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Market Provision of Broadcasting: A Welfare Analysis*

Abstract

This paper presents a theory of the market provision of broadcasting and uses it to address the nature of market failure in the industry. Advertising levels may be too low or too high, depending on the nuisance cost to viewers, the substitutability of programs, and the expected benefits to advertisers from contacting viewers. Market provision may allocate too few or too many resources to programming and these resources may be used to produce programs of the wrong type. Monopoly ownership may produce higher social surplus than competitive ownership and the ability to price programming may reduce social surplus.
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1 Introduction

Individuals in western countries spend a remarkable portion of their lives watching television and listening to radio. In the U.S., the average adult spends around four hours a day watching television and three hours a day listening to the radio.[1] Television and radio are also key ways that producers advertise their products. In the U.S., television advertising accounted for 23.4% of total advertising expenditures in 1999 and radio accounted for 8%.[2] All of this makes television and radio broadcasting of central economic importance.

In the U.S., the bulk of radio and television broadcasting has always been provided by private commercial broadcasters. In Europe and Japan, broadcasting has historically been provided publicly, financed through a mixture of television license fees, appropriations from general taxation, and advertising. Since the 1980s, however, commercial broadcasting has dramatically expanded in these countries. The market now plays a significant role in providing broadcasting in almost all western countries. Despite this, the welfare economics of commercial broadcasting remains obscure. Will market provision lead to excessive advertising levels? Will it allocate too few resources to programming and will these resources be used to produce appropriate programming? How will the ownership structure of broadcasting stations impact market outcomes?

Such questions arise continually in debates about the appropriate regulation of the broadcasting industry. Excessive advertising is an issue in the U.S. where non-program minutes now exceed 20 minutes per hour on some network television programs and 30 minutes per hour on certain radio programs.[3] In Europe, advertising ceilings are imposed on broadcasters and it is natural to

[1] The Radio Advertising Bureau reports that in 1998 the average weekday time spent listening by adults is 3 hrs and 17 minutes; weekend time spent listening is 5 hrs and 30 mins (http://www.rab.com/station/mgfb99/fac5.html). The Television Advertising Bureau reports that in 1999 the average adult man spent 4 hours and 2 minutes watching television per day, while the average adult woman spent 4 hours and 40 minutes (http://www.tvb.org/tvfacts).

[2] Total advertising expenditures were $215 billion. Other important categories were newspapers (21.7%); magazines (5.3%); direct mail (19.2%) and yellow pages (5.9%) (http://www.tvb.org/tvfacts).

[3] Non-program minutes include commercials, station and networks promos, and public service announcements. The 1999 Television Commercial Monitoring Report indicates that non-program minutes on prime time network

wonder if the U.S. should follow suit.[4] Concerns about the programming provided by commercial radio led the F.C.C. to announce that it was setting up hundreds of free "low-power" radio stations for non-profit groups across the U.S. (Leonhardt (2000)). More generally, such concerns are key to the debate about the role for public broadcasting in modern broadcasting systems (see the Davies Report (1999)). The effect of ownership structure is currently an issue in the U.S. radio industry which, following the Telecommunications Act of 1996, has seen growing concentration. One concern is that this will lead to higher prices for advertisers and less programming (see Ekelund, Ford, and Jackson (1999)).

This paper presents a theory of commercial broadcasting and uses it to explore the nature of market failure in the industry. The theory is distinctive in yielding predictions on both the programming and advertising produced by a market system. It therefore permits an analysis of how well commercial broadcasting fulfills its two-sided role of providing programming to viewers/listeners and permitting producers to contact potential customers.

The next section explains how our analysis relates to three different strands of literature: prior work on broadcasting, the classical theory of public goods, and recent work on competition in two-sided markets. Sections 3 and 4 set up the model and explore how market provision of broadcasting differs from optimal provision. Section 5 analyzes how the ability to price programming impacts market performance and whether market provision produces better outcomes under monopoly or competitive ownership. Section 6 extends the model to discuss duplication, viewer switching, and alternative views of advertising. Section 7 concludes with a summary of the main lessons.

shows in November 1999 ranged from 12.54 minutes per hour to 21.07 minutes. Commercial minutes ranged from 9.31 minutes to 15.07 minutes. Kuczynski (2000) reports that commercial minutes exceed 30 minutes per hour on some radio programs.

[4] These ceilings vary by country. In the U.K. the limit for private television channels is 7 minutes per hour on average. In France, it is 6 minutes and, in Germany, 9 minutes (Motta and Polo (1997)). In the U.S., the National Association of Broadcasters, through its industry code, once set an upper limit on the number of commercial minutes per hour and this was implicitly endorsed by the F.C.C. In 1981, this practice was declared to violate the antitrust laws and no such agreement exists today (Owen and Wildman (1992)). In 1990, Congress enacted the Children's Programming Act which limits advertising on children's programming to 12 minutes per hour on weekdays and 10 minutes per hour on weekends.

2 Relationship to the literature

Previous normative work on the market provision of broadcasting (see Owen and Wildman (1992) or Brown and Cave (1992) for reviews) has focused on the type of programming produced and the viewer/listener benefits it generates.[5] The literature concludes that the market may provide programming sub-optimally: popular program types will be excessively duplicated (Steiner (1952)) and speciality types of programming will tend not to be provided (Spence and Owen (1977)). To illustrate, consider a radio market in which 3/4 of the listening audience like country music and 1/4 like talk, and suppose that the social optimum calls for one station to serve each audience type. Then, the literature suggests that the market equilibrium might well involve two stations playing country music. Duplication arises when attracting half of the country listening audience is more profitable than getting all the talk audience. There is no talk station when capturing 1/4 of the audience does not generate enough advertising revenues to cover operating costs, despite the fact that aggregate benefits to talk listeners exceed operating costs.

While these conclusions are intuitively appealing, the literature's treatment of advertising is unsatisfactory. First, advertising levels and prices are assumed fixed. Each program is assumed to carry an exogenously fixed number of advertisements and the revenue from each advertisement equals the number of viewers times a fixed per viewer price (Steiner (1952), Beebe (1977), Spence and Owen (1977) and Doyle (1998)).[6] Second, the social benefits and costs created by advertisers'

[5] The fact that broadcasting is used by both viewers and advertisers and that the latter also create surplus has been largely ignored. One exception is Berry and Waldfogel's (1999) empirical study of the U.S. radio broadcasting industry, which estimates whether free entry leads to too many radio stations. Their study is distinctive in clearly distinguishing between the social benefits of additional radio stations stemming from delivering more listeners to advertisers and more programming to listeners.

[6] There are a number of exceptions. Assuming that a broadcaster's audience size is reduced by both higher subscription prices and higher advertising levels, Wildman and Owen (1985) compare profit maximizing choices under pure price competition and pure advertising competition and conclude that viewer surplus would be the same in either case. However, theirs is not an equilibrium analysis. Making a similar assumption that viewers are turned off by higher levels of advertisements, Wright (1994) and Vaglio (1995) develop equilibrium models of competition in an advertiser supported system. However, their models are both too ad hoc and too intractable to yield insight into the normative issues. Masson, Mudambi, and Reynolds (1990) develop an equilibrium model of competition by advertiser supported broadcasters in their analysis of the impact of concentration on advertising prices but their model permits neither an analysis of the provision of programming nor a welfare analysis.

consumption of broadcasts are not considered. These features preclude analysis of the basic issue of whether market-provided broadcasts will carry too few or too many advertisements. More fundamentally, since advertising revenues determine the profitability of broadcasts, one cannot understand the nature of the programming the market will provide without understanding the source of advertising revenues. Since these revenues depend on both the prices and levels of advertising, the literature offers an incomplete explanation of advertising revenues and hence its conclusions concerning programming choices are suspect.

The theory developed in this paper provides a detailed treatment of advertising, while preserving the same basic approach to thinking about the market developed in the literature. To enable a proper welfare analysis, the model incorporates the social benefits and costs of advertising. The benefits are that advertising allows producers to inform consumers about new products, facilitating the consummation of mutually beneficial trades. The costs stem from its nuisance value. In addition, the model assumes that broadcasters choose advertising levels taking account of their effect on the number of viewers and on advertising prices. In this way, advertising revenues and hence program profitability are determined endogenously.

Since the first version of this paper was completed, a spate of papers on broadcasting has appeared.[7] For our purposes, particularly noteworthy is Hansen and Kyhl's (2001) welfare comparision of pay per view broadcasting with pure advertiser-supported provision of a single event (like a boxing match). Their analysis takes into account the nuisance cost of advertisements to viewers and endogenizes advertising levels. Our analysis of pricing in Section 5.1 extends their welfare comparison beyond the case of a single monopoly-provided program. Also related are Gabszewicz, Laussel and Sonnac (2001) and Dukes and Gal-Or (2003) who develop spatial models of broadcasting competition in which two broadcasters compete in both programming and

[7] A selection of these papers were presented at a recent conference and can be found at http://www.core.ucl.ac.be/media/default.html.

advertising levels. Gabszewicz, Laussel and Sonnac argue that advertising ceilings will lead stations to choose more similar programming. Dukes and Gal-Or provide a more detailed treatment of the product market in which advertisers compete and argue that product market competition can lead stations to choose less differentiated programming. While both of these papers develop models that endogenize programming and advertising levels, neither focuses on the welfare issues motivating this paper.

The paper also contributes to the classical theory of public goods (see Cornes and Sandler (1996) for a comprehensive review). It points out that radio and television broadcasts can be thought of as public goods that are "consumed" by two types of agents. The first are viewers/listeners who receive a direct benefit from the broadcast. The second are advertisers who, by advertising on the broadcast, receive an indirect benefit from contacting potential customers. The nuisance to viewers means that advertisers' "consumption" imposes an externality on viewers. However, advertisers can be excluded and broadcasters can earn revenues by charging advertisers for accessing their broadcasts, enabling market provision.

The special features of broadcasts make them a distinct type of public good and their market provision raises interesting theoretical issues. In particular, it is not clear a priori how market provision diverges from optimal provision. Since advertisers' consumption of a broadcast imposes an externality on viewers, optimal provision requires that advertisers face a Pigouvian corrective tax for accessing programming. The price advertisers must pay to broadcasters to advertise on their programs may be thought of as playing this role. Accordingly, the basic structure of market provided broadcasting - free provision to viewers/listeners financed by charges to advertisers - appears similar to that of an optimal structure. The issues are how well equilibrium prices of advertising internalize the externality and whether advertising revenues generate appropriate incentives for the provision of broadcasts.

Finally, the paper contributes to the nascent literature on competition in "two-sided markets" (see Armstrong (2002), Tirole and Rochet (2001), and the references therein). A two-sided market is one involving two groups of participants who interact via intermediaries. These intermediaries typically compete for business from both groups. In a broadcasting context, the two groups are viewers and advertisers and the intermediaries are the broadcasters. There are formal similarities between our model and those being developed in this literature. In particular, Rysman (2002) uses a model with similar theoretical underpinnings in his interesting study of the market for yellow pages directories. His paper also has the great merit of structurally estimating the parameters of his model. Wright (2002) uses a related model in his theoretical study of fixed-to-mobile telephony. We note the relationships between our model and these papers in the sequel.

3 The model

We are interested in modeling a basic broadcasting system in which programs are broadcast over the air and viewers/listeners can costlessly access such programming. Thus, we will be assuming that viewers/listeners have the hardware (i.e., televisions and radios) allowing them to receive broadcast signals. Broadcasters cannot exclude consumers by requiring special decoders, etc.[8]

There are two channels, each of which can carry one program. There are two types of program, indexed by $i \in \{0, 1\}$. Examples of program types are "top 40" and "country" for radio, and "news" and "sitcom" for television. For concreteness, we focus on television and henceforth refer to consumers as viewers. Programs can carry advertisements. Each advertisement takes a fixed amount of time and thus advertisements reduce the substantive content of a program. The cost of producing either type of program with a advertisements is K.[9]

[8] This is still a reasonable model of radio broadcasting in the United States. It is also a reasonable model for television in countries, like the United Kingdom, in which most viewers still pick up television signals via a rooftop antenna. In the United States, however, the majority of households receive television via cable. The cable company charges a monthly fee and can exclude consumers from viewing certain channels, which permits the use of subscription prices. Our basic model applies to cable when all consumers are hooked up and subscription prices are not used. We introduce subscription prices in section 5.1.

[9] We thus assume that producing advertisements costs the same as producing regular programming. Our qualitative results are unaffected if advertisements cost more than programming; i.e., if the cost of producing a program with a advertisements is $K + ca$.

There are N potential viewers, each of whom watches at most one program. Viewers are distinguished by their preferences over program types. Formally, each viewer is characterized by a taste parameter $\lambda \in [0, 1]$. A type λ viewer obtains a *net viewing benefit* $\beta - \gamma a - \tau\lambda$ from watching a type 0 program with a advertisements and $\beta - \gamma a - \tau(1 - \lambda)$ from a type 1 program, where $\beta > \tau > 0$ and $\gamma > 0$. Not watching any program yields a zero benefit. The formulation implies that if the programs carry the same level of advertisements, viewers with λ less than $1/2$ prefer a type 0 program, while the remainder prefer a type 1 program.[10] The parameter γ measures the *nuisance cost* of advertisements and is the same for all viewers. The *transport cost* parameter τ represents the degree to which the programs are substitutes. Viewers' tastes are uniformly distributed, so that the fraction of viewers with taste parameter less than λ is just λ.

Advertisements are placed by producers of new goods and inform viewers of the nature and prices of these goods. Having watched an advertisement for a particular new good, a viewer knows his willingness to pay for it and will purchase it if this is no less than its advertised price. There are m producers of new goods, each of which produces at most one good. New goods are produced at a constant cost per unit, which with no loss of generality we set equal to zero. Each new good is characterized by some type $\sigma \in [0, \overline{\sigma}]$ where $\overline{\sigma} \leq 1$. New goods with higher types are more likely to be attractive to consumers. Specifically, a viewer has willingness to pay $\omega > 0$ with probability σ for a new good of type σ and willingness to pay 0 with probability $1 - \sigma$. The fraction of producers with new goods of type less than σ is $F(\sigma)$. We assume that $F(0) = 0$ and that F is increasing and continuously differentiable, with a strictly log concave density.

Since a consumer will pay ω or 0, each new producer will advertise a price of ω. A lower price does not improve the probability of a sale. Thus, a new producer with a good of type σ is willing to pay $\sigma\omega$ to contact a viewer. Accordingly, if an advertisement reaches V viewers and costs P,

[10] Our viewer model is basically a Hotelling-style spatial model. The N viewers are distributed along the unit interval and the two program types are located at opposite ends of the interval.

the number of firms wishing to advertise is $a_d(P,V) = m \cdot [1 - F(P/V\omega)]$. This represents the *demand curve for advertising.* Note that since new producers' willingness to pay to reach viewers is independent of the number of viewers reached, demand just depends on the *per-viewer price* of the advertisement P/V. Let $P(a,V)$ denote the corresponding *inverse demand curve.* For future reference, note that $P(0,V)$ equals the willingness to pay of the highest type producer to reach V viewers, which is $\overline{\sigma}\omega V$. Note also that we may write $P(a,V) = Vp(a)$ where the *inverse per-viewer demand curve* $p(a)$ is implicitly defined by the equation $a = m \cdot [1 - F(p/\omega)]$.

Given that each new producer sets a price of ω, consumers receive no expected benefits from buying new products: producers extract all the surplus from the transaction. This implies that viewers get no *informational benefit* from watching a program with advertisements. Viewers therefore allocate themselves across their viewing options so as to maximize their net viewing benefits.[11]

4 Optimal vs market provision

4.1 Optimal provision

To understand optimal provision, it is helpful to think of the two types of program as discrete public goods each of which costs K to provide and each of which may be consumed by two types of agents - viewers and advertisers. By an advertiser "consuming" a program, we simply mean that its advertisement is placed on that program. The optimality problem is to decide which of these public goods to provide and who should consume them. We first analyze the desirability of providing one program rather than none, and then consider adding the second program.

[11] The model can be extended to incorporate informational benefits by assuming that each consumer's valuation of a new producer of type σ's product is uniformly distributed on $[\underline{\omega}, \overline{\omega}]$ with probability σ and is 0 with probability $1-\sigma$. Assuming that $\underline{\omega} > \frac{\overline{\omega}}{2}$, the type σ new producer's optimal price is $\underline{\omega}$ and, hence, if a consumer watches an advertisement placed by a type σ new producer, he obtains an informational benefit $\sigma\frac{\overline{\omega}-\underline{\omega}}{2}$. Such informational benefits do not change our main conclusions. In particular, market provided advertising levels can be greater or smaller than optimal levels and the market may over or underprovide programs. Holding constant the social benefit of advertising, increasing the share captured by consumers increases market provided advertising levels. This is because such informational benefits reduce the cost of advertising to viewers. The details of this extension are in the appendix of the draft at http://www.people.virginia.edu/˜sa9w/.

Given that viewers tastes are distributed symmetrically, if one program is provided, its type is immaterial. For concreteness, consider a type 0 program. Following the *Samuelson rule* for the optimal provision of a discrete public good, provision of the program will be desirable if the sum of benefits it generates exceed its cost. Typically, the aggregate benefit associated with a public good is just the sum of all consumers' willingnesses to pay. However, in the case of broadcasts, there are externalities between the two types of consumers.

More specifically, suppose that the program has a advertisements and hence is "consumed" by a new producers. Then, viewers for whom $\lambda \leq \min\{1, \frac{\beta-\gamma a}{\tau}\}$ will watch and obtain a benefit $\beta - \gamma a - \tau\lambda$. Clearly, the a advertisements should be allocated to those new producers who value them the most, so the aggregate benefits generated by the program are

$$B_1(a) = N \int_0^{\min\{1, \frac{\beta-\gamma a}{\tau}\}} (\beta - \gamma a - \tau\lambda) d\lambda + \int_0^a P(\alpha, N(\min\{1, \frac{\beta - \gamma a}{\tau}\})) d\alpha. \qquad (1)$$

The first term represents viewer benefits and the second advertiser benefits.

The optimal level of advertising equates marginal social benefit and cost. The marginal social benefit is just the willingness to pay of the marginal advertiser which is $P(a, N(\min\{1, \frac{\beta-\gamma a}{\tau}\}))$. The marginal social cost depends upon the impact of an additional advertisement on viewers. If the additional advertisement does not cause any viewers to switch off, the cost is just the aggregate nuisance cost $N\gamma$. If it does cause some viewers to switch off, then the profits those viewers generated to advertisers are included in the cost.

The situation is illustrated in Figure 1. The horizontal axis measures the level of advertising, while the vertical axis measures dollars per advertisement. The downward sloping curve is the inverse demand curve $P(a, N(\min\{1, \frac{\beta-\gamma a}{\tau}\}))$, measuring the marginal social benefit of advertising. This curve kinks at the advertising level $\frac{\beta-\tau}{\gamma}$ where viewers begin to switch off. The upward sloping curve is the marginal social cost of advertising. The marginal cost is just the nuisance cost γN up until the advertising level $\frac{\beta-\tau}{\gamma}$. Additional advertisements beyond this level cause viewers to switch off and the marginal cost jumps up to $\gamma N(\frac{\beta-\gamma a}{\tau}) + N\ \frac{\gamma}{\tau}\int_0^a \frac{\partial P}{\partial V} d\alpha$.[12] The optimal advertising level, denoted a_1^o, is determined by the intersection of the two curves. In the Figure, the optimal level is such that not all viewers watch, but this need not be the case.

Providing the program is desirable if the operating cost K is less than the maximized benefits $B_1(a_1^o)$. These benefits equal the "gross" viewing benefits $N[\beta - \tau/2]$ that viewers would enjoy if there were no advertising plus the net benefit from advertising. The latter is the area between the two curves in Figure 1.

It is natural to interpret the price eliciting a_1^o as a *Pigouvian corrective tax.* Each new producer's consumption of the program imposes an externality on viewers through the nuisance cost and, possibly, on other advertisers through the loss of audience. Advertisers' consumption of the program should thus be taxed and the optimal tax is $P(a_1^o, N(\min\{1, \frac{\beta-\gamma a_1^o}{\tau}\}))$.[13]

Adding a type 1 program will be desirable if the increase in aggregate benefits it generates exceeds its cost K. When both programs are provided, advertising levels on the two programs should be the same.[14] If the common level of advertisements is a, all those viewers for whom $\lambda \leq \min\{\frac{1}{2}, \frac{\beta-\gamma a}{\tau}\}$ will watch the type 0 program and obtain a benefit $\beta - \gamma a - \tau\lambda$. Those viewers for whom $1-\lambda \leq \min\{\frac{1}{2}, \frac{\beta-\gamma a}{\tau}\}$ will watch the type 1 program and obtain a benefit $\beta - \gamma a - \tau(1-\lambda)$. Since the a advertisements are allocated to those new producers who value

[12] The fact that for sufficiently high advertising levels the marginal cost starts to decrease, simply reflects the reality that there are fewer viewers on whom nuisance costs are imposed.

[13] Each viewer who watches confers an external benefit on the advertisers since he might purchase one of their goods. It might therefore be desirable to subsidize viewers to watch. We do not consider such subsidies since they would seem difficult to implement. Even if it were possible to monitor use of a radio or television, the difficulty would be making sure that a viewer/listener was actually watching/listening. That said, commercial radio stations sometimes give out prizes to listeners by inviting them to call in if they have the appropriate value of some random characteristic (like a telephone number) and this is like a listener subsidy.

[14] Divergent advertising levels cause some viewers to watch a less preferred program and, because all viewers are of equal value to advertisers, this situation is dominated by one in which net aggregate advertising benefits are the same but levels are equalized.

them the most,[15] the aggregate benefits from providing both programs are

$$B_2(a) = 2[N \int_0^{\min\{\frac{1}{2}, \frac{\beta-\gamma a}{\tau}\}} (\beta - \gamma a - \tau\lambda)d\lambda + \int_0^a P(\alpha, N(\min\{\frac{1}{2}, \frac{\beta - \gamma a}{\tau}\}))d\alpha]. \qquad (2)$$

The two terms represent per channel viewer and advertiser benefits, respectively.

The per channel marginal social benefit and cost curves are illustrated in Figure 2. The intercepts of the curves are half those of the marginal benefit and cost curves in Figure 1, because each channel attracts only half the viewers when $a = 0$. However, the level of advertising at which these viewers start to switch off is higher, increasing from $(\beta-\tau)/\gamma$ to $(\beta-\tau/2)/\gamma$ because viewers enjoy their programming more. Accordingly, the marginal social cost of advertising remains constant over a longer interval of advertising levels. In the Figure, all viewers are watching at the benefit maximizing advertising level, a_2^o. Comparing Figures 1 and 2, it should be clear that if a_1^o is such that everybody is watching with only one channel, then a_2^o must equal a_1^o. Otherwise, a_2^o will exceed a_1^o.

Maximal aggregate benefits with two channels are $B_2(a_2^o)$. These benefits equal the gross viewing benefits $N[\beta - \tau/4]$ plus the net benefit from advertising which is twice the maximized area between the two curves in Figure 2. The gain in benefits from the second program is $\Delta B^o = B_2(a_2^o) - B_1(a_1^o)$ and, if K is less than ΔB^o, provision of both programs is desirable.

4.2 Market provision

Suppose that the two channels are controlled by competiting broadcasters. In standard fashion, we model competition as a two stage game. In Stage 1, each broadcaster chooses what type of program to broadcast, if any. In Stage 2, given the programs offered, each broadcaster chooses a

[15] Notice that the same new producers advertise on both programs. This is because the two programs are watched by different viewers and (since marginal production costs are constant) contacting one set of consumers does not alter the willingness to pay to contact another set.

level of advertising.[16] We study the Subgame Perfect Nash equilibrium of this game.[17]

We first solve for advertising levels and revenues in Stage 2, for given Stage 1 choices. Suppose that only one broadcaster decides to operate its station and assume it broadcasts a type 0 program. If it runs a advertisements, its program will be watched by viewers for whom $\lambda \leq \min\{1, \frac{\beta-\gamma a}{\tau}\}$. To sell a advertisements it must set a price $P(a, N(\min\{1, \frac{\beta-\gamma a}{\tau}\}))$ so its revenues will be

$$\pi_1(a) = P(a, N(\min\{1, \frac{\beta - \gamma a}{\tau}\}))a. \qquad (3)$$

Let a_1^* be the revenue maximizing advertising level. The only complication in characterizing a_1^* is the kink in the revenue function that occurs at the advertising level beyond which viewers start to switch off. The situation is illustrated in Figure 3. The marginal revenue curve jumps downward at the advertising level beyond which viewers start to switch off. The revenue maximizing advertising level depends on precisely where the marginal revenue intersects the horizontal axis.

To be more precise, let $\widehat{a}$ be the advertising level at which marginal revenue is zero, assuming that all viewers watch; i.e.,

$$P(\widehat{a}, N) + \frac{\partial P(\widehat{a}, N)}{\partial a}\widehat{a} = 0. \qquad (4)$$

Let $\widetilde{a}$ be the advertising level at which marginal revenue is zero, assuming that viewers are switching off; i.e.,

$$P(\widetilde{a}, N(\frac{\beta - \gamma\widetilde{a}}{\tau})) + \frac{\partial P(\widetilde{a}, N(\frac{\beta-\gamma\widetilde{a}}{\tau}))}{\partial a}\widetilde{a} - N\frac{\gamma}{\tau}\frac{\partial P(\widetilde{a}, N(\frac{\beta-\gamma\widetilde{a}}{\tau}))}{\partial V}\widetilde{a} = 0. \qquad (5)$$

These advertising levels are illustrated in Figure 3. When $\widehat{a} \leq (\beta - \tau)/\gamma$, then the revenue maximizing advertising level a_1^* equals $\widehat{a}$ and all viewers watch. If $\widetilde{a} \geq (\beta - \tau)/\gamma$, then a_1^* equals

[16] Identical results emerge under the assumption that the two stations simultaneously choose the per viewer prices they charge advertisers. This is because each station has a monopoly in delivering its viewers to advertisers.

[17] This is a convenient point to spell out the relationship between our model and that of Rysman (2002). A model very similar to Rysman's could be obtained by assuming: (i) the two broadcasters are competing manufacturers of yellow pages directories; (ii) the viewers are yellow pages users to whom the directories are provided freely; (iii) the new producers are firms who advertise in the yellow pages; (iv) the cost of producing (and delivering) a yellow page directory with a advertisements is $K + c(a)$; and (v) γ (the nuisance cost) is negative, so that users prefer using a directory with more advertisements. The fact that users prefer more advertisements in a directory creates a positive network externality.

$\widetilde{a}$ and some viewers are excluded. Otherwise, the advertising level is optimally set at the highest level consistent with all viewers watching so that a_1^* equals $(\beta - \tau)/\gamma$. This is the case illustrated in Figure 3.

If both broadcasters provide programs, they will provide different types. For if they duplicate each other, competition for viewers will drive advertising levels and revenues to zero. Call the two broadcasters A and B and suppose that A shows a type 0 program with a_A advertisements and B a type 1 with a_B advertisements. Assuming that all viewers watch, viewers for whom λ is less than $\frac{1}{2} + \frac{\gamma}{2\tau}(a_B - a_A)$ will watch A's station and the remainder will watch B's. The two broadcasters' revenues will therefore be

$$\pi_2^A(a_A, a_B) = P(a_A, N[\frac{1}{2} + \frac{\gamma}{2\tau}(a_B - a_A)])a_A, \qquad (6)$$

and

$$\pi_2^B(a_A, a_B) = P(a_B, N[\frac{1}{2} + \frac{\gamma}{2\tau}(a_B - a_A)])a_B. \qquad (7)$$

At equilibrium, each broadcaster balances the negative effect of higher advertising levels on viewers with the positive effect on marginal revenue. Using the first order conditions for each firm's optimization, it is straightforward to show that the equilibrium advertising levels equal a_2^*, where a_2^* satisfies[18] :

$$P(a_2^*, \frac{N}{2}) + \frac{\partial P(a_2^*, \frac{N}{2})}{\partial a} a_2^* = \frac{N}{2} \frac{\gamma}{\tau} \frac{\partial P(a_2^*, \frac{N}{2})}{\partial V} a_2^*. \qquad (8)$$

The term on the left hand side is marginal revenue when the number of viewers is fixed at $N/2$. The term on the right hand side reflects the revenue consequences of losing viewers to the other station. The equilibrium level is illustrated in Figure 4. The two downward sloping curves are the inverse demand and marginal revenue curves with $N/2$ viewers. The upward sloping curve is just $\frac{N}{2} \frac{\gamma}{\tau} \frac{\partial P}{\partial V} a$. The equilibrium advertising level is where the upward sloping curve intersects the marginal revenue curve.

[18] For all viewers to watch requires that $\beta - \tau/2 \geq \gamma a_2^*$ and we assume this in what follows.

It is interesting to note that the equilibrium advertising level with two stations can be either smaller or larger than that with only one station. Recall that $P(a, V) = Vp(a)$ where $p(a)$ is the inverse per-viewer demand and let $R(a) = p(a)a$ denote *per-viewer revenue*. Then from equation (4) we see that $\widehat{a}$ is the advertising level that maximizes per-viewer revenue; i.e., $R'(\widehat{a}) = 0$. Equations (5) and (8) imply, respectively, that $R'(\widetilde{a}) = \frac{\gamma}{\beta-\gamma\widetilde{a}}R(\widetilde{a})$ and $R'(a_2^*) = \frac{\gamma}{\tau}R(a_2^*)$. It is clear from these equations that $\widehat{a}$ exceeds a_2^* and that a_2^* exceeds $\widetilde{a}$ when $\widetilde{a} < (\beta - \tau)/\gamma$. Thus, given our characterization of a_1^*, if $(\beta-\tau)/\gamma \geq \widehat{a}$, then a_1^* is larger than a_2^*, while if $(\beta-\tau)/\gamma < \widetilde{a}$, then a_1^* is smaller than a_2^*. The key point to note is that with one station, in the range in which higher advertising levels cause viewers to switch off, they switch off at a faster rate than they switch over to the competitor in the two station case. This means that viewer demand is more elastic with one station and so the advertising level is lower.

Turning to Stage 1, let $\pi_1^* = \pi_1(a_1^*)$ denote the broadcaster's revenues in the one channel case and $\pi_2^* = \pi_2^J(a_2^*, a_2^*)$ each broadcaster's revenues in the two channel case. Neither broadcaster will provide a program if K exceeds π_1^*; one will provide a program if K lies between π_1^* and π_2^*; and both will provide programs if π_2^* exceeds K.

4.3 Optimal and market provision compared

Conditional on the market providing one or both programs, will they have too few or too many advertisements? With two programs, it is clear from Figures 2 and 4 that the equilibrium advertising level (a_2^*) may be bigger or smaller than the optimal level (a_2^o) depending on the nuisance cost. If γ exceeds $\overline{\sigma}\omega$ then the optimal advertising level is zero and the market over-provides advertising. At the other extreme, when the nuisance cost is negligible, the market under-provides advertising. From Figure 2, note that as γ tends to 0, the marginal social cost of advertising approaches zero and a_2^o tends to m. Intuitively, if viewers find advertising costless to watch, then all advertisers should have a chance to inform them. However, from Figure 4, as γ tends to 0, a_2^* approaches the level at which the marginal revenue curve intersects the horizontal axis ($\widehat{a}$) which is strictly less than m.

Whether advertising is over- or under-provided also depends on how "competitive" the market is for viewers. A lower transport cost τ means the programs are closer substitutes. From Figure 4, the equilibrium level of advertising is increasing in τ and approaches zero as τ tends to zero. Intuitively, when the programs are closer substitutes there is greater competition for viewers. However, from Figure 2, the optimal level is independent of τ as long as all viewers watch. Thus, for sufficiently small τ, advertising *must be under-provided* if γ is smaller than $\overline{\sigma}\omega$.

When the market provides only one program, the story is the same with respect to the nuisance cost. The equilibrium advertising level (a_1^*) exceeds the optimal level (a_1^o) for large γ and is below it for small γ. However, lower transport costs no longer increase the likelihood of under-provision. Indeed, lower values of τ make viewers less likely to switch off and this either has no effect on the equilibrium advertising level or raises it.

Our main findings about adverting levels are summarized in:

Proposition 1 *With either one or two programs, the equilibrium advertising level is below the optimal one if the nuisance cost of advertising is low enough and above it if the nuisance cost is high enough. With two programs, there exists a critical nuisance cost $\gamma_2 \in (0, \omega\overline{\sigma})$ such that the market provided advertising level is lower (higher) than the optimal level as γ is smaller (larger) than γ_2. This critical cost is decreasing in the transport cost τ so that under-provision is more likely when the programs are closer substitutes for viewers.*

Proof: We have already established the first claim. To prove the remainder of the proposition, we write a_2^o as $a_2^o(\gamma)$ and similarly for a_2^*. By continuity, there exists $\gamma_2 \in (0, \omega\overline{\sigma})$ such that $a_2^o(\gamma_2) = a_2^*(\gamma_2)$. We need to show that it is unique and decreasing in τ.

Recall that $R(a) = p(a)a$ denotes the per viewer revenue curve. Using the fact that $P(a, V) = Vp(a)$ and equation (8), we know that $R'(a_2^*(\gamma)) = \frac{\gamma}{\tau}R(a_2^*(\gamma))$. We are assuming that the parameters satisfy $\beta - \tau/2 > \gamma a_2^*(\gamma)$ for all γ. Thus, if $a_2^o(\gamma) = a_2^*(\gamma)$ then it must be the case that $\gamma a_2^o(\gamma) < \beta - \tau/2$. Accordingly, the (per channel) marginal social benefit and cost of advertising at $a_2^o(\gamma)$ are, respectively, $P(a_2^o(\gamma), \frac{N}{2})$ and $\gamma \frac{N}{2}$. The fact that marginal social benefit equals cost implies that $p(a_2^o(\gamma)) = \gamma$. Thus, when $a_2^o(\gamma) = a_2^*(\gamma)$ it must be the case that $a_2^o(\gamma) = a_2^*(\gamma) = a$ where $\tau R'(a)/R(a) = p(a)$. Our assumptions about the distribution of advertiser types imply that $R(a)$ is strictly concave and this implies that there is a unique advertising level satisfying this equation. Since both $a_2^o(\gamma)$ and $a_2^*(\gamma)$ are decreasing, there exists a unique γ_2 at which $a_2^o(\gamma) = a_2^*(\gamma)$. As τ increases the advertising level satisfying the equation increases, implying that γ_2 must decrease. ■

Another way of phrasing this conclusion is that the market price of advertising can be higher or lower than the Pigouvian corrective tax. Thus, while it is possible for the market price of advertising to be "just right", there are no economic forces ensuring the equivalence of the two prices. The Pigouvian corrective tax reflects the negative externalities that advertisers impose, while the market price of advertising reflects the dictates of revenue maximization. Revenue maximization only accounts for nuisance costs to the extent that they induce viewers to switch off or over to another station. This may over- or under-estimate the true social costs.

The most striking thing about the proposition is the possibility that market provided programs may have too few advertisements. While the governments of many countries set ceilings on advertising levels on commercial television and radio, we are not aware of any governments subsidizing advertising levels![19] Two considerations are important in understanding why under-advertising may arise. First, in the two program case, broadcasters must compete for viewers and the only way they can do this is by lowering advertising levels. When the programs are close substitutes, this competition for viewers forces advertising levels below optimal levels. Second, even with two

[19] That said, as noted in the introduction, concern about increasing concentration in the United States radio industry is partly motivated by fears about high advertising prices and hence (presumably) low advertising levels.

programs, broadcasters have a monopoly in delivering their audience to advertisers.[20] This means that broadcasters hold down advertisements in order to keep up the prices that they receive.[21]

This monopoly power is partly an artifact of the static nature of our analysis. In a dynamic world, viewers may be expected to switch between channels, giving advertisers different ways to reach them. Thus, in Section 6 we present a two-period extension of our model to investigate the implications of viewer switching for our conclusions about advertising levels.

Turning to programming, the question is whether the market provides too few or too many types of program.[22] It is fairly obvious that the market can under-provide programs. While the social benefits of programming come from two sources, broadcasters only capture a share of advertiser benefits. When these benefits are small relative to viewer benefits (large β and τ, small m and/or $\omega\overline{\sigma}$), advertising revenues are considerably less than the aggregate benefits of programming and under-provision can result.

More interesting is the possibility of over-provision. For this to arise, the equilibrium revenues with two channels π_2^* must exceed the social benefits of adding the second channel, ΔB^o. Then, there exists a range of operating costs for which the optimal number of programs is one, while the market provides two. Even though broadcasters' revenues only reflect advertiser benefits, π_2^* could in principle exceed ΔB^o because it includes revenues that are obtained from "stealing" the

[20] In the literature on competition in two-sided markets, this situation is known as a "competitive bottleneck" (Armstrong (2002)). It arises in Rysman's study of the yellow pages market because users are assumed (reasonably enough) to use a single directory. It would also arise, for example, in the newspaper industry when readers only read a single newspaper.

[21] Our results on the possibility of under-provision of advertising are reminiscent of those of Shapiro (1980), who shows that a monopoly good producer will under-provide informative advertising by choosing to reach fewer consumers than is optimal. This is because the firm does not capture the full surplus generated by the marginal advertisement. If the monopolist could perfectly price discriminate across consumers, it would choose the optimal advertising reach. In our model, if the monopoly broadcaster could perfectly discriminate across advertisers, then its marginal benefit curve is the demand curve in Figure 1 but its marginal cost is lower than marginal social cost by the nuisance cost to viewers that it does not internalize. It therefore always chooses excessive advertising (see also Hansen and Kyhl (2001)). With competition and perfect price discrimination, the equilibrium advertising level will still be below the optimal level when τ is sufficiently small.

[22] The analysis here compares the number of program types provided by the market with the optimal number. A slightly different problem, in the spirit of Mankiw and Whinston (1986), would be to compare the number of program types provided by the market with the number in an optimal "second-best" system which treated as a constraint the fact that with $i \in \{1,2\}$ types of programs, the advertising levels would be a_i^*. Our choice is motivated by the desire to understand if market provision can actually achieve the first best.

advertising revenues of the first program. The following proposition develops conditions for over- and under-provision.

Proposition 2 *(i) If $P(\widehat{a}, N/2)\widehat{a} < N\frac{\tau}{4}$, the market does not over-provide programs, and under-provides them for some values of the operating cost K. (ii) If $P(\widehat{a}, N/2)\widehat{a} > N\frac{\tau}{4}$, the market overprovides programs for some values of K if the nuisance cost of advertising is sufficiently small.*

Proof: We need to show that if $P(\widehat{a}, N/2)\widehat{a} < N\frac{\tau}{4}$, then ΔB^o exceeds π_2^* for all γ, while if $P(\widehat{a}, N/2)\widehat{a} > N\frac{\tau}{4}$, then ΔB^o is less than π_2^* for γ sufficiently small. Note first that equilibrium revenues π_2^* converge to $P(\widehat{a}, N/2)\widehat{a}$ as γ tends to zero: from Figure 4 the equilibrium advertising level converges to the level at which the marginal revenue curve intersects the horizontal axis. Since $P(a, V) = Vp(a)$, this is the level $\widehat{a}$ defined in equation (4). In addition, equilibrium revenues π_2^* are bounded above by $P(\widehat{a}, N/2)\widehat{a}$ since equilibrium advertising levels are decreasing in γ.

On the other hand, ΔB^o converges to $N\frac{\tau}{4}$ as γ tends to zero. As γ gets small, the optimal advertising level with one program is such that everybody watches. As noted earlier, then a_2^o equals a_1^o and the social benefits of advertising are the same with one channel as with two. Accordingly, ΔB^o is just the increase in viewing benefits created by the additional channel which is $N\frac{\tau}{4}$. This represents a lower bound, as ΔB^o is the maximized increase in viewer and advertiser benefits from an additional channel. It follows from all this that if $P(\widehat{a}, N/2)\widehat{a} < N\frac{\tau}{4}$, then ΔB^o exceeds π_2^* for all γ, while if $P(\widehat{a}, N/2)\widehat{a} > N\frac{\tau}{4}$, then ΔB^o is less than π_2^* for γ sufficiently small. ■

Since the literature on market provision of public goods emphasizes under-provision, the possibility of over-provision of broadcasting is noteworthy.[23] The key feature permitting over-provision is that the social benefit of an additional program is less than the direct benefits it generates (i.e.,

[23] The possibility of over-provision is also stressed by Berry and Waldfogel (1999). They structurally estimate a model of radio broadcasting based on the work of Mankiw and Whinston (1986). This model implies that the equilibrium number of stations will always exceed the number that maximizes total non-viewer surplus (broadcasting stations plus advertisers) and they quantify the extent of this overprovision. While they are unable to observe viewer surplus, they are able to compute the values of programming that would make the equilibrium optimal.

ΔB^o is less than $B_2(a_2^o)/2$). This is because programs are substitutes for viewers. Although the entering station's revenues exclude viewer benefits and hence are less than the direct benefits it generates, they may exceed the social benefits since they are partly offset by the reduction in revenues of the incumbent station. This is a familiar problem with firm decision making when entry is costly (Spence (1976)).

The previous two propositions establish that there is no guarantee that market outcomes are optimal. Nonetheless, the market may produce something close to the optimum for a range of parameter values.[24] Accordingly, the market does not *necessarily* provide broadcasting inefficiently.

5 Further issues concerning market provision

This section uses the model to address two classic questions concerning the market provision of broadcasting. The first is how the possibility of pricing programming impacts market performance. This has long interested public good theorists (see Samuelson (1958, 1964) and Minasian (1964)). The issue was the central concern of Spence and Owen (1977) and continues to attract attention in the broadcasting literature (Doyle (1998), Hansen and Kyhl (2001) and Holden (1993)). It is of policy interest since it is becoming easier to exclude viewers and price access to programming.[25]

The second question is whether the market produces better outcomes under monopoly or competitive ownership. This has been a key question in the literature (see Steiner (1952), Beebe (1977) and Spence and Owen (1977)) and remains a policy relevant issue today, given the current

[24] To see this, suppose that ΔB^o exceeds K so that the optimum involves providing both programs. Suppose further that a_2^o is such that all viewers watch and that the Pigouvian corrective tax, $P(a_2^o, N/2)$, is sufficiently high that the revenues it would generate are sufficient to finance the provision of both programs; i.e., $P(a_2^o, N/2)a_2^o > K$. Then, if γ is close to γ_2 (the critical nuisance cost defined in Proposition 1) the market will provide two channels showing different types of programs with an advertising level close to a_2^o. By continuity, a_2^* is close to a_2^o which means that $P(a_2^*, N/2)$ is close to $P(a_2^o, N/2)$. This, in turn, implies that $\pi_2^* > K$ which ensures that the market will operate both channels.

[25] In Europe, direct broadcast satellite channels like Canal Plus are partially financed by subscription pricing. In the United States, premium cable channels such as HBO and Showtime are often priced individually. Other cable channels, such as ESPN and CNN, are "bundled" and sold as a package. In this case, both cable companies and the cable networks are involved in pricing decisions. In our model, bundling does not make sense because viewers watch at most one program. Obviously, it would be interesting to extend the analysis to incorporate bundling.

discussion of the appropriate restrictions to put on media ownership.

5.1 Does pricing help?

To understand how pricing changes market outcomes, it is instructive to begin with the two station case. Suppose that station A chooses a type 0 program with a_A advertisements and subscription price s_A and B a type 1 program with a_B advertisements and price s_B. Maintaining the assumption that all viewers watch, viewers for whom λ is less than $\frac{1}{2}+\frac{s_B+\gamma a_B-(s_A+\gamma a_A)}{2\tau}$ watch A and the remainder watch B. From each viewer, broadcaster J will earn a revenue $s_J + R(a_J)$ where $R(a) = p(a)a$ is the per-viewer (advertising) revenue curve introduced earlier. Thus, we can write revenues as:

$$\pi_{2s}^{A} = N[\frac{1}{2} + \frac{s_B + \gamma a_B - (s_A + \gamma a_A)}{2\tau}](s_A + R(a_A)), \qquad (9)$$

and

$$\pi_{2s}^{B} = N[\frac{1}{2} + \frac{s_A + \gamma a_A - (s_B + \gamma a_B)}{2\tau}](s_B + R(a_B)). \qquad (10)$$

The number of viewers each broadcaster gets is solely determined by its "full price", $\gamma a_J + s_J$. For any given full price, the broadcaster chooses the advertising level and subscription price that maximize revenue per viewer. Starting from the equilibrium without pricing in which each station runs a_2^* advertisements, imagine a broadcaster reducing its advertising level marginally by Δa and charging a price $\gamma\Delta a$ to keep its full price constant. The change in revenue per viewer is $(\gamma - R'(a_2^*))\Delta a$. This will be positive if and only if $a_2^* > a_s$, where a_s satisfies the first order condition $R'(a) \leq \gamma$ (= if $a > 0$). Accordingly, if $a_2^* \leq a_s$ broadcasters have no incentive to use pricing and the equilibrium continues to involve both stations running a_2^* advertisements. In this case, advertising alone is the most profitable way to extract surplus from viewers.

If $a_2^* > a_s$, the broadcasters will reduce advertising levels to a_s and charge positive subscription prices. In this case, broadcasters respond to viewers' dislike of commercials by reducing advertisements and raising subscription prices. Using the first order conditions for each station's optimal price, it is straightforward to show that the equilibrium subscription price is $s_2^* = \tau - R(a_s)$.[26]

Broadcasters' equilibrium profits in this case attain the "Hotelling level" of $\tau/2$ and are higher than without pricing.[27] We show below that advertising levels with pricing are always less than the optimal level when the latter is positive. With pricing, broadcasters internalize the nuisance cost to viewers which is the only force leading to over-provision.

With one station, the story is much the same. If $a_1^* \le a_s$, the broadcaster has no incentive to use pricing and the revenue maximizing strategy continues to be running a_1^* advertisements. If $a_1^* > a_s$, the broadcaster reduces advertising levels to a_s and charges a positive subscription price. In this case, pricing raises profits. If $\beta + R(a_s) - \gamma a_s < 2\tau$, the optimal subscription price is $s_1^* = \frac{\beta - \gamma a_s - R(a_s)}{2}$ and some viewers do not watch. Otherwise, the optimal subscription price is $s_1^* = \beta - \gamma a_s - \tau$ and all viewers watch.[28]

Our main findings concerning the impact of pricing on market outcomes are summarized in:[29]

Proposition 3 *The market provides at least as many types of programs with pricing as without and more under some conditions. When the market provides the same number of programs in both*

[26] This assumes that $\beta + R(a_s) - \gamma a_s \ge \frac{3}{2}\tau$ which guarantees that all viewers watch.

[27] Note that equilibrium profit is independent of how much revenue broadcasters receive from advertisers. This is similar to a result obtained by Wright (2002) in his study of the interaction between competing mobile telephone firms and a single fixed-line firm. In Wright's model, the mobile telephone firms must choose both a subscription price for their subscribers and an access fee to the fixed-line firm for allowing its customers to call their subscribers. The fixed-line firm simply chooses a subscription price for its customers. Wright shows that the equilibrium profits of the mobile telephone firms depend only upon their subscriber base and are independent of access charges received on incoming calls. In Wright's model the fixed-line firm's customers are analagous to our advertisers and the mobile firms who deliver people for these customers to call are analagous to our broadcasters. Wright's assumption that mobile subscribers are indifferent to receiving calls from fixed line customers corresponds to our setting when nuisance costs are zero. While the fixed-line firm has no direct parallel in our model, it can be thought of as an intermediary that channels advertisers' demand to the broadcasters. Using this analogy, it is possible to draw parallels between Wright's other main results and the results in this section.

[28] One difference between the one and two station cases is that, in the former, we have been unable to show that the equilibrium advertising level is necessarily below the optimal level. While the single station internalizes the nuisance cost of advertisements to viewers with pricing, it does not fully internalize the lost surplus to advertisers resulting from viewers being crowded out. This problem does not arise with two stations since, by assumption, all viewers are watching at the equilibrium.

[29] The result that the market will provide more programs with pricing is also obtained by Spence and Owen (1977) and Doyle (1998).

regimes, the equilibrium advertising level with pricing is unchanged or lower than without. Indeed, in the two program case, it is below the optimal level whenever the latter is positive. Moreover, the "full price" (nuisance costs plus subscription price) faced by viewers with pricing is unchanged or higher than without.

Proof: To prove the first statement it suffices to show that profits are strictly higher when pricing is used. For one station this is obvious. For two stations, revenues are $N\tau/2$ with pricing and $P(a_2^*, N/2)a_2^*$ without. Using the fact that $P(a,V) = Vp(a)$, we can write $P(a_2^*, N/2)a_2^* = NR(a_2^*)/2$ so that the result holds if $\tau > R(a_2^*)$. As noted earlier, equation (8) implies that $R'(a_2^*) = \frac{\gamma}{\tau}R(a_2^*)$. Thus, the result holds if $\gamma > R'(a_2^*)$ or, equivalently, if $a_2^* > a_s$. But this is precisely the condition for pricing to be used.

The second statement was proved in the text. For the third statement, suppose that $a_2^o > 0$. We need to show that $a_2^o > \min\{a_s, a_2^*\}$. Our assumption that all viewers watch in the two station equilibrium implies that $\beta - \tau/2 > \gamma \min\{a_s, a_2^*\}$. Thus, we can assume that $\beta - \tau/2 > \gamma a_2^o$ for if this were not the case it must be that $a_2^o > \min\{a_s, a_2^*\}$. Accordingly, the (per channel) marginal social benefit and cost of advertising at a_2^o are, respectively, $P(a_2^o, \frac{N}{2})$ and $\gamma\frac{N}{2}$. The fact that marginal social benefit equals cost implies that $p(a_2^o) = \gamma$. This implies that $a_2^o > a_s$ since $R'(a_2^o) < p(a_2^o) = \gamma = R'(a_s)$.

For the final claim, we show that the full price with pricing is at least as high as without. Consider first the two program case. If $a_2^* \leq a_s$ there is nothing to show, so assume that $a_2^* > a_s$. In this case, we need to show that γa_2^* is less than $\gamma a_s + s_2^* = \gamma a_s + \tau - R(a_s)$. From (8) we know that $R'(a_2^*) = \frac{\gamma}{\tau}R(a_2^*)$ and hence it is enough to show that

$$R(a_s) - \gamma a_s < \frac{\gamma}{R'(a_2^*)}R(a_2^*) - \gamma a_2^*.$$

Defining the function $\varphi(a) = \gamma R(a)/R'(a) - \gamma a$ and recalling that $R'(a_s) = \gamma$, this inequality can be written as $\varphi(a_s) < \varphi(a_2^*)$. Since $a_s < a_2^*$, the inequality will follow if $\varphi(\cdot)$ is increasing on the interval $[a_s, a_2^*]$. But, since $R(\cdot)$ is strictly concave, we have that

$$\varphi'(a) = \frac{R'(a)^2\gamma - R''(a)\gamma R(a)}{R'(a)^2} - \gamma = \frac{-R''(a)\gamma R(a)}{R'(a)^2} > 0.$$

Now consider the one program case. Again, if $a_1^* \leq a_s$ there is nothing to show, so assume that $a_1^* > a_s$. Suppose first that $a_1^* \leq (\beta - \tau)/\gamma$ so that all viewers watch without pricing. If some viewers are not watching with pricing then clearly the full price must be higher, so we can assume that all viewers are watching. In this case, the full price with pricing is $\gamma a_s + s_1^* = \beta - \tau$. Since $a_1^* \leq (\beta - \tau)/\gamma$, the result follows. Next suppose that $a_1^* > (\beta - \tau)/\gamma$. Then it follows that $a_1^* = \widetilde{a}$. Suppose first that $\beta + R(a_s) - \gamma a_s < 2\tau$, so that the subscription price is $s_1^* = \frac{\beta - \gamma a_s - R(a_s)}{2}$. Then we need to show that $\gamma\widetilde{a} < \frac{\beta + \gamma a_s - R(a_s)}{2}$. As noted earlier, (5) implies that $R'(\widetilde{a}) = \frac{\gamma}{\beta - \gamma\widetilde{a}} R(\widetilde{a})$. Thus the inequality can be written as

$$R(a_s) - \gamma a_s < \frac{\gamma}{R'(\widetilde{a})} R(\widetilde{a}) - \gamma\widetilde{a}$$

or $\varphi(a_s) < \varphi(\widetilde{a})$. Since $a_s < \widetilde{a}$, this holds because $\varphi(\cdot)$ is increasing on the interval $[a_s, \widetilde{a}]$. If $\beta + R(a_s) - \gamma a_s \geq 2\tau$, then we need to show that $\gamma\widetilde{a} < \beta - \tau$. But this follows from the fact that

$$\beta - \tau \geq \beta - \frac{(\beta + R(a_s) - \gamma a_s)}{2} = \frac{\beta + \gamma a_s - R(a_s)}{2} > \gamma\widetilde{a}.$$

■

Will pricing permit the market to generate a higher level of welfare? There are many circumstances in which it will. For example, when $\gamma \geq \omega\overline{\sigma}$ and $K < \frac{N}{4}\tau$, optimal provision involves two programs and no advertising. Without pricing, the market cannot achieve this. With pricing, however, market provision is fully optimal. Viewers are charged a subscription price τ and exposed to no advertisements (since $a_s = 0$). Each broadcaster earns revenues $\frac{N}{2}\tau$, more than sufficient to cover operating costs.

However, there are circumstances under which *pricing reduces welfare*. If pricing does not change the number of programs provided, it must reduce surplus if advertising levels are already underprovided without pricing. It may also reduce welfare when the rise in full price induced by pricing causes some viewers to switch off. For example, suppose that one program is provided with and without pricing. If nuisance costs are close to zero, the advertising level without pricing will be $\widehat{a}$. This is almost the same as the advertising level with pricing (a_s) since $R'(\widehat{a}) = 0$. However, without pricing all consumers watch, while with pricing some viewers are crowded out if $\beta + R(a_s) < 2\tau$. This is the drawback of pricing television emphasized by Samuelson (1958).

Pricing may also reduce welfare when it increases programs. Suppose that the market provides one program without pricing and that all viewers watch. If $K < N\frac{\tau}{2}$ the market will provide an additional program with pricing. Since the equilibrium advertising level with pricing is lower than without and all viewers watch with only one program, pricing reduces advertiser benefits. The extra viewing benefits it generates are $N\frac{\tau}{4}$. Thus, if $K > N\frac{\tau}{4}$, aggregate surplus is lower with pricing.

Pricing also has some interesting distributional consequences. If it does not change the amount of programming, it is likely to make both viewers and advertisers worse off. Viewers are worse off because they face higher full prices and advertisers are worse off because advertising prices are higher. Pricing therefore redistributes surplus from viewers and advertisers to broadcasters.

5.2 Monopoly versus competitive ownership

Suppose that the two channels are controlled by a single broadcaster. If this monopoly chooses to operate both stations, then it selects the advertising level that maximizes

$$2P(a, N(\min\{\frac{1}{2}, \frac{\beta - \gamma a}{\tau}\}))a. \qquad (11)$$

If it operates only one station, its revenue maximizing advertising level is a_1^* and its revenues π_1^*. Letting $\Delta\pi$ be the incremental profit from offering the second program, the monopoly provides both programs if K is less than $\Delta\pi$, and one program if K is between $\Delta\pi$ and π_1^*.

First note that advertising levels will be *higher under monopoly* if both stations are operated under both ownership regimes. Since all viewers watch in the competitive equilibrium, the two-channel monopolist will lose no viewers by raising advertising levels marginally on both channels. This action will raise profit since advertising levels under competition fall short of the level that maximizes revenue per viewer (since $R'(a_2^*) > 0$). In fact, the monopoly will continue to increase advertising levels until it either it starts crowding out viewers or revenue per viewer is maximized. Thus, its advertising level is $\widehat{a}$ if all viewers would watch at this level or the highest advertising level such that all viewers watch which is $(\beta - \tau/2)/\gamma$.

The logic underlying this result is similar to that of Masson, Mudambi, and Reynolds (1990). Broadcasters compete for viewers by reducing advertising levels to render their programs more attractive. A monopoly owner, by contrast, is only worried about viewers turning off completely and so advertises more.[30] One implication is that *per viewer advertising prices will be lower under monopoly*, so concerns about increasing concentration raising prices to advertisers may be misguided. That said, a monopoly does not necessarily raise advertising levels if it reduces the number of stations. Since a_1^* may be less than a_2^*, it is possible that monopoly may reduce advertising.

The impact of monopoly on programming is ambiguous *a priori*. Although the monopoly internalizes business stealing (which discourages programming), it puts on more advertisements so that each program earns more revenue than under competition (which encourages programming). This second effect was ignored by previous analyses since they assumed fixed advertising levels. When the first effect outweighs the second effect, monopoly ownership provides less programming. For example, if the nuisance cost of advertising is small, the one station monopoly can expose the

[30] This finding is consonant with the explanation offered by some observers of the United States radio industry that increased concentration of ownership explains increased advertising levels. For example, Duncan's American Radio analysts J.T. Anderton and Thom Moon argue that "As bottom-line pressures increase from publicly-traded owners, the number of commercials on the air has risen. The biggest change when a new owner takes over seems to be the addition of one new stopset per hour. The rationalization offered by most owners is that they limited unit loads because they needed to compete effectively with a direct format competitor: "Fewer commericals gives the listener more reasons to stay with me." Now the reasoning is, "We own the other station they're most likely to change to, so we have them either way. Why limit spot loads?""

entire audience to the advertising level that maximizes revenue per viewer ($\widehat{a}$). It therefore has no incentive to operate a second station. Under competitive ownership, however, the profits to each station are high because equilibrium advertising levels are high. Less clear is whether the second effect can outweigh the first under our specific assumptions. However, it is not hard to find alternative assumptions under which monopoly ownership leads to more programs.[31]

The next proposition summarizes these conclusions about the impact of monopoly ownership.[32]

Proposition 4 *Suppose that both programs are provided under competition. Then, if monopoly ownership also delivers both programs, it will lead to higher advertising levels and lower per viewer advertising prices. However, monopoly ownership will produce less programming if the nuisance cost of advertising is sufficiently small.*

What can be said about the welfare comparison of monopoly and competitive ownership? In contrast to standard markets, there is no presumption that monopoly ownership in broadcasting produces worse outcomes. If both regimes deliver both programs, then the welfare comparison simply depends on relative advertising levels. If advertising levels are too high with competitive ownership, then they are even higher with monopoly, so that monopoly must reduce welfare. If they are too low, then monopoly ownership can raise welfare. If monopoly reduces the amount of programming, then the welfare analysis needs to take account of both changes in advertising levels and programming. Welfare comparisons are complicated by the fact that both advertising and programming could be either over- or under-provided with competitive ownership.

This analysis of the relative merits of monopoly and competition should be contrasted with

[31] For example, suppose that the "distance" disutility is no longer linear, but is instead given by $T(\lambda)$ where $T(\cdot)$ is increasing at an increasing rate. Moreover, suppose that the demand for advertisements is perfectly elastic. Then it is readily shown that the monopolist has a greater incentive to provide the second program.

[32] When pricing is possible, it is straightforward to show that monopoly can never lead to more programming than competition. Moreover, advertising levels are invariant to ownership regime as long as prices are used under competition.

the classic discussion in Steiner (1952). In our model, the fact that the monopoly internalizes business stealing discourages programming. By contrast, in Steiner's analysis it encourages the monopoly to produce more variety. Steiner argued that competition would duplicate popular program types, while a monopoly would have no incentive to duplicate because this would simply steal viewers from its own stations. It would, however, have an incentive to also provide less popular programming to the extent that this attracted more viewers.[33] While this argument does not emerge from our basic model, it does in the extension considered in the next section.

6 Extensions

This section addresses three important questions. First, is duplication of popular program types a problem with market provision, as suggested by the existing literature? Second, how are our findings concerning advertising levels impacted by the possibility that, in a dynamic world, viewers may switch between channels? Third, how do our results depend upon our specific model of advertiser demand?

6.1 Duplication

Our basic model is inappropriate for studying duplication because it assumes that both types of programs are equally popular. However, allowing one program type to be more popular does not generate duplication. If both broadcasters choose the more popular program type, competition for viewers would drive advertising levels and revenues down to zero. Thus, broadcasters will avoid duplication even when doing so would increase viewers.

The fierce advertising competition driving this conclusion reflects the assumption that two programs of the same type are perfect substitutes for viewers. In reality, there is considerable variation within a type of program: talk programs can discuss current affairs or offer personal

[33] As Beebe (1977) pointed out, if there were a "lowest common denominator" program that all viewers would watch, then a monopoly would have no incentive to provide anything else even if viewers had strong and idiosyncratic preferences for other types of programs.

advice; country programs can play classics or current hits; etc. Such variation means that programs of the same broad type are not perfect substitutes and hence broadcasters can and do offer programs of the same type. However, the welfare consequences of duplication are then less clear because there is a viewer benefit to having multiple differentiated programs of the same type. Thus, whether the market produces too much duplication is unclear.

This question can be addressed with an extension of the model. Suppose there are two varieties of each program type $i \in \{0, 1\}$, denoted i_1 and i_2. Each viewer is now characterized by a pair $(i, \xi) \in \{0, 1\} \times [0, 1]$ where i denotes his preferred type of program, and ξ his preferences over varieties of this program. Thus, a type (i, ξ) viewer gets gross viewing benefits $\beta - \gamma a - \tau\xi$ from watching a type i program of variety i_1 and $\beta - \gamma a - \tau(1 - \xi)$ from watching a type i program of variety i_2. To keep things simple, viewers receive no benefits from watching either variety of their less preferred type of program. There are N_i viewers preferring type i programs and type 0 programs are more popular (i.e., $N_0 > N_1$). For both program types, ξ is uniformly distributed on the interval $[0, 1]$.

With both stations operating, there are two possible market outcomes: *duplication* in which both broadcast type 0 programs of different varieties and *diversity* in which they broadcast different types of program. Since a lower value of τ means that the two varieties are closer substitutes, intuition suggests that the market outcome will be diversity for τ sufficiently low and duplication for τ sufficiently large. Indeed, it is easy to show that there exists a critical level of τ, such that the market outcome will be duplication for τ larger than this value and diversity for smaller τ.

If τ is large, providing both varieties of a type 0 program generates significant viewing benefits for type 0 viewers. Since these viewers are more numerous than type 1 viewers, optimal provision may then involve duplication. The key question is whether the market generates duplication in circumstances when optimal provision involves diversity. Our next proposition provides sufficient conditions for this to occur.[34]

Proposition 5 *Suppose that both optimal and market provision involve both channels operating. Then, if* $N_1 \in (\frac{\tau N_0}{4\beta-2\tau}, \frac{N_0}{2})$*, market provision involves duplication and optimal provision involves diversity when the nuisance cost of advertising is sufficiently small.*

Proof: Note first that equilibrium advertising levels under both duplication and diversity converge to the level that maximizes revenue per viewer ($\widehat{a}$) as γ becomes small. Moreover, under diversity, all type i viewers would watch the type i program. Thus, the market outcome will be duplication if $\frac{N_0}{2} > N_1$. With optimal provision, advertising levels under duplication and diversity converge to m as γ becomes small and, under diversity, all type i viewers would watch the type i channel. Moving from duplication to diversity must therefore raise advertiser benefits because the total viewing audience is greater under diversity ($N_0 + N_1$ vs. N_0). In addition, the move would create new viewing benefits of $N_1[\beta - \frac{\tau}{2}]$ for type 1 viewers, at a cost of a loss of viewing benefits of $N_0[\frac{\tau}{4}]$ for type 0 viewers. Accordingly, if $N_1[\beta - \frac{\tau}{2}] > N_0[\frac{\tau}{4}]$, diversity dominates duplication from a welfare standpoint. Thus, if $N_1 \in (N_0\frac{\tau}{4\beta-2\tau}, \frac{N_0}{2})$ market provision involves duplication and optimal provision involves diversity for sufficiently small γ. ■

Two further points about duplication should be noted. First, under monopoly ownership of the two channels, the market outcome would be diversity under the conditions of this proposition. This illustrates the advantage of monopoly stressed by Steiner. Second, duplication may be less likely with pricing because the ability to price may increase the advantage of having a more dedicated viewer base. To see this, suppose that τ is sufficiently small so that if broadcasters duplicate, they do not use prices. In this case, duplication is just as attractive as when pricing is infeasible. But monopoly profits can rise when pricing is feasible even when τ is small, so that

[34] Although this proposition restores the conclusion that the market can produce socially inefficient duplication, it does not imply that excessive diversity is impossible. In principle, the fiercer competition in advertising levels under duplication may encourage broadcasters to provide diversity before it is socially optimal. We have been unable to completely rule out this possibility in our model.

the profit from being the sole station in either niche rises.

6.2 Switching viewers

In the basic model, each broadcaster has a monopoly in delivering its viewers to advertisers. Exploitation of this monopoly power is one factor in explaining the possibility of under-advertising: broadcasters hold down advertising levels to drive up the price of reaching their exclusive viewers. In a dynamic world, viewers are likely to switch between channels, allowing advertisers to reach the same viewers through different stations. Broadcasters' desires to drive up prices are then dampened by the possibility that advertisers might choose to contact viewers via advertising on another station. This should mitigate the problem of under-advertising.

To investigate this logic, we now allow for two viewing periods, indexed by $t \in \{1, 2\}$.[35] Each viewer is now characterized by (λ_1, λ_2) where λ_t represents the viewer's period t preferences. As for the static model, we assume that in each period the parameter λ_t is distributed uniformly on the interval $[0, 1]$. However, we assume that for a fraction δ of viewers, $\lambda_2 = 1 - \lambda_1$, so that preferences differ across periods. For the remaining $1 - \delta$, $\lambda_2 = \lambda_1$ and preferences are stable. The parameter δ indexes the degree of correlation in the tastes of viewers across the periods. To motivate this formulation, imagine that the media is radio, the two periods are morning and afternoon, and the program types are news and music. Some people prefer music in both periods and others prefer news. But some like news in the morning and music in the afternoon and some the other way round. The size of this latter group is measured by δ.

To focus cleanly on the impact of competition for advertisers on advertising levels, we take each broadcaster's programming choice as exogenous: station A shows a type 0 program in each

[35] A dynamic model is necessary given the technological infeasibility of watching two television programs at once. In other advertising markets, such as yellow pages, magazines, or newspapers, it is possible to introduce competition for advertisers in a static framework. However, even static models of this form prove tricky to analyze (Armstrong (2002)).

period, while B shows a type 1 program.[36] We further assume that each broadcaster runs the same number of advertisments in each period. Finally, we assume that the distribution of advertiser types is uniform; i.e., that $F(\sigma) = \sigma/\overline{\sigma}$. We study the Nash equilibrium of the game in which each broadcaster simultaneously chooses its advertising level anticipating the impact on the price it can charge and its advertising revenues.[37]

We present results for the two extremes in which $\delta = 0$ and $\delta = 1$.[38] When $\delta = 0$, the game is analagous to that studied above - in equilibrium, all viewers watch the same channel in both periods and advertisers must advertise on both channels to contact all viewers. When $\delta = 1$, viewers switch between channels and advertisers can reach viewers *either* by advertising simultaneously on both channels *or* by advertising twice on one channel.

We briefly sketch how to solve the model when $\delta = 1$. The key step is to derive the inverse demand functions that the broadcasters face. Suppose that $a_B \geq a_A$ and that all consumers watch in both periods. In each period, viewers choose channels just as in the basic model. Thus, letting V_J denote the number of viewers of station J in each period, we have that

$$V_A = N[\frac{1}{2} + \frac{\gamma}{2\tau}(a_B - a_A)], \qquad (12)$$

and

$$V_B = N[\frac{1}{2} + \frac{\gamma}{2\tau}(a_A - a_B)]. \qquad (13)$$

No B viewers watch B's channel in both periods, while some of A's viewers remain loyal if $a_B > a_A$.

Let P_J be the market clearing price for advertising once on station J. Since B has higher advertising levels and hence less viewers, $P_A \geq P_B$. Advertisers have two basic options. They

36 We leave for future work the issue of how broadcasters compete in program scheduling. See Cancian, Bills and Bergstrom (1995) for a discussion of some technical difficulties that may arise in modelling program scheduling.

37 In this extension, because stations no longer have a monopoly in delivering their viewers to advertisers, it is no longer true that competition in advertising levels is equivalent to competition in prices. We study competition in advertising levels because it is much more tractable.

38 A full characterization of equilibrium is well beyond the scope of this paper. This is because for δ sufficiently close to 1 the only equilibrium is in mixed strategies.

can advertise twice on B or simultaneously on both stations. All other options are dominated. Advertising twice on B costs $2P_B$ but does not reach the viewers who watch A in both periods. Advertising simultaneously on both stations costs P_A+P_B and reaches all viewers. Failing to reach viewers is more costly for advertisers with more appealing products (high σ), so advertiser types choose over these two options in a monotonic way. Specifically, if $P_B/V_B \leq P_A/V_A$, advertisers with $\sigma \in [\frac{P_B}{\omega V_B}, \frac{P_A-P_B}{\omega(V_A-V_B)}]$ advertise twice on B, while those with $\sigma \in [\frac{P_A-P_B}{\omega(V_A-V_B)}, \overline{\sigma}]$ advertise simultaneously on both stations.[39]

If the prices P_A and P_B clear the market, the advertising levels a_A and a_B must equal half the desired number of advertisements on stations A and B. Given that $F(\sigma) = \sigma/\overline{\sigma}$, this means that

$$a_A = \frac{m}{2}[1 - \frac{P_A - P_B}{\overline{\sigma}\omega(V_A - V_B)}] \qquad (14)$$

and

$$a_B = \frac{m}{2}[1 - \frac{P_B}{\overline{\sigma}\omega V_B}] + \frac{m}{2}[\frac{P_A - P_B}{\overline{\sigma}\omega(V_A - V_B)} - \frac{P_B}{\overline{\sigma}\omega V_B}]. \qquad (15)$$

Inverting these, we obtain the inverse demands:

$$P_A(\cdot) = \overline{\sigma}\omega[V_A(1 - \frac{2a_A}{m}) + V_B(\frac{a_A - a_B}{m})], \qquad (16)$$

and

$$P_B(\cdot) = \overline{\sigma}\omega V_B[1 - \frac{a_A + a_B}{m}]. \qquad (17)$$

It follows from this that J's revenues are given by:

$$\pi_J(a_A, a_B) = \{ \begin{matrix} 2\overline{\sigma}\omega[V_J(1 - \frac{2a_J}{m}) + V_{-J}(\frac{a_J - a_{-J}}{m})]a_J & for\ a_J \leq a_{-J} \\ 2\overline{\sigma}\omega V_J[1 - \frac{a_A + a_B}{m}]a_J & for\ a_J > a_{-J} \end{matrix} \qquad (18)$$

Observe that π_J is a continuously differentiable function of a_J and that

$$\frac{\partial \pi_J(a,a)}{\partial a_J} = \overline{\sigma}\omega N[(1 - \frac{3a}{m}) - \frac{\gamma}{\tau}(1 - \frac{2a}{m})a]. \qquad (19)$$

[39] If $P_B/V_B > P_A/V_A$, the per viewer price of advertising on B is higher than on A and no advertisers will advertise twice on B.

Setting this derivative equal to zero, the equilibrium level of advertising is $a_A = a_B = a^*(1)$ where $a^*(1)$ is implicitly defined by the equation[40]

$$1 - \frac{3a^*(1)}{m} = \frac{\gamma}{\tau}a^*(1)(1 - \frac{2a^*(1)}{m}). \qquad (20)$$

By contrast, when $\delta = 0$ and viewers' preferences are stable across periods, the equilibrium level of advertising is $a^*(0)$ where $a^*(0)$ is implicitly defined by the equation

$$1 - \frac{4a^*(0)}{m} = \frac{\gamma}{\tau}a^*(0)(1 - \frac{2a^*(0)}{m}). \qquad (21)$$

It is apparent that $a^*(1) > a^*(0)$, implying that broadcasters hold down advertising levels more when they have a monopoly in delivering viewers. This means lower advertising prices and that under-advertising is less likely when viewers switch. More formally, we have:

Proposition 6 *In the two period model with $\delta \in \{0, 1\}$ there exists a critical nuisance cost $\gamma(\delta) \in (0, \omega\overline{\sigma})$ such that the equilibrium advertising level $a^*(\delta)$ is lower (higher) than the optimal level as γ is smaller (larger) than $\gamma(\delta)$. Moreover, $\gamma(1)$ is less than $\gamma(0)$, so that under-advertising is less likely when viewers switch stations.*

Proof: The optimal level is independent of δ and maximizes

$$4N \int_0^{\min\{\frac{1}{2}, \frac{\beta-\gamma a}{\tau}\}} (\beta - \gamma a - \tau\lambda)d\lambda + 2\int_0^{2a} P(\alpha, N(\min\{\frac{1}{2}, \frac{\beta - \gamma a}{\tau}\}))d\alpha.$$

The first term reflects viewer benefits and the second advertiser benefits (cf. (2)). Assuming that all viewers watch, the optimal level, denoted a^o, satisfies the first order condition $p(2a^o) \leq \gamma$ with equality if $a^o > 0$. We can now use similar arguments to those used to establish Proposition 1 to show that for $\delta \in \{0, 1\}$ there exists $\gamma(\delta) \in (0, \omega\overline{\sigma})$ such that the equilibrium advertising level is lower (higher) than the optimal level as γ is smaller (larger) than $\gamma(\delta)$. Since $a^*(1)$ exceeds $a^*(0)$, we have that $\gamma(1)$ is less than $\gamma(0)$. ■

[40] It may be shown that each broadcaster's revenue function is a quasi-concave function of its advertising level so that the first order condition implies a global maximum.

Thus, while under-advertising is still a possibility when viewers switch between channels, it is less likely than when viewers remain loyal to one channel. Each broadcaster is deterred from lowering its advertising level to increase its price by the credible threat that advertisers will simply switch all their business to its rival. Competition for advertisers therefore mitigates, but does not eliminate, the problem of under-advertising identified in the basic model.

6.3 Alternative models of advertiser demand

We have adopted a very specific model of the demand for advertising.[41] Advertisers are monopoly suppliers of new goods who wish to inform consumers about their products. These advertisers obtain all the gains from trade and each consumer's willingness to pay for any particular good is independent of the information received about any other good. These are strong assumptions and it is important to consider the sensitivity of our conclusions to our particular specification.

The positive results of the paper (such as the impact of pricing on advertising levels and programming) were derived using only general properties of the demand function for advertising. Thus, they will be true under any model of advertising generating a downward sloping demand curve. Our specification matters for the normative results. Its key implication is that the inverse demand function measures the social marginal benefit of advertising. This provides a neutral benchmark case where the marginal advertiser's willingness to pay correctly reflects the social benefit of an advertisement.

Even when advertising informs consumers about new goods, the advertising literature identifies a number of reasons why private benefit may diverge from social benefit. Shapiro (1980) notes that a monopolist's private benefit to informing consumers about its good will underestimate the social benefit whenever consumers capture some of the surplus from trade. Supposing that suppliers do not gain all the surplus from trade would lead the inverse demand function to understate the social

[41] See Bagwell (2003) for a comprehensive review of the economics of advertising.

benefit of advertising. This per se reduces the likelihood of excessive advertising. However, when consumers obtain surplus from new goods, the effective nuisance cost of advertising is reduced and this increases equilibrium advertising levels (see footnote 11).

If though the new goods are *substitutes* for consumers, the inverse demand curve for advertising may overstate its marginal social benefit. For example, following Grossman and Shapiro (1984), suppose that individuals purchase a single good from those they have been informed about. Then there is a business stealing externality in placing an advertisement insofar as trade may come at the expense of the advertiser's competitor. The likelihood of there being too few commercials is reduced if the business stealing externality dominates the consumer surplus one.

An alternative perspective on advertising is that it *persuades* individuals that they would benefit from a product and so increases consumer willingness to pay. The normative implications of this approach depend very much on how one views the "persuasion". If it generates a legitimate increase in willingness to pay, then it is similar to informative advertising from a social perspective insofar as both types create surplus-enhancing trades. However, if persuasion makes consumers crave products they do not really want, then their pre-advertisement demand curves reflect their true willingness to pay and (ignoring pre-existing distortions) buying advertised goods is just a transfer from consumers to advertisers generating no net wealth (see Dixit and Norman (1978)). Advertising therefore has no social benefit and its optimal level is zero. Ignoring political economy issues, commercial broadcasting will be dominated by tax-payer financed public broadcasting.

7 Conclusion

This paper has analyzed the nature of market failure in the broadcasting industry. Equilibrium advertising levels under monopoly or competition can be above or below socially optimal levels. A monopoly broadcaster does not fully internalize the nuisance costs of advertisements to viewers, only caring to the extent that they induce viewers to switch off. However, the broadcaster holds down advertising levels to bolster prices. Under competition, broadcasters only care about nuisance costs insofar as they induce viewers to switch stations. Depending on the substitutability of programs, this may over- or under-state the true nuisance costs to viewers. Competitive broadcasters also retain market power over advertisers to the extent that they can offer exclusive access to their viewers. This market power leads them to hold down advertising levels.

It is perhaps surprising that there is no clear-cut case for advertising ceilings. However, the possibility that advertising levels are too low reflects our benchmark assumption that the demand price of advertising equals its marginal social benefit. As we have noted, there are reasons to believe that the marginal advertiser's willingness to pay may exceed social benefit and this decreases the likelihood of there being too few commercials. Even when the market provides excessive advertising, however, ceilings may be undesirable because they reduce revenues and hence may constrict programming.[42]

Markets can provide too few or too many programs. A broadcaster's decision to provide programming ignores the extra viewer and advertiser surpluses generated, and the loss of advertising revenue inflicted on competitors. Underprovision will arise when the benefits of programming to viewers are high relative to the benefits advertisers get from contacting viewers. This may explain the prevalence of public broadcasting in the early stages of a country's development when advertising benefits are likely to be low. Overprovision can arise when program benefits are low relative to advertiser benefits and nuisance costs are low. The market may also misallocate resources by providing multiple varieties of popular program types, when society would be better served with programs of different types. The problem, once again, is that stations do not account for the lost advertising revenues to competitors when choosing their format.

Regarding the debate over the role of public or not-for-profit broadcasting, the results make

[42] Ceilings may also reduce program quality as argued by Wright (1994) and/or reduce program differentiation as argued by Gabszewicz, Laussel, and Sonnac (2001).

clear that the market may not always provide socially valuable programming. However, the possibility that the market overprovides programming means that arguments for public broadcasting should not be made on a priori grounds (as in, for example, the Davies Report (1999)). Any assessment of the case for public broadcasting should also consider how programming and funding decisions are made in the public sector, an interesting subject for further study.[43]

There should be no presumption that increased concentration of ownership in the broadcasting industry is necessarily detrimental to social welfare. Such concentration may raise advertising levels or reduce programming, but this may be desirable. Welfare analysis is complicated by the fact that even if one knows how concentration changes the equilibrium, one needs to know whether advertising and programming were over- or under-provided beforehand.

Finally, the ability to price programming does not necessarily solve the problems of market provision. With such pricing, broadcasters can internalize the nuisance of advertisements by substituting prices for advertising at the margin. In addition, pricing enables more programming by allowing broadcasters to directly extract revenue from viewers. However, lower advertising levels and more programming are not necessarily socially desirable. Pricing may also result in some viewers being inefficiently excluded.

[43] For an entertaining discussion of this issue see Coase (1966).

References

Anderson, Simon and Stephen Coate, [2000], "Market Provision of Public Goods: The Case of Broadcasting," NBER Working Paper 7513.

Armstrong, Mark, [2002], "Competition in Two-Sided Markets," mimeo, Nuffield College, Oxford.

Bagwell, Kyle, [2002], "The Economic Analysis of Advertising," mimeo, Columbia University.

Becker, Gary and Kevin Murphy, [1993], "A Simple Theory of Advertising as a Good or Bad," *Quarterly Journal of Economics*, 107, 942-964.

Beebe, Jack, [1977], "Institutional Structure and Program Choices in Television Markets," *Quarterly Journal of Economics*, 91, 15-37.

Berry, Steven and Joel Waldfogel, [1999], "Free Entry and Social Inefficiency in Radio Broadcasting," *Rand Journal of Economics*, 30, 397-420.

Brown, Allan and Martin Cave, [1992], "The Economics of Television Regulation: A Survey with Application to Australia," *The Economic Record*, 68, 377-94.

Cancian, Maria, Bills, Angela and Theodore Bergstrom, [1995], "Hotelling Location Problems with Directional Constraints: An Application to Television News Scheduling," *Journal of Industrial Economics*, 43, 121-124.

Coase, Ronald, [1966], "The Economics of Broadcasting and Government Policy," *American Economic Review*, 56, 440-447.

Cornes, Richard and Todd Sandler, [1996], *The Theory of Externalities, Public Goods and Club Goods* (Second Edition), Cambridge University Press: Cambridge.

Davies, Gavyn et al, [1999], *The Future Funding of the BBC*: *Report of the Independent Review Panel*, Department of Culture, Media and Sport.

Dixit, Avinash and Victor Norman, [1978], "Advertising and Welfare," *Bell Journal of Economics*, 9, 1-17.

Doyle, Chris, [1998], "Programming in a Competitive Broadcasting Market: Entry, Welfare and Regulation," *Information Economics and Policy*, 10, 23-39.

Dukes, Anthony and Esther Gal-Or, [2003], "Minimum Differentiation in Commercial Media Markets," *Journal of Economics and Management Strategy*, 12, in press.

Ekelund, Robert, Ford, George and John Jackson, [1999], "Is Radio Advertising A Distinct Local Market? An Empirical Analysis," *Review of Industrial Organization*, 14, 239-256.

Gabszewicz, Jean, Laussel, Didier and Nathalie Sonnac, [2001], "TV Broadcasting Competition and Advertising," mimeo, CORE.

Grossman, Gene and Carl Shapiro, [1984], "Informative Advertising with Differentiated Products," *Review of Economic Studies*, 51, 63-81.

Hansen, Claus and Soren Kyhl, [2001], "Pay-per-view Broadcasting of Outstanding Events: Consequences of a Ban," *International Journal of Industrial Organization,* 19, 589-609.

Holden, Steinar, [1993], "Network or Pay-per-view?" *Economics Letters*, 43, 59-64.

Kuczynski, Alex, [2000], "Radio Squeezes Empty Air Space for Profit," *New York Times*, January 6, 2000.

Leonhardt, David, [2000], "Let a Thousand New Voices Bloom," *New York Times*, July 16, 2000.

Mankiw, N. Gregory and Michael Whinston, [1986], "Free Entry and Social Inefficiency," *Rand Journal of Economics*, 17, 48-58.

Masson, Robert, Mudambi, Ram and Robert Reynolds, [1990], "Oligopoly in Advertiser-Supported Media," *Quarterly Review of Economics and Business*, 30 (2), 3-16.

Minasian, Jora, [1964], "Television Pricing and the Theory of Public Goods," *Journal of Law and Economics*, 7, 71-80.

Motta, Massimo and Michele Polo, [1997], "Concentration and Public Policies in the Broadcasting Industry: The Future of Television," *Economic Policy*, 25, 294-334.

Owen, Bruce and Steven Wildman, [1992], *Video Economics*, Harvard University Press: Cambridge, MA.

Rochet, Jean-Charles and Jean Tirole, [2001], "Platform Competition in Two-Sided Markets," mimeo, Toulouse.

Rysman, Marc, [2002], "Competition between Networks: A Study of the Market for Yellow Pages," *Review of Economic Studies*, forthcoming.

Samuelson, Paul, [1958], "Aspects of Public Expenditure Theories", *Review of Economics and Statistics*, 40, 332-338.

Samuelson, Paul, [1964], "Public Goods and Subscription TV: Correction of the Record," *Journal of Law and Economics*, 7, 81-83.

Shapiro, Carl, [1980], "Advertising and Welfare: Comment," *Bell Journal of Economics*, 11, 749-752.

Spence, Michael, [1976], "Product Selection, Fixed Costs and Monopolistic Competition," *Review of Economic Studies*, 43, 217-235.

Spence, Michael and Bruce Owen, [1977], "Television Programming, Monopolistic Competition and Welfare," *Quarterly Journal of Economics*, 91, 103-126.

Steiner, Peter, [1952], "Program Patterns and Preferences, and the Workability of Competition in Radio Broadcasting," *Quarterly Journal of Economics*, 66, 194-223.

1999 Television Commercial Monitoring Report, American Association of Advertising Agencies.

Vaglio, Alessandro, [1995], "A Model of the Audience for TV Broadcasting: Implications for Advertising Competition and Regulation," *Rivista Internazionale di Scienze Economiche e Commerciali*, 42 (1), 33-56.

Wildman, Steven and Bruce Owen, [1985], "Program Competition, Diversity, and Multichannel Bundling in the New Video Industry," in Eli Noam, (ed.), *Video Media Competition: Regulation, Economics and Technology*, Columbia University Press: New York.

Wright, Donald, [1994], "Television Advertising Regulation and Program Quality," *The Economic Record*, 70, 361-367.

Wright, Julian, [2002], "Access Pricing under Competition: An Application to Cellular Networks," *Journal of Industrial Economics*, 50, 289-315.