The Regulation of Audiovisual Content:
Quotas and Conflicting Objectives

by

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Abstract

Governments use a range of instruments to influence radio and television content. The paper finds that under conditions that one could hardly describe as exceptional, content measures designed to increase the demand for certain programs by cable or satellite distributors will, paradoxically, reduce the size of the audience that is likely to watch such programs. Likewise, it finds that quotas, which at face value appear designed to boost the audience of certain programs, may have the opposite effect. They can also lower the total number of such programs purchased or produced by a cable or satellite operator.

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1. Introduction

Regulators use a range of instruments to influence radio and television content. Some impose minimum quotas on the amount of time allocated to programs such as news and current affairs; others set maximum quotas on hours devoted to programs such as sports and variety shows. As well, regulators may set guidelines in regard to regional diversity and original content. They often limit commercials time and the frequency of program interruptions by commercial messages. Regulators may also constrain the packaging of channels by cable and satellites operators. For example, they may require distributors to include local channels in a basic package or exclude them.[1]

The defense of content rules rests on several claims. The paternalistic justification is based on the twofold argument that the audience's tastes in audiovisual matters are not up to scratch, and that the fitting response to that shortcoming is intervention by a well-meaning regulator. A related claim is that, absent regulation, broadcasters devote excessive time to programming with mass-appeal and that this "failure" ought to be corrected by forcing them to cater to the minority with more refined tastes. A third argument is that consumer externalities are significant in television. Programs such as public affairs are deemed to contribute to society while others - with violent content perhaps – have an adverse effect on society. If so, "good" programming deserves encouragement at the expense of "bad" programming.

Policies that support the distribution of domestically produced programming rest on similar grounds. Locally produced programs are viewed as merit goods because they promote the national culture and strengthen the national identity. Intervention is justified because the public is unwilling to pay what policy makers think is appropriate to obtain the social benefits from home-grown productions. Content regulation is also the object of denigration. Opponents of content regulation argue that it is a disguised make-work measure for the benefit of a few home-based groups that inspire voters and therefore enjoy disproportionate clout with politicians.[2]

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[1] This obligation applies to cable distributors in Canada. The trade issues that local content regulation raises in Australia are discussed in Allens Arthur Robinson (2004). An economic analysis of must-carry rules as they apply to the US can be found in Chae (1998) and Vita (1997). For an analysis of bans on pay-per-view broadcast of certain events in the EU, see Hansen and Kyhl (2001).

[2] See e.g. Stanbury (1996)

Content protection has been the object of passionate debates. From an economist's perspective, it is best to regroup the issues under the following headings: (i) Are the policy goals spelled out in law or regulations sensible from a welfare point of view ? (ii) Do the very specific content rules perform satisfactorily in terms of achieving the intended goals, regardless of the merits of these goals? [3]

This paper is concerned with the latter question. It starts from the premise that much content regulation is inspired by two objectives. First, to increase the production of programs deemed to have particular merit. Second, to increase the size of the audiences that watch these programs. It is in terms of these objectives that the paper assesses the impact of content rules. We show that content measures designed to increase the demand for certain programs will, paradoxically, reduce the size of the audience likely to watch them. We also find that quotas designed to boost the audience of programs may have the opposite effect. These quotas may also lower the number of such programs purchased by distributors.

Section 2 sets out the basic assumptions of a model in which all television is subscriber-supported. A monopolistic firm - cable or satellite operator - faces the following problem: (1) How to allocate a given number of channels to different types of content; (2) how to bundle these channels into packages targeted at subscribers; specifically how many optional packages to offer in addition to the basic service, and how many channels to include in each package; (3) how much content of each type to include in each package; (4) how to price each package. Sections 2.2 and 2.3 present an intuitive solution for the case of a firm not constrained by content regulation.[4] They provide the baseline against which quota-constrained outcomes are set. Section 3 explores the effects of two different content rules. The first rule forces the service provider to devote a minimum number of channels to programming of a particular type. The second rule forces the distributor to include in the basic package a minimum number of channels devoted to a specific type of programming. A final section discusses the results and looks at possible extensions.

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[3] A summary of the directives on the Audiovisual Policy of the European Union can be found in European Commission (1998). Australian television regulation is examined in Brown and Cave (1992); Canadian domestic content rules are discussed in Schultz (1996) and Stanbury (1996).

2. The model

2.1. Assumptions

Programming is distributed by a single firm, a cable or satellite operator. The total number of channels available to that operator - denoted x - is determined by technology. Each channel is devoted entirely to one or the other of the following program types: sports and documentaries. The cost of acquiring and distributing programming is zero[5].

The audience, whose size is given, is assumed to appreciate variety in programming. Specifically, the utility derived by each viewer from access to any given number of channels, is higher when some of the channels are devoted to sports and others to documentaries, than when all channels are devoted to the same content. Individual preferences have the form $V[\theta_i;\ s_i,\ d_i] = \theta_i\ u(s_i)+(1-\theta_i\ )u(d_i)$ where s_i and d_i respectively denote the number of sports and documentary channels to which the viewer i has access. The parameter $\theta_i \in [0,1]$ captures the inclination of viewer i towards sports relative to documentaries. The function $u(.)$ is strictly increasing and concave, and $u(0) = 0$.

These assumptions carry the following implications

1) $sign\dfrac{\partial V}{\partial \theta_i} = sign(s_i - d_i)$ (1a)

2) $V[\theta_i\ ;s_i,\ d_i]$ attains a maximum at s_i* and d_i* that satisfied the first order condition $u'(s_i*) / u'(d_i*) = (1-\theta_i) / \theta_i$, where $s_i* + d_i* = x$. (1b)

3) $F(\theta) \equiv V[\theta; s*(\theta)\ , d*(\theta)]$ is convex, its minimum is at $\theta = 1/2$ (1c)

We specialize the model by assuming that there are two classes of viewers/consumers. Class 1 has preference index θ_1 and class 2 has index θ_2, with $\theta_1 > \theta_2$. The proportion of the audience belonging to class 1 is α. The firm knows the values θ_1, θ_2 and α, but it does not know to which class an individual member of the audience belongs.

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[4] A formal analysis appears in Crampes and Hollander (2004).

[5] These two assumptions are not critical and facilitate both reasoning and presentation.

With p_1 and p_2 denoting the prices for access to the bundles targeted at classes 1 and 2 respectively, the firm's profit function can be written $\Pi = \alpha p_1 + (1- \alpha) p_2$. Maximization requires that the seller determine the following: How many channels to allocate to sports and how many to documentaries? Whether to sell the same bundle to the two groups or to target a different bundle at each group? In the latter case, how many sports channels and how many documentary channels to include in each bundle. Finally, how to set the price of the single bundle, or the two bundles?

With s and d denoting the total number of channels allocated to sports and documentaries, and s_i and d_i denoting the number of channels in each category found in the package targeted at group i, $i=\{1,2\}$, profits are maximized subject to the constraints (2)-(4) below:

1) Technical constraints

$$s_i \leq s, \qquad d_i \leq d, \qquad s + d \leq x, \qquad i = 1,2 \tag{2}$$

2) Participation constraints

$$V[\theta_i\,; s_i, d_i] - p_i \geq 0 \qquad i = 1,2 \tag{3}$$

3) Self-selection constraints

$$V[\theta_i; s_i, d_i] - p_i \geq V[\theta_i; s_j, d_j] - p_j \qquad i\,, j=1,2 \text{ and } i \neq j \tag{4}$$

The maximization above does not presuppose that the seller offers two distinct bundles. Indeed, $s_1 = s_2$, $d_1 = d_2$ and $p_1 = p_2$ is a feasible outcome. Also, no constraint is violated by setting $s_i = d_i = p_i = 0$, as there is no obligation to sell to both classes.

We derive first the optimal number of bundles, the composition of each bundle and prices as functions of α, θ_1, θ_2, for a *given* channel allocation (s, d). We then determine the allocation of channel capacity - i.e. the optimal s and d.

2.2. Bundle composition and prices for given channel allocation s and d.

Consider first bundle composition for the particular case where the capacity allocation has $s < d$. Because class *2* viewers are more inclined towards documentaries than class 1 viewers, they are willing to pay a higher price than class 1 members for the bundle that contains all the channels. For that reason, it is natural to take as a starting point a hypothetical offer under which a bundle containing all the channels is targeted at class 2, and an empty bundle containing zero channels is targeted at class 1. The profit maximizing prices associated with such offer are

$$p_1 = V(\theta_1;0,0) = 0 \qquad \text{and} \qquad p_2 = \theta_2\, u(s) + (1\text{-}\theta_2)\, u(d) \equiv V(\theta_2; s, d)\,.$$

These prices satisfy (2)-(4) and yield a profit equal to $(1\text{-}\alpha)\, p_2$.

We now perturb this offer in the following way: we maintain bundle composition and price in regard to class *2* and we target at class 1 a different bundle, made up of an equal number of sports and documentary channels.

Let z denote the number of channels of each type included in the revised bundle aimed at class 1. Clearly, one must have $z \leq s < d$. Because $V[\theta_1; z, z] = V[\theta_2; z, z] = u(z) < V[\theta_2; s, d]$, it must be true that selling the smaller bundle at a price $p_1 = u(z)$ does not prompt class *2* consumers to switch to the smaller bundle[6]. Therefore, the additional profits obtained by changing the composition of the smaller bundle are $\alpha\, p_1 = \alpha\, u(z)$. Because prices can still be chosen to satisfy the constraints (3) and *(4)*, profit maximization calls for the highest feasible z, i.e. $z = s$.

Note that the profits obtained from selling an equal number of sports and documentary channels to class 1 are higher than the profits derived from the sale to class 1 of any bundle that has $d_1 < s_1$ or $s_1 < d_1$. To see this, start from any hypothetical solution where $s_1 = d_1$ and examine first how profits change when d_1 is reduced. It is clear that lowering d_1 forces the distributor to lower p_1 in order to satisfy the participation constraint of class 1. No change in p_2 is required because, even with p_1 lower than before, class 2 consumers derive negative surplus from a purchase of the bundle targeted at class 1. Because p_1 is now lower and p_2 is the same as before, profits are lower than under the offer where $s_1 = d_1$.

Consider next the case where, starting from $s_1 = d_1$, one reduces the number of sports channels contained in the bundle targeted at class 1 Clearly, p_1 must fall in response to such reduction. Because the bundle targeted at class 1 now counts fewer sports

[6] Class 2 consumers would in fact obtain zero surplus regardless of the bundle they subscribe to.

channels than documentary channels, the lower p_1 would bring about a switch by class 2 consumers towards the bundle targeted at group 1 if p_2 were left unchanged. The reason is that class 1 members have a greater appreciation for sports than class 2 members. Therefore, the fall in p_1 is larger than the loss in utility that class 2 would suffer as a result of the reduction of the number of sports channels in the small bundle, *if* it actually subscribed to that bundle. To prevent a switch by class 2, p_2 must be reduced. Because p_1 and p_2 are now smaller, profits are lower than under the offer where $s_1 = d_1$.

The conclusion is that a 2-bundle offer, with composition ($s_1 = d_1 = s$) and ($s_2 = s < d_2 = d$) yields higher profits than any alternative that has $s_1 < s$ or $d_1 < s$. For such 2-bundle offer, the optimal p_2 insures that the self-selection constraint of class 2 is binding and that the participation constraints of *both* classes hold with equality.

Still to be investigated, is the question whether profits can be made larger by expanding the bundle targeted at class 1, i.e. by setting $d_1 > s$ while maintaining $s_1 = s$. In this regard, one notes that the increase in p_1 that accompanies an increase in d_1 is $\partial V(\theta_1; s_1, d_1)/\partial d_1 = (1-\theta_1)\, u'(d_1)$.[7] Because this increase in p_1 is less than the gain in utility that class *2* consumers would derive from switching to the smaller bundle, the price p_2 must be lowered to prevent a switch by class 2 to the bundle targeted at class 1. The required reduction in p_2 is $[(1-\theta_1) - (1-\theta_2)]\, u'(d_1)$, where the term $(1-\theta_1)\, u'(d_1)$ stands for the increase in p_2 made possible by the increase in p_1, and the term $(1-\theta_2)\, u'(d_1)$ represents the decrease in p_2 necessary to compensate class 2 subscribers for the larger number of documentary channels to which they have access when subscribing to the (smaller) bundle targeted at class 1. The net effect on total profits of these changes in p_1 and p_2 is therefore $u'(d_1)\,\Delta$, where $\Delta \equiv \{(1-\theta_1) - (1-\alpha)(1-\theta_2)\}$.

The implication is that an expansion of the number of documentary channels included in the bundle targeted at class 1 beyond $d_1 = s$ reduces profits when $\Delta < 0$. However, when $\Delta > 0$, profits are enhanced when d_1 is increased and they attain a maximum for $d_1 = d$. The outcome then is a single bundle targeted at both classes and $p_1 = p_2$.

[7] The latter is true because the participation constraint of class 1 is binding.

Yet to be established, is the fact that selling a bundle containing all the channels to group 2 is indeed profit maximizing when $s < d$. To see this, consider any alternative offer having $s_2 < s$ and/or $d_2 < d$. It is obvious that under such offer, p_2 has to be smaller than for an offer where $s_2 = s$ and $d_2 = d$. This means in particular that an offer of a bundle targeted at class 2 that would include less than the total number of channels could be more profitable than offering a bundle including all channels only if it allows a higher p_1.

To examine whether such thing is possible, consider first the following offer: $d_2 < d$ and $s_2 = s$. Clearly, such offer would entail a lower p_2 than an offer having $d_2 = d$. The lower p_2 may - if d_2 is significantly smaller than d - bring about a decrease in p_1 but it can never yield an increase in p_1. Thus, total profits could not increase above those derived from when $s < d$. Using a similar argument one shows that a bundle $d_2 = d$ and $s_2 < s$ cannot yield higher profits than the bundle $d_2 = d$ and $s_2 = s$.

The conclusion is that for all $s < d$ the solution is either $s_1 = s_2 = s$ and $d_1 = d_2 = d$ or $s_1 = s_2 = s = d_1$ and $d_2 = d$. A similar analysis applies to the cases $s = d$ and $s > d$ with results summarized below:

Proposition 1

i) For all channel allocations where $d > s$, a single bundle is offered at the price $p = V(\theta_1; s, d)$ when $\Delta \equiv (1-\theta_1) - (1-\alpha)(1-\theta_2) \geq 0$. Two bundles are offered when $\Delta < 0$, the larger bundle containing s sports and d documentary channels, the smaller bundle containing s sports and s documentary channels. Class 2 subscribes to the large bundle at the price $p_2 = V(\theta_2; s, d)$; class 1 subscribes to the small bundle at the price $p_1 = V(\theta_1; s, s) = u(s)$.

ii) For the channel allocation $s = d$, a single bundle is offered at $p = u(x/2)$

iii) For all channel allocations $d < s$, the firm offers a single bundle at the price $p = V(\theta_2; s, d)$ when $\Gamma = \theta_2 - \alpha\theta_1 \geq 0$. It offers two bundles when $\Gamma < 0$, the larger bundle containing s sports and d documentary channels, the smaller bundle containing d sports and d documentary channels. Class 1 subscribes to the large bundle at the price $p_1 = V(\theta_1; s, d)$; class 2 subscribes to the small bundle at the price $p_2 = V(\theta_2; d, d) = u(d)$.

An implication of Proposition 1 is that when $s < d$, profits under a 2-bundle offer are

$$\alpha u(s) + (1-\alpha)[\theta_2 u(s) + (1-\theta_2)u(d)] = [1-(1-\alpha)(1-\theta_2)]u(s) + (1-\alpha)(1-\theta_2)u(d)$$

i.e., they are equal to the profits derived from the sale of a single bundle having *d* documentary channels and *s* sports channels to a "virtual consumer" with preference index $\theta_v = 1-(1-\alpha)(1-\theta_2)$. Thus, in order to compare the profits obtained from a 2-bundle offer with the profits from a 1-bundle offer, one should set the willingness to pay for the single bundle of class 1, against the willingness of the virtual consumer to pay for that very same bundle.[8]

A similar analysis can be conducted for the case $s > d$. It will show that there exists a virtual consumer indexed $\theta_w \equiv \alpha\theta_1$ such that profits derived from the sale of a single bundle containing all channels to that consumer are equal to those obtained from the sale of the bundle $s_2 = d_2 = d$ to class 2 and of the bundle $d_1 = d$, $s_1 = s$ to class 1.[9]

2.3. Choosing a capacity allocation

So far, we have established only how for *given s* and *d,* the number of bundles and their composition are determined as functions of preference parameters. The question to be addressed now, is how *s* and *d* themselves are chosen.

Consider Figure 1 which displays the functions $V_1 \equiv V(\theta_1; s, d)$, $V_2 \equiv V(\theta_2; s, d)$ and $V_v \equiv V(\theta_v; s, d)$ for the particular case where $\theta_2 < \theta_1 < 1/2$.

[insert Figure 1]

It is apparent from Figure 1 that the optimal number of sports channels is given by

$$s^* = \begin{cases} \text{argmax } V(\theta_1; s, x\text{-}s) & \text{when } \Delta \geq 0 \quad \text{[Fig.1a]} \\ \text{argmax } V(\theta_v; s, x\text{-}s) & \text{when } \Delta < 0 \quad \text{[Fig. 1b]} \end{cases}$$

Similarly, for the case $½ < \theta_2 < \theta_1$, the optimal capacity allocation is

$$s^* = \begin{cases} \text{argmax } V(\theta_2; s, x\text{-}s) & \text{when } \Gamma \geq 0 \\ \text{argmax } V(\theta_w; s, x\text{-}s) & \text{when } \Gamma < 0 \end{cases}$$

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[8] It also follows that when $s < d$, it must be true that $sign\ [V(\theta_1; s, d) - V(\theta_v; s, d)] = sign\ [\theta_v - \theta_1]$. Note that $\Delta = \theta_v - \theta_1$.

[9] Note that terms "small" and "large" used to describe the bundles, could be replaced by the terms "basic" and "optional" since in equilibrium one bundle is fully contained in the other. The price of the optional service would then equal the difference in price between the two bundles. For expository

When $\theta_2 < 1/2 < \theta_1$, profit maximization requires $s = d = x/2$ if a single bundle is offered to subscribers. The profits derived from such offer are equal to $u(x/2)$. To determine whether a 1-bundle offer is indeed optimal, $u(x/2)$ must be set against the profits derived from the following configurations: (i) $s > d$ and 2-bundle offer; (ii) $s<d$ and a 2-bundle offer. In this regard, note from (1c) that $\theta_v < 1/2$ [or, equivalently, $\theta_2 < (1-2\alpha) / 2(1-\alpha)$] is a necessary and sufficient condition for alternative (ii) to yield profits in excess of $u(x/2)$ [10]. Similarly, the solution (i) yields profits larger than $u(x/2)$ if and only if $\theta_w > 1/2$, that is iff $\theta_1 > 1/2\alpha$. In summary:

Proposition 2

i) For $\theta_2 < \theta_1 < 1/2$, optimal channel allocation requires $s^* < d^* = x - s^*$ where

$$u'(s^*)/u'(d^*) = \begin{cases} \dfrac{1-\theta_1}{\theta_1} & \text{for } \Delta \geq 0 \quad (\text{1–bundle}) \\[2ex] \dfrac{(1-\alpha)(1-\theta_2)}{1-(1-\alpha)(1-\theta_2)} & \text{otherwise} \quad (\text{2–bundle}) \end{cases}$$

ii) For $1/2 < \theta_2 < \theta_1$ the optimal channel allocation has $s^* > d^* = x - s^*$ where

$$u'(s^*)/u'(d^*) = \begin{cases} \dfrac{1-\theta_2}{\theta_2} & \text{for } \Gamma \geq 0 \quad (\text{1–bundle}) \\[2ex] \dfrac{1-\alpha\theta_1}{\alpha\theta_1} & \text{otherwise} \quad (\text{2–bundle}) \end{cases}$$

iii) For $\theta_2 < 1/2 < \theta_1$, the optimal channel allocation satisfies

$$\frac{u'(s^*)}{u'(d^*)} = \begin{cases} \dfrac{1-\alpha\theta_1}{\alpha\theta_1} & \text{for } \alpha > \dfrac{1}{2\theta_1} \quad \text{yielding } s^* > d^* \quad (\text{2–bundle}) \\[2ex] 1 & \text{for } \dfrac{1}{2\theta_1} > \alpha > \dfrac{1-2\theta_2}{2(1-\theta_2)} \quad \text{yielding } s^* = d^* \quad (\text{1–bundle}) \\[2ex] \dfrac{(1-\alpha)(1-\theta_2)}{1-(1-\alpha)(1-\theta_2)} & \text{for } \alpha < \dfrac{1-2\theta_2}{2(1-\theta_2)} \quad \text{yielding } s^* < d^* \quad (\text{2–bundle}) \end{cases}$$

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purposes we find it more convenient to continue using the terms "small" and "large" rather than "basic" and "optional".

[10] Note that whenever an allocation $s < d$ yields higher profits than $s = d = x/2$ with $\theta_v < 1/2$, it also yields higher profits than an allocation where $s > d$.

Proposition 2 states that whenever profit maximization requires a 2-bundle offer, channel allocation is tailored to the preferences of a "virtual" consumer. The preference parameter of that consumer is different from those of class 1 and class 2 consumers. It is a function of the θ of the class purchasing the larger bundle *and* of the proportion of the viewing public represented by that class. This result is unlike that found in standard models [e.g. Maskin and Riley (1984) and Corts (1995)] where the specification of the product targeted at the group with the highest willingness to pay is chosen to maximize the contribution to total profits made by that group.[11]

Figure 2 displays the different equilibria associated with different θ_1, θ_2 and α. In the areas I_a, I_b and I_c, a single bundle is sold to both groups. Specifically, in area I_a we have $s^* > d^*$ with programming tailored to the tastes of group 2; in area I_b, we have $s^* < d^*$ with programming tailored to the tastes of group 1. In area I_c we have $s^* = d^* = x/2$. By contrast, in area *II (III)*, type 2 receives a small (large) bundle and type 1 receives a large (small) bundle.

[Insert figure 2]

3. Content regulation

We examine first the effects of an obligation to allocate a minimum number of channels to documentaries, $d \geq d^r$. Then, we look at a regulation requiring that each bundle offered to subscribers contain no less than a prescribed number of documentary channels, $\min(d_1, d_2) \geq d^r$.

3.1. A quota on the allocation of capacity: $d \geq d^r$

Consider first the case where $d^* < s^*$ in the absence of the constraint.[12] Note first, that when $d^* < s^*$, the content constraint may be binding even for $d^r < x/2$. Imposing such constraint brings about an upward adjustment of the number of documentary channels until $d = d^r$. Because the sign of Γ does not depend on the value of *d,* it

[11] A result usually referred to as non-distortion at the top.

[12] Recall that this outcome entails an equal number of documentary channels offered to both groups, regardless of whether the outcome is a 1-bundle or a 2-bundle offer.

follows from part (iii) of Proposition 1, that the optimal number of bundles remains the same as for the non-constrained equilibrium.

For $d^r > x/2$ by contrast, it follows from part (i) of Proposition 1 that the sign of Δ determines whether profits are higher under a 1-bundle or a 2-bundle offer. To examine the range of possibilities we turn again to Figure 2 which displays the locus of points for which $\Delta = 0$, i.e. the locus of preference parameters θ_1 and θ_2 for which the optimal 1-bundle offer yields the same profits as the optimal 2-bundle offer.

Figure 2b, shows the line $\Delta = 0$ going through T. Preference parameters located to the right of that line yield $\Delta < 0$ implying that a 2-bundle offer yields the highest profits. Conversely, a 1-bundle offer is optimal for all points to the left of the line. This means that for preference parameters in areas I_b and *III* the optimal number of bundles in the constrained case is the same as in the non-constrained case. Areas I_a and I_c by contrast, are crossed by the line $\Delta = 0$. The implication is that imposing the constraint will, for some preference parameters, bring about a switch away from a 1-bundle towards a 2-bundle configuration. The effect of an increase in d^r will therefore be a reduction in the number of documentary channels included in the small bundle.

Consider now Figure 2a. As drawn, the line $\Delta = 0$ divides the areas I_a, I_c and *II*. This is only one of three possible configurations. When α is only slightly larger than 1/2, the whole area *II* is located to the right of $\Delta = 0$. For $\alpha > 1/2$, all of area I_c is located to the left of $\Delta = 0$. This means that for $\alpha > 1/2$, the constraint may bring about a switch from a 1-bundle to a 2-bundle configuration, but also from a 2-bundle to a 1-bundle configuration. Again, we note that a switch away from the 1-bundle configuration brings about a decrease in the number of documentary channels included in the basic service.

The effects of the constraint are rather different when preference parameters are in area *II*. In the absence of a constraint the equilibrium has $s^* = s_1 > s_2 = d_1 = d_2 = d^*$. The effect of the content quota may be a switch to a 1-bundle configuration or, to a configuration with 2 bundles that differ from each other in regard to the number of documentary channels rather than in the number of sports channels.

At this point, one can also address the question how the total number of documentary channels being subscribed to is affected by the constraint. Let that number be denoted Y where $Y \equiv \alpha d_1 + (1-\alpha)d_2$. Note first that when profit maximization entails a 1-bundle offer in the non-constrained as well as the constrained case, Y must increase when a binding constraint is imposed because a 1-bundle offer always entails $Y = d$. Consider next the case where the non-constrained configuration has $d_2^* > d_1^*$. Because the 2-bundle configuration is maintained when the constraint is imposed, any increase in d_2 must be matched by an equal decrease in $d_1 = s$. But, because $\alpha < 1/2$, it follows that Y increases as d^r increases.

Things are more complicated when the constraint brings about a switch from a 1-bundle to a 2-bundle solution. Consider area I_c and recall that any increase in the number of documentaries included in the large bundle is matched by a decrease of an equal number of documentary channels in the smaller bundle. Therefore, the effect of the constraint is to increase Y when $\alpha < 1/2$ and to decrease Y when $\alpha > 1/2$.

For θ's belonging to area I_a, when the constrained solution is a 2-bundle offer, the effects on Y are as follows: Increases in d^r which maintain $d^r < x/2$, increase Y. Increases in d^r, where $d^r \in [x/2, x]$, lead to a further increase in Y when $\alpha < 1/2$. When $\alpha > 1/2$, they lower Y. The conclusion is therefore that imposing the constraint always raises Y when $\alpha < 1/2$, but, when $\alpha > 1/2$, Y may increase or decrease. The latter outcome is more likely, when d^r is very large and the number of documentary channels offered in the non-constrained solution is close to $x/2$.

The same ambiguous effect on Y shows up when the θ's belong to area II. As long as $d^r < x/2$, tightening the constraint increases Y. However a further tightening lowers Y since $\alpha > 1/2$. In summary:

Proposition 3

Imposing a minimum quota on the number of channels to be allocated to documentaries may bring about a switch from a 1-bundle to a 2-bundle regime or vice versa. When the constrained optimum is a 2-bundle offer, the number of documentary channels included in the basic service may be lower than in the non-constrained equilibrium. The total number of documentary channels the public subscribes to may fall when the quota is imposed.

3.2. The basic package must contain a minimum number of documentary channels: $\min(d_1, d_2) \geq d^r$

The qualitative effects again depend on preference parameters and on the number of viewers of each type. Consider the following cases[13]:

Case (i) $d_2^* > d^r > d_1^*$

Case (ii) $d^r > d_2^* \geq d_1^*$

Under case (i), the constraint can be met without changing the channel allocation of the non-constrained solution. Case (ii) requires a change in channel allocation.

Case (i): $d_2^* > d^r > d_1^*$

Because an allocation $d_2 > d_1$ entails prices that leave group 1 with zero surplus [see part (i) of Proposition 1], conditions (3) and (4) can be rewritten [14]

$$\theta_1 u(s_2) + (1-\theta_1)u(d_2) \leq p_2 \leq \theta_2 u(s_2) + (1-\theta_2)u(d_2) + \min[0, (\theta_1-\theta_2)(u(s_1)-u(d_1)] \quad (5)$$

As profits are increasing in prices, the optimal p_2 must be equal to the upper bound of the feasible interval. Hence, $\Pi = \alpha p_1+(1-\alpha)p_2$ can be restated as

$$\Pi = \alpha[\theta_1 u(s_1)+(1-\theta_1)u(d_1)]+(1-\alpha)[\theta_2 u(s_2)+(1-\theta_2)u(d_2)+\min[0,(\theta_1-\theta_2)(u(s_1)-u(d_1)] \quad (6)$$

Bundle composition is now chosen subject to the following constraints

$s_1 \leq s$ $\quad s_2 \leq s,$ $\quad d_2 \leq d$ $\quad$ and $\quad d \leq x-s$

[13] We know from Proposition 2 that $d_1^* > d_2^*$ is not possible.

[14] Recall that for group 1 the participation constraint is binding when $s_1 \geq d_1$ and the self-selection constraint is binding for $s_1 \leq d_1$.

Because profits are increasing in s_2, d_2 and d, the last three of the above constraints are binding. Also, because the self-selection constraint of class 2 can only be met for $s_1 \le d_1 = d^r$, the objective function can be rewritten

$$\Pi^r(d^r) = \theta_1 u(s) + (1-\alpha)(1-\theta_2)u(x-s) + [(1-\theta_1)-(1-\alpha)(1-\theta_2)]u(d^r) \qquad (7)$$

This function is to be maximized with respect to s, subject to $s \le d^r$. The non-constrained maximum is attained at $\tilde{s}$ and $\tilde{d}$, where

$$\frac{u'(\tilde{s})}{u'(\tilde{d})} = \frac{(1-\alpha)(1-\theta_2)}{\theta_1}. \qquad (8)$$

The solution to the constrained problem is therefore

$$s = \begin{cases} \tilde{s} \text{ if } \tilde{s} \le d^r \\ d^r \text{ otherwise} \end{cases}$$

Figure 3 displays a collection of functions $\Pi^r(d^r)$.[15] A larger d^r yields a curve closer to the horizontal axis.

[insert Figure 3]

The qualitative nature of the solution depends on the value of d^r. For $d^r \le \tilde{s}$, the bundle composition is $s_1 = s_2 = s = d^r > s_v$ and $d_2 = d = x - d^r$. Specifically, as d^r increases, the solution to the constrained maximization moves along the curve V_v displayed in Figure 3, as a movement from point A to point B. [16]As d^r increases further, it eventually enters an interval bounded from below by $\tilde{s}$ and from above by $\bar{d}$, such that for all $d^r \in (\tilde{s}, \bar{d})$, the channel allocation as well as the composition of the bundle targeted at class 2 remains $s = \tilde{s}$ and $d = \tilde{d}$.

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[15] It follows from the concavity of $u(.)$ and from $\Delta \equiv (1-\theta_1)-(1-\alpha)(1-\theta_2) \le 0$ that $\hat{s} > \tilde{s} > s_v$ where $\hat{s} = arg\,max\,V(\theta_1; s, x-s)$.

[16] Because the solution stays on V_v, the entire surplus is removed from consumers in both classes.

The upper bound $\bar{d}$ of the interval is the value of d^r for which the profits from the constrained 2-bundle offer and those from an optimal constrained 1-bundle are equal to each other. In the appendix it is shown that

$$\bar{d} \in \begin{cases} (\hat{d}, \tilde{d}) & \text{for} \quad \theta_2 < \theta_1 < \tfrac{1}{2} \quad \text{(9a)} \\ (x/2, \tilde{d}) & \text{for} \quad \theta_2 < \tfrac{1}{2} < \theta_1 \quad \text{(9b)} \end{cases}$$

where $\hat{d} = x - \hat{s}$ and $\hat{s} = argmax\ V(\theta_1; s, x\text{-}s)$

All increases in d^r within the interval ($\tilde{s}$, $\bar{d}$) are accompanied by increases in p_1 and decreases in p_2 that leave an increasing amount of surplus to class 2 subscribers. In Figure 3 the effect of increases in d^r in this interval are shown as a move from point B to point C.

At $d^r = \bar{d}$ the firm switches to a single bundle (point D) and, as d^r increases beyond $\bar{d}$ the equilibrium moves from point D towards E along V_1.

Case (ii): $d^r > d_2^* \geq d_1^*$

We examine separately the cases (i) $d_2^* > d_1^*$ and (ii) $d_2^* = d_1^*$.

(i) The non-constrained solution $d_2^* > d_1^*$ can arise only when $\theta_2 < \theta_1 < 1/2$ or, when $\theta_2 < 1/2 < \theta_1$.

In the former case $d_2^* > \bar{d} \in (\hat{d}, \tilde{d})$; in the latter $d_2^* > \bar{d} \in (x/2, \tilde{d})$. Therefore it must be true that the offer of a single bundle is optimal when the constraint is imposed.

(ii) Consider now the case where the non-constrained equilibrium has $d_2^* = d_1^*$. The question one must address is whether the constrained optimum always has the form $d = d^r = d_1 = d_2 > s = s_1 = s_2$ or, whether there exist parameter values for which a solution of the form $d = d_2 > d^r = d_1 > s = s_1 = s_2$ yields higher profits? To answer this question, consider the 1-bundle offer of the form $d = d^r = d_1 = d_2 > s = s_1 = s_2$ and examine if a perturbation of that offer which increases d_2 and lowers s_1 and s_2 by an equal amount could increase total profits. Specifically, verify whether there exists a $\varepsilon > 0$ for which

$$\frac{\partial \Pi}{\partial \varepsilon} = (1-\alpha)(1-\theta_2)u'(d^r + \varepsilon) - \theta_1 u'(x - d^r - \varepsilon) > 0$$

Note first that from $d^r > x/2$, and the concavity of u(.), it follows that $u'(d^r + \varepsilon) < u'(x - d^r - \varepsilon)$. Therefore, $\Omega \equiv (1-\alpha)(1-\theta_2) - \theta_1 < 0$ is sufficient to insure the optimality of the 1-bundle offer. The locus of points for which $\Omega = 0$ is shown in Fig. 2. Clearly, $\Omega < 0$ for all parameter values in areas I_a, I_c and *II*.

While portions of areas I_b and *III* may have $\Omega > 0$, it turns out that the single bundle remains optimal even for preference parameters in these areas. To show this, we postulate that the profit maximizing solution is a 2-bundle offer, and show that it leads to a contradiction.

Indeed, suppose that the solution had the form $d = d_2 > d^r = d_1 > s = s_1 = s_2$. Clearly, the profits derived from such offer must be lower than the profits from a 2-bundle offer with identical d and s, but having $d_1 = s$.[17] But then, the non-constrained 2-bundle offer must also yield profits in excess of those gained from the constrained 1-bundle offer. In the absence of a constraint the latter must obviously be lower than the profit obtained from a 1-bundle offer. This, however, contradicts Proposition II which states that for preference parameters belonging to areas I_b or *III*, the same number of documentary channels are offered to both groups when maximization is not subject to a content requirement. Findings are summarized as follows:

Proposition 4

Let d_1^* and d_2^* denote the number of documentary channels a non-constrained operator chooses to include in the bundles offered to subscribers. There exist values $\tilde{s}$ defined by (8) and $\bar{d}$ defined by (9) such that imposing a content constraint of the form $min\,(d_1,d_2) \geq d^r$ affects the number of bundles and their composition as follows:

[17] Because the latter is the non-constrained solution for given s and d [see Proposition 1]

a) $\left.\begin{aligned} d_1 &= s_1 = s_2 = s = d^r \\ d_2 &= d = x - d^r \end{aligned}\right\}$ for $s_v \le d^r \le \tilde{s}$

b) $\left.\begin{aligned} d_1 &= d^r,\ s_1 = s_2 = s = \tilde{s} \\ d_2 &= d = x - \tilde{s} \end{aligned}\right\}$ for $\tilde{s} \le d^r \le \bar{d}$

c) $\left.\begin{aligned} s_1 &= s_2 = s = x - d^r \\ d_1 &= d_2 = d = d^r \end{aligned}\right\}$ for $d^r \ge \bar{d}$

.

4. Concluding remarks

Legislative texts and governmental policy statements attest to the fact that the primary goals of policies that favor specific audiovisual content are the enhancement of the production of certain types of program and the increase of the size of the audiences of these programs. Audiovisual content policies come in various forms; some measures apply equally to all operators in the industry, others are imposed on a case by case basis. We have looked at the effects of simple content quotas that come close to some of regulatory schemes one is likely to encounter in practice. We have found that setting a minimum quota on the number of channels devoted to one type of content may in fact produce a fall in the audience of that type of content. We have also determined that the requirement that a minimum number of channels devoted to a particular form of content be included in the basic service may result in a decline of the audience of that form of content. It may also bring about a fall in the total number of channels devoted to such content.

The paper has stressed the dependence of outcomes on the effects that imposing a quota has on the number of bundles being offered and on bundle composition. By endogenizing the number of bundles and bundle composition our paper has established a link between the literature on product specification and the literature on bundling. Endogenizing of the composition of the packages offered to subscribers complicates the analysis considerably. A number of assumptions - most importantly that all programs belong to one of two possible types and that the market is served by a single firm - were made to insure tractability. Additional work will have to determine the extent to which the results found in this paper, carry over to environments with competition among several service providers. The intuition is that, as competition intensifies, the number of channels subscribed to "à la carte" should increase relative to the number of subscriptions for entire menus.

Appendix

To show *(9),* substitute $\bar{d}$ for d^{r} into (7) and set the maximum value of (7) equal to the maximum profits that can be obtained from a single bundle offer.

$$\theta_1 u(\tilde{s}) + (1-\alpha)(1-\theta_2)u(\tilde{d}) + [(1-\theta_1)-(1-\alpha)(1-\theta_2)]u(\bar{d}) = \theta_1 u(\hat{s}) + (1-\theta_1)u(\hat{d})] \quad \text{(A.1)}$$

The latter can be rewritten

$$[\theta_1 u(\tilde{s}) + (1-\alpha)(1-\theta_2)u(\tilde{d})] - [\theta_1 u(\hat{s}) + (1-\alpha)(1-\theta_2)u(\hat{d})] = \Delta[u(\hat{d}) - u(\bar{d})] \quad \text{(A.2)}$$

Because the left-hand-side of (A.2) is positive [see (8)], and because $\Delta < 0$, it follows that $\bar{d} > \hat{d}$. To see that $\bar{d} >$½ when $\theta_2 <$½ $< \theta_1$, set (7) with d^{r} replaced by $\bar{d}$ equal to the profits that can be obtained from selling a single bundle containing an equal number of sports and documentary channels to both groups

$$\theta_1 u(\tilde{s}) + (1-\alpha)(1-\theta_2)u(\tilde{d}) + [(1-\theta_1)-(1-\alpha)(1-\theta_2)]u(\bar{d}) = u(x/2)$$

The latter can be rewritten

$$[\theta_1 u(\tilde{s}) + (1-\alpha)(1-\theta_2)u(\tilde{d})] - [\theta_1 u(x/2) + (1-\alpha)(1-\theta_2)u(x/2)] = \Delta[u(x/2) - u(\bar{d})]$$

By Proposition 2(iii), the condition $(1-2\theta_2) > 2\alpha(1-\theta_2)$ is both necessary and sufficient for a non-constrained equilibrium with $d_1^* < d_2^*$. Because $(1-2\theta_2) > 2\alpha(1-\theta_2) \Leftrightarrow (1-\alpha)(1-\theta_2) > ½$, it must also entail $\Delta<0$ when $\theta_1>½$. Hence, $\bar{d} >½$. In regard to the upper bounds of the intervals in (9) note that (A.1) can be rewritten as

$$[\theta_1 u(\tilde{s}) + (1-\theta_1)u(\tilde{d})] - [\theta_1 u(\hat{s}) + (1-\theta_1)u(\hat{d})] = \Delta[u(\tilde{d}) - u(\bar{d})] \quad \text{(A.3)}$$

Since $(\hat{s},\hat{d}) = \arg\max V(\theta_1; s, d)$, the left-hand-side of (A.3) is negative, and because $\Delta<0$, we can conclude that $\tilde{d} > \bar{d}$.

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