x}{\zeta'(x)} > -1$ is sufficient to ensure that this is satisfied for (x_A, a_A) which is then the unique solution to the maximisation problem.

A.1.2 Pay-per-view

Setting up the Hessian matrix gives

$$\begin{pmatrix} \Pi_{xx} & \Pi_{xa} \\ \Pi_{xa} & \Pi_{aa} \end{pmatrix} = \begin{pmatrix} 2\zeta'(x) + \zeta''(x)\,x & -\eta'(a) + \psi'(a) \\ -\eta'(a) + \psi'(a) & -\eta''(a)\,x + \psi''(a)\,x \end{pmatrix}.$$

Using the first order conditions, we have

$$\begin{pmatrix} \Pi_{xx} & \Pi_{xa} \\ \Pi_{xa} & \Pi_{aa} \end{pmatrix} = \begin{pmatrix} 2\zeta'(x_P) + \zeta''(x_P)\,x_P & 0 \\ 0 & -\eta''(a_P)\,x_P + \psi''(a_P)\,x_P \end{pmatrix},$$

yielding the conditions

$$2\zeta'(x_P) + \zeta''(x_P)\,x_P < 0,$$

$$-\eta''(a_P) + \psi''(a_P) < 0.$$

The assumption $\frac{\zeta''(x)x}{\zeta'(x)} > -1$ is sufficient to ensure that the first condition is fulfilled whereas the second is fulfilled by the properties of the functions $\eta(\cdot)$ and $\psi(\cdot)$. Thus, provided that there is an interior point satisfying the first order conditions, we know that this is the unique solution to the maximisation problem.

A.1.3 Social Planner

From (7), we get the following second order condition

$$\begin{aligned} W_{aa} &= \frac{\eta''(a)\psi(a) + \eta'(a)\psi'(a)}{\zeta'(x)} + (\psi''(a) - \eta''(a))x \\ &\quad - \left(\frac{\zeta''(x)\eta'(a)\psi(a)}{[\zeta'(x)]^2} - \psi'(a) + \eta'(a)\right)\frac{dx}{da}. \end{aligned}$$

After inserting $\frac{dx}{da}$ derived from (8), the second order condition $W_{aa} < 0$ states

$$\begin{aligned} 0 &> \frac{\eta''(a)\psi(a)x + \eta'(a)\psi'(a)x}{\zeta'(x)} + \psi''(a)x^2 - \eta''(a)x^2 \\ &\quad + \left(\psi'(a)x - \frac{\eta'(a)\psi(a)}{\zeta'(x)}\frac{\zeta''(x)x}{\zeta'(x)} - \eta'(a)x\right)\frac{\eta'(a)}{\zeta'(x)}, \end{aligned}$$

which is fulfilled if

$$(\psi'(a) - \eta'(a))x - \frac{\eta'(a)\psi(a)}{\zeta'(x)}\frac{\zeta''(x)x}{\zeta'(x)} > 0.$$

It is seen from (9) that the assumption $\frac{\zeta''(x)x}{\zeta'(x)} > -1$ is sufficient to ensure that this is satisfied for (x_S, a_S) which is then the unique solution to the maximisation problem.

A.2 Second Degree Price Discrimination

Assume that IC and PC are binding. Rewriting these constraints using the specific functional forms yields

$$x_1 = \frac{\alpha}{\beta} - \frac{p + \gamma(a_1^2 - a_2^2)}{(1-\lambda)\beta}, \tag{15}$$

$$x_2 = \frac{p + \gamma(a_1^2 - a_2^2)}{(1-\lambda)\beta} - \frac{\gamma a_2^2}{\lambda\beta}. \tag{16}$$

Inserting these conditions and the specific functional forms in the profit expression gives

$$\Pi(p, a_1, a_2) = (p + a_1)\left(\frac{\alpha}{\beta} - \frac{p + \gamma(a_1^2 - a_2^2)}{(1-\lambda)\beta}\right) + a_2\left(\frac{p + \gamma(a_1^2 - a_2^2)}{(1-\lambda)\beta} - \frac{\gamma a_2^2}{\lambda\beta}\right) - \Omega.$$

The first order conditions with respect to p, a_1, and a_2 equal

$$\Pi_p = \frac{\alpha}{\beta} - \frac{p + \gamma(a_1^2 - a_2^2)}{(1-\lambda)\beta} - \frac{p + a_1 - a_2}{(1-\lambda)\beta} = 0, \tag{17}$$

$$\Pi_{a_1} = \frac{\alpha}{\beta} - \frac{p + \gamma\left(a_1^2 - a_2^2\right)}{(1-\lambda)\beta} - 2\gamma a_1 \frac{p - a_2 + a_1}{(1-\lambda)\beta} = 0, \tag{18}$$

$$\Pi_{a_2} = \frac{\lambda p + \gamma\left(\lambda a_1^2 - 3a_2^2\right) + 2\lambda\gamma a_2 (p + a_1)}{\beta(1-\lambda)\lambda} = 0. \tag{19}$$

Substracting (18) from (17) gives the following solution for the advertising level in the first broadcast

$$a_1 = \frac{1}{2\gamma}, \tag{20}$$

which is identical to the advertising level with pay-per-view without price discrimination. Inserting this solution into (17) and (19) gives

$$p = \frac{1-\lambda}{2}\alpha - \frac{3}{8\gamma} + \frac{\gamma}{2}a_2^2 + \frac{1}{2}a_2, \tag{21}$$

$$p\left(\gamma a_2 + \frac{1}{2}\right) + \frac{a_2}{2} + \frac{1}{8\gamma} - \frac{3\gamma}{2\lambda}a_2^2 = 0. \tag{22}$$

Combining these two equations yields

$$8\lambda(\gamma a_2)^3 + 12(\lambda - 2)(\gamma a_2)^2 + [8\alpha\gamma(1-\lambda) + 6]\lambda(\gamma a_2) + (4\gamma\alpha(1-\lambda) - 1)\lambda = 0. \tag{23}$$

Solutions to a_1, a_2, x_1, x_2, and p are determined by (15), (16), (20), (21), and (23). Afterwards, total surplus under second degree price discrimination may be derived by inserting these solutions into

$$W_{2.} = \int_0^{x_1} \zeta(s)\,ds + \psi(a_1)x_1 - \eta(a_1)x_1 + \lambda\int_{x_1}^{x_1+x_2} \zeta(s)\,ds + \psi(a_2)x_2 - \eta(a_2)x_2,$$

where we, for simplicity, have assumed that $\tilde{\Omega} = 0$. After inserting specific functional this equals

$$\begin{aligned} W_{2.} &= (1-\lambda)\left(\alpha x_1 + \frac{1}{2}\beta x_1^2\right) + \left(a_1 - \gamma(a_1)^2\right)x_1 \\ &\quad + \lambda\left(\alpha(x_1 + x_2) + \frac{\beta}{2}(x_1 + x_2)^2\right) + \left(a_2 - \gamma(a_2)^2\right)x_2. \end{aligned} \tag{24}$$

Finally, relative total surplus is derived by

$$z(\alpha, \gamma, \lambda) = \frac{W_{2.}}{W_A}.$$

In order to compare $z(\alpha, \gamma, \lambda)$ and $z(\alpha, \gamma, 0)$ for different parameter values, the following Lemma is useful

Lemma 1 *$z(\alpha, \gamma, \lambda)$ is constant along a hyperbola $\gamma = \rho/\alpha$ for a given value of λ where ρ is a positive constant.*

Proof. For a given value of λ, we consider points in the parameter space lying on the hyperbola $\gamma = \rho/\alpha$ where ρ is a constant. It is easy to show from (20) and (23) that

$$a_1 = \alpha \cdot a_1(\rho, \lambda) \quad , \quad a_2 = \alpha \cdot a_2(\rho, \lambda).$$

From (15), (16), (21), and the above relationships, we get

$$p = \alpha \cdot p(\rho, \lambda),$$
$$x_1 = \frac{\alpha}{\beta} \cdot x_1(\rho, \lambda),$$
$$x_2 = \frac{\alpha}{\beta} \cdot x_2(\rho, \lambda).$$

Inserting into (24), we get

$$W_{2.} = \frac{\alpha^2}{\beta} \cdot W_{2.}(\rho, \lambda).$$

It follows directly from the solution of W_A in Section 4 that

$$\frac{W_{2.}}{W_A} = k(\rho, \lambda),$$

where $k(\rho, \lambda)$ is a constant. □

This lemma implies that we only need to compare $z(\alpha, \gamma, \lambda)$ and $z(\alpha, \gamma, 0)$ for $\alpha = \gamma$ and a given value of λ. Unfortunately, it is impossible to find closed form solutions to equation (23). Therefore, Figure 2 is made by first solving for a_2 for a given set of parameters using Mathematica. Afterwards, the solutions to the other variables are found using (15), (16), (20), and (21). Finally, $z(\alpha, \gamma, \lambda)$ is calculated using the above formulas.

To be a solution the following must be satisfied (i) $p \geq 0$ and (ii) $\Pi_{2.} \geq \Pi_P$. If the first constraint is binding, the solution is identical to the pure advertising solution. This corresponds to the horizontal line at 1 starting the curves in Figure 2. If the second condition is binding, the solution is identical to the pay-per-view solution without price discrimination. This occurs to the right of the intersections between the dashed curves and the solid curve.

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Figure 1a. Comparing the number of viewers.

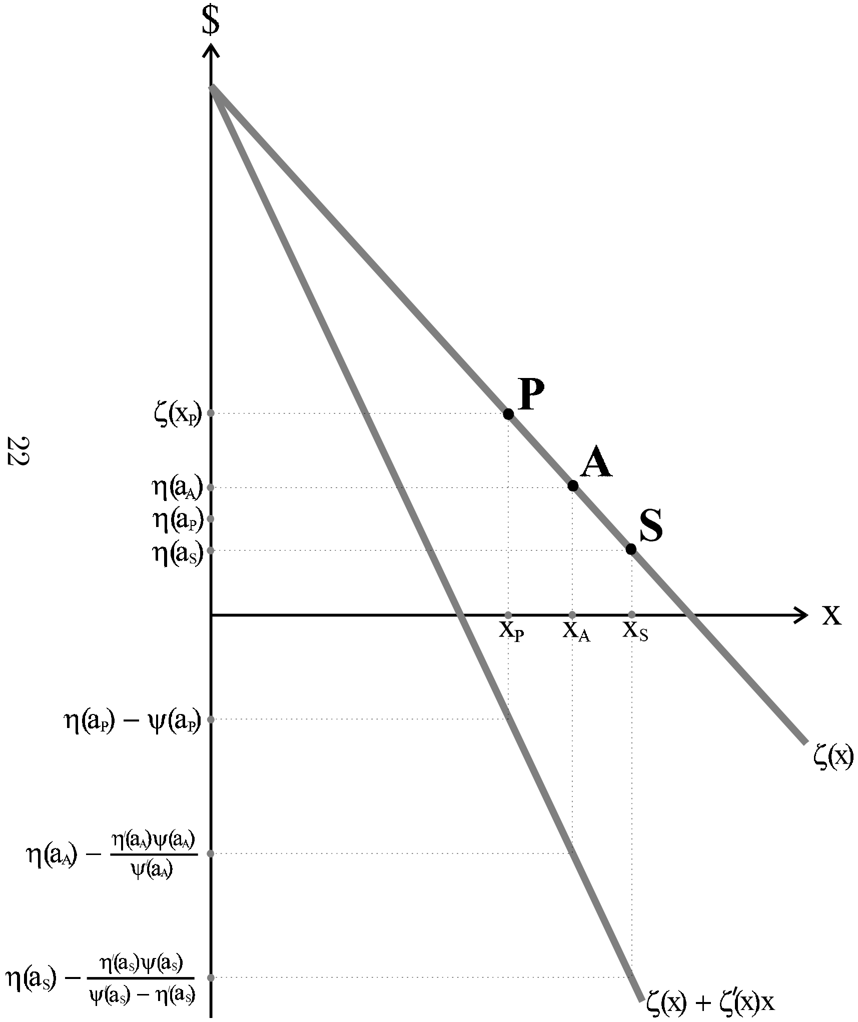

Figure 1b. Comparing advertising levels.

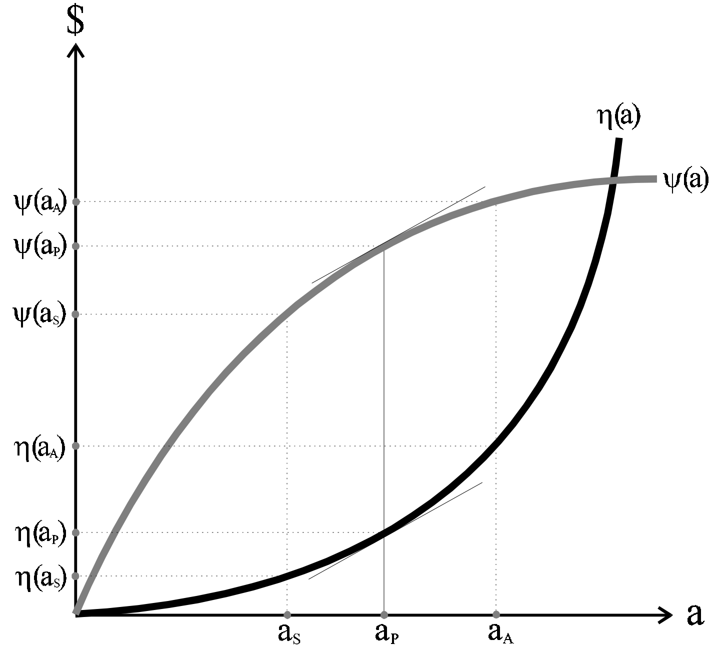

Figure 2
Pay-per-view vs. Advertising with Standard Price Setting and Second Degree Price Discrimination