TV ADVERTISING, PROGRAMMING INVESTMENTS, AND PRODUCT-MARKET OLIGOPOLY *

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Abstract:

We present a model of the TV-advertising market that encompasses both the product markets and the market for TV programs. We argue that the TV industry has several idiosyncratic characteristics that need to be modeled, and show that the strategic interaction in this industry differs from other industries in many respects. We find that a move from a TV monopoly to a TV duopoly may reduce both the total number of viewers and the total amount of TV advertising. A softening of price competition in each product market results in more investment in programming, higher price per advertising slot, and more advertising. A reduction of the number of firms in each product market may have the opposite effect if the price competition in the product market is sufficiently soft initially. Finally, we find that even small asymmetries between product markets can cause large asymmetries with respect to which producers buy advertising on TV.

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1. INTRODUCTION

The television industry is often referred to as part of the entertainment business. In that respect, it is an important industry, for example in terms of the time people spend watching TV.[1] However, it is also important as a transmitter of advertising for producers in the product markets.[2] The purpose of this article is to investigate the two-fold role of television, both as a provider of entertainment and as a transmitter of advertising. Our main focus is on the interplay between the TV market and the product markets through the market for advertising. We examine how the rivalry between TV channels and the profit potential in the product markets affect TV channels' prices on advertising slots, their investments in programming, and the producers' purchase of advertising on TV.

Despite the important role of the TV industry, there are relatively few studies of this particular industry in the economics literature. The studies that do exist typically focus on how rivalry between TV channels affects program diversity.[3] With a few notable exceptions, the choice of advertising on TV is not taken into consideration.[4] One of the

[1]See, for example, Robinson and Godbey (1999).

[2]The amounts spent on TV advertising are significant. In one survey, TV advertising in the US amounted to $ 41.1 billion, out of a total advertising of $ 79.5 billion; *i.e.*, more than half of all advertising (see http://adage.com/dataplace/archives/dp394.html). In another survey, TV advertising in the US was projected to $ 52 billion, 39 % of total advertising (see http://adage.com/dataplace/topmarkets/). According to the latter survey, TV's share of total advertising varies considerably between countries. While its share is 60 % in Brazil, its share of total advertising is only 23 % in Germany.

[3]Steiner (1952), focusing on radio broadcasting, was concerned about whether competing radio stations would air identical type of programs at the same time. For elaborations on his model, see Owen and Wildman (1992). Spence and Owen (1977) use a model of monopolistic competition to compare the program diversity of pay-TV and advertising-financed TV. In Nilssen and Sørgard (1998), a TV duopoly where TV channels choose both programs' contents and their time scheduling is discussed. Empirical studies of program diversity, such as Rust and Eechambadi (1989), Rust *et al*. (1992), Goettler (1999), and Goettler and Shachar (1999), primarily focus on how to estimate the viewers' demand for TV programs and the implications for TV stations' program choice; see also Berry and Waldfogel (1999) on radio broadcasting.

[4]Zhou (1999) examines the timing of commercial breaks in a monopoly as well as a duopoly TV industry. However, he does not model the producers' choice of advertising. Grossman and Shapiro (1984), on the other hand, do model the producers' choice of advertising. But in neither of these models are the TV channels' choices of advertising space and price of advertising analyzed. In Nilssen and Sørgard (2000),

notable exceptions is Anderson and Coate (2000).[5] Their study relates closely to the existing literature on program diversity, since they analyze a TV channel's choice between two types of programs. They view advertising as a link between the product markets and the TV market, and their main concern is the market's ability to provide an efficient outcome. On the one hand, viewers dislike commercial breaks. On the other hand, viewers, as consumers, receive information about new products from advertisements on TV. They find that the market in some cases leads to under-provision of advertisements and/or programming and in some cases to over-provision.

Another exception is Motta and Polo (1997a). They examine how TV channels' investments in programming to attract viewers affect the structure in the TV market. In line with Sutton (1991), they find that, even in a large market, the number of TV channels can be limited in a free-entry equilibrium. The reason is that a large market size triggers intense rivalry in programming and thereby a high endogenous fixed cost per firm.

Our model encompasses the two-fold role of television, as is the case in the models introduced in Anderson and Coate (2000) and Motta and Polo (1997a). However, our study is different from theirs in many other respects. One important distinction between our model and Anderson and Coate's (2000) model is that we let investments in programming be a choice variable. Although our model approach thus is much more closely related to Motta and Polo (1997a), it still has a focus distinctly different from theirs. We examine how product-market competition affects the equilibrium outcome in the TV industry. The profit potential in the product market depends on the toughness of

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the model introduced in Grossman and Shapiro (1984) is extended to take into account rivalry between TV stations on the price of advertising.

[5]Gabszewicz *et al*. (2000) is another notable exception, and it shares many similarities with the modeling approach in Anderson and Coate (2000). They introduce advertising in a Hotelling-type model of the TV

price competition, the number of producers, as well as other factors.[6] Motta and Polo (1997a) do not raise this issue, nor do Anderson and Coate (2000). In addition, we examine the interplay between several product markets, another issue not raised neither in Motta and Polo (1997a) nor in Anderson and Coate (2000).

A basic feature in our model is that viewers are attracted to a TV channel that invests in programming, but they dislike TV advertising. A TV channel, on the other hand, earns its revenues by selling advertising slots to producers in the product market and attracts viewers for this advertising by investing in programming. The producers in the product markets expand sales by advertising. Clearly, then, advertising is the link between the TV market and the product markets. Since an increase in the amount of advertising tends to reduce the number of TV viewers, there are *diminishing returns to TV advertising*. In addition, there is *congestion in TV advertising*: The more one producer advertises its own products on a particular TV channel, the fewer viewers are available there for other producers to advertise to.

The TV channels set the amounts of programming investment and the prices (or quantities) of advertising, while the producers determine their demand for advertising and the product price. There are, however, numerous questions that arise when we try to model the TV industry, questions that have not been discussed in the existing literature.

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industry. Each TV firm chooses a program which consists of a mix of entertainment and culture. In contrast to our model, neither the product market nor the programming investment is explicitly modeled.

[6]Sutton (1991) shows, both theoretically and empirically, that the structure in advertising-intensive industries differs from other industries. In particular, the endogenous nature of advertising results in high fixed costs and thereby a limited number of firms. [See also Robinson and Chang (1996).] This suggests that the products markets in question here have a limited number of active firms. In fact, among the top ten advertisers on network TV in the US in 1999, there are three automobile producers (*GM*, *Ford* and *DaimlerChrysler*) and five producers of dominant brands in consumer goods industries such as, for example, cosmetics and beer (*Procter & Gamble*, *Johnson & Johnson*, *Philip Morris*, *Unilever and Diageo*). On spot TV in the US, six out of the top ten advertisers are automobile firms. See the data reported on http://adage.com/dataplace/archives. This suggests that the major advertisers on TV are

For example, it is not clear (i) whether the TV channels set the quantity or price of advertising, nor (ii) whether advertising is priced per slot or per viewer. In Section 2, where we present our model and its equilibrium, we therefore also report how different assumptions affect the equilibrium outcomes and the interaction between different choice variables (strategic substitutes versus strategic complements). This enables us to better understand the implications of some idiosyncratic characteristics in the TV industry.

Among the results reported in this section, we find that advertising in the two TV channels are either complementary goods for the advertisers (if advertising is priced per slot) or independent goods (if advertising is priced per viewer). In the former case, TV channels' prices of advertising are strategic substitutes, while if TV channels choose quantities and/or advertising is priced per viewer, then TV channels' strategic variables are strategic complements. Interestingly, we find that a TV channel's two strategic variables, programming investment and either price or quantity, always reinforce each other: Increasing one also increases the marginal profit with respect to the other. The outcome is that, when the price of advertising is high, so is also investment in programming. In all cases that we consider, the positive effect of the latter on the demand for advertising dominates the negative effect of the former, so that also advertising is high when the price of advertising is high. Advertising and programming investments are the highest when advertising is priced per slot and TV channels compete in prices.

In Sections 3 to 5, we apply the model to investigate three different issues. We start out, in Section 3, by asking how rivalry in the TV market affects the equilibrium outcome. This is done by analyzing the transition from monopoly to duopoly. We find

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dominant firms in what we typically characterize as oligopolistic industries. In line with this, we find it plausible to assume strategic interaction in the product markets that we model.

that adding a TV channel may actually decrease the amount of TV advertising as well as the total number of viewers. This happens when, in a duopoly situation, viewer leakage between the TV channels is large.

In Section 4, we ask how product-market competition affects the equilibrium outcome. A change in product market competition can come about through either a change in the number of firms in a market or a change in market conduct. In our model, the two interact: We find that an increase in the number of firms in each product market decreases advertising when producers compete in quantities but increases advertising when producers collude.

Finally, in Section 5, we ask how the existence of several product markets affects the TV industry. We analyze a case of two product markets that differ with respect to the number of firms in each. We find that, in equilibrium, the firms operating in the less concentrated, and thus less profitable, profit market find advertising so unprofitable that they choose to abstain from advertising altogether, leaving advertising to the firms in the more profitable product market.

In Section 6, we summarize our results and point to some issues for future research. Proofs not given in the text are collected in the Appendix.

2. THE MODEL AND ITS EQUILIBRIUM

Consider n advertising firms and a TV industry with two TV channels, where $n \geq 2$.[7] The n advertising firms may or may not belong to the same product market. For now, we

[7]For some of our results, we need to extend our model, in a straightforward way, to the case of a single-channel TV monopoly.

assume only that the product markets are identical, so that firms are symmetric in terms of their gains from advertising.

There are at least two issues concerning the modeling of competition between TV channels. The first one is already a classic one in the modern theory of industrial organization: Do TV channels compete in the market for TV advertising by choosing quantities or prices? A quick look at any commercial TV station's programming may indicate that the quantity of advertising on a channel is restricted by the programs being aired there. If, for example, a TV channel transmits a series of 25-minute sit-coms during an evening, there will only be time for 5 minutes of advertising per half-hour. Such a capacity constraint points, along the lines suggested by Kreps and Scheinkman (1983) and Tirole (1988), in the direction of treating the quantity of advertising as the actual decision variable for a TV channel. On the other hand, there are also other programs on any TV station's schedule where the quantity of advertising is much more flexible. For example, when transmitting newscasts and sports events, the TV station may be able to put on air large quantities of advertising. In order to accommodate a small amount of advertising sold, a TV channel can fill in with advertising for its own programs.[8] This points in the direction of letting the price of advertising be a TV channel's decision variable, with its quantity of advertising being determined by how much it can sell at its chosen price. In line with this reasoning, we assume that the TV channels set prices of advertising. However, in the discussion of the model in this Section, we also explore the effects of letting quantity rather than price being the decision variable.

[8]Such advertising for own programs are called "tune-ins". According to Shachar and Anand (1998), tune-ins constituted about one-sixth of total advertising on US TV networks in 1995.

The second modeling issue is more idiosyncratic to the TV industry: What is the unit of pricing of advertising? One argument would be that the TV channels are able to keep records of how many viewers any program has. This is done through viewer meters that record, for a sample of the population, which programs are watched. These records are then used to determine how much advertisers will have to pay for the advertising they purchase on a TV channel. These concerns make it important to include, in our initial analysis, the case of advertising being priced per viewer. At the same time, however, there are reasons to believe that this recording has its limitations. In fact, it has been reported that TV channels have not been able to set a price per viewer of advertising.[9] When this is the case, it is closer to the more standard flavor where price is set per advertising slot. We therefore assume, later on, that the TV channels set a price per advertising slot. However, when presenting the model in this Section, we explore the effects of the two alternative assumptions: letting the firms set the price of advertising either per viewer or per slot.

Other aspects of our model are more straightforward, such as the sequencing of decisions. It is crucial that TV viewers make their decisions knowing the benefit they gain from each TV channel. Thus, TV channels' programming decisions, as well as advertising firms' advertising decisions, are made before TV viewers make their choices in our model. At the same time, the effect of advertising on the product markets is only felt after the advertising has been actually aired and watched by the viewers-consumers. Thus, product-market competition takes place after the TV viewers' decisions are made.

[9]According to Goettler (1999), a typical contract between an advertiser and a TV channel specifies the prices to be paid for an advertising slot and minimum guaranteed ratings. When the guaranteed ratings are not attained, the advertiser's ad is aired later, in another show. However, the additional ad slot is typically aired on a less popular show and does not fully compensate advertisers.

Finally, we will assume that the advertising firms make their decisions about how much to advertise on each channel only after the TV channels have committed, not only their programming investments, but also to their prices (or quantities) of advertising. These considerations give rise to the following four-stage game:

Stage 1: Each TV-channel chooses its price (or quantity) of advertising and its investments in programming.

Stage 2: Each producer determines how much to advertise in each TV channel.

Stage 3: Each viewer decides whether or not to watch TV and, if so, which TV channel to watch.

Stage 4: The producers compete in the product market.

For the sake of analytical simplicity, we will represent a TV channel's decision on programming investments by the resulting attractiveness of the channel's programs. We will denote our measure of attractiveness by *quality*, in line with Motta and Polo (1997a) and Sutton (1991), although there is arguably only a weak connection between the popularity and the quality of TV programs.[10]

Since we are interested in finding the subgame perfect equilibrium of this game, we proceed by backward induction and start out with describing and analyzing stage 4.

Stage 4: The product market

In Section 4, we will discuss the product market in detail. For the moment, let us simply assume that a firm's profits, gross of advertising costs, are proportional to its level of advertising. Thus, in our model, there are constant returns to scale in advertising when

[10] A different approach is taken by Cabizza and De Fraja (1998), who let quality be a measure of the regulator's taste for the programming, rather than of its popularity among viewers.

the product market is viewed in isolation. As will be clear shortly, diminishing returns to advertising are introduced through the effect of advertising on TV viewers' behavior.

Let firm *i*'s advertising on channel *k* be denoted a_{ik}. Define Z_{ik} as firm *i*'s gross profit per viewer of channel *k*. The assumption we will stick to throughout is that the effect of advertising is multiplicatively separable from the other effects. To start with, we also assume that those other effects are the same for all advertising firms. In particular, we assume, for now, that there exists some $K > 0$ such that:

$$Z_{ik} = Ka_{ik}, \tag{1}$$

While we, in this section and the next, simply assume (1) to hold, we will, in Section 4, present a model of the product markets with the property that (1) holds in equilibrium. Later on, in Section 5, we will allow *K* to differ across product markets, although not across firms in the same market.

Stage 3: The viewers

At stage 3, viewers decide whether or not to watch a TV channel. A typical viewer is attracted by the quality of TV programs but dislikes commercial breaks.[11] In line with this, we assume that a channel's number of viewers is increasing (decreasing) in own (rival) program quality and decreasing (increasing) in own (rival) number of advertising slots.

Let q_k denote program quality in channel *k*. Moreover, define total advertising on

[11]It is documented that viewers try to escape from advertising breaks, see, *e.g.*, Moriarty and Everett (1994) and Danaher (1995). In this respect, TV advertising may be distinctly different from advertising in other media. In particular, readers may actively look for certain advertisements in newspapers or magazines. Accordingly, Häckner and Nyberg (2000), in their analysis of the newspaper industry, assume that newspaper readers like advertising. Other analyses of media valued by their consumers for their advertising include Rysman (2000) on Yellow Pages, and Baye and Morgan (1999) on information gateways on the Internet.

channel k as $\alpha_k := \sum_i a_{ik}$. We specify the following audience function for TV channel k, *i.e.*, the channel's number of viewers:[12]

$$v_k = [q_k - \alpha_k] - d[q_h - \alpha_h], \quad b > 0, d \in (0, 1), \ k, h \in \{1, 2\}, k \neq h. \qquad (2)$$

The parameter d captures the extent to which viewers switch TV channel because of a difference in the net program quality, $q - \alpha$. In the case of a TV monopoly, the number of viewers for the single channel is given by the expression in (2), with $d = 0$.

Note that our audience function, where an increase in advertising reduces a channel's number of viewers, introduces diminishing returns to a producer's advertising: The more a firm advertises on a TV channel, the fewer viewers the channel has, and the lower gross profits the firm earns. But this also creates a congestion effect from advertising: The reduction in the number of viewers caused by one firm's advertising affects negatively not only this firm but also other firms advertising on the same TV channel.

Stage 2: Producers choose advertising

At stage 2, the producers in the product markets decide how much to advertise on each TV channel. This is a special kind of congestion game between the advertisers: When one advertiser increases its advertising on a TV channel, this will reduce the number of viewers on this channel for all its advertisers. Moreover, since viewers may switch between the TV channels as a result of differences in net quality, an advertiser may help its own (and all other advertisers') advertising on one channel by increasing its

[12]This audience function resembles, and is inspired by, the one in Motta and Polo (1997a). Theirs, unlike ours, is derived from a discrete-choice model of viewer behavior. Their formulation is, however, not analytically tractable for a number of our purposes.

advertising on the other channel. This causes advertising on the two channels to be complementary goods – but only when advertising is priced per slot. We have:[13]

Proposition 1: *The demand for advertising.*

(i) If advertising is priced per slot, then advertising on the two channels are complementary goods for the advertising firms, and advertising demand at each TV channel is a decreasing function of the two channels' prices per advertising slot.

(ii) If advertising is priced per viewer, then advertising on the two channels are independent goods for the advertising firms, and advertising demand at each TV channel is an increasing function of the channel's price of advertising per viewer.

Proof: (i) Let r_k denote the price per advertising slot charged by channel *k*. Producer *i* has the following maximization problem at stage 2:

$$\underset{a_{i1},a_{i2}}{Max}\ \pi_i = \sum_{k=1}^{2} Z_{ik} v_k - \sum_{k=1}^{2} r_k a_{ik} = \sum_{k=1}^{2} (K v_k - r_k) a_{ik} \qquad (3)$$

Total gross profits are the per-capita gross profits times the number of viewers. Producer *i*'s advertising on the two channels is determined by the following first-order conditions:

$$\frac{d\pi_i}{da_{ik}} = K\left[\left(q_k - dq_h\right) - 2\left(a_{ik} - da_{ih}\right) - \left(\alpha_{-i,k} - d\alpha_{-i,h}\right)\right] - r_k = 0\,,\ k, h \in \{1, 2\},$$

where $\alpha_{-i,k} = \sum_{j \neq i} a_{jk}$.

[13]In all cases with symmetric producers, as they are here, we will resort to analyzing symmetric equilibria.

In a symmetric equilibrium, this gives rise to a system of two equations, which we solve for a producer's demand for advertising in each channel. We find that a producer's demand for advertising space is determined by the TV channels' program quality and advertising prices in the following way:

$$a_k = \frac{1}{n+1}\left[q_k - \frac{r_k + dr_h}{K(1-d^2)}\right],\ k, h \in \{1, 2\}, \qquad (4)$$

where a_k denotes a producer's demand for advertising on channel k. From this expression, we see that advertising on one channel is complementary to advertising on the other, and demand is decreasing in the prices.

(ii) Let ρ_k be the price charged by channel k per viewer from each advertiser. Now, producer i solves the problem:

$$\underset{a_{i1}, a_{i2}}{Max}\ \pi_i = \sum_{k=1}^{2} Z_{ik} v_k - \sum_{k=1}^{2} \rho_k v_k = \sum_{k=1}^{2} (K a_{ik} - \rho_k) v_k$$

Proceeding as above, this gives rise to the following demand for advertising on channel k:

$$a_k = \frac{1}{n+1}\left[q_k + \frac{\rho_k}{K}\right] \qquad (5)$$

Thus, the demand for advertising in one channel is independent of the price of advertising per viewer on the other channel, and demand is increasing in own price. *QED*.

Because of symmetry, total advertising on channel k is simply

$$\alpha_k := n a_k,\ k \in \{1, 2\}, \qquad (6)$$

where the proper expression to be inserted for a_k depends on how advertising is priced.

To see why advertising in the two channels are complements when advertising is priced per slot, note that an increase in the advertising price of one channel will decrease the amount of advertising there. This decrease in advertising makes the channel more attractive for viewers, and some viewers move over from the other channel. This reduction in the number of viewers on the other channel leads to a reduction in advertising in that channel as well.

Notice from (5) that, when advertising pricing is per viewer, demand appears to be increasing in the price. However, in this case, we have a decision variable on the demand side that does not match the unit of pricing. If a TV channel's price of advertising per viewer increases, then each advertiser would like to decrease his advertising on this channel, in terms of viewers watching the advertising. But in order to do this, the advertiser must act so as to decrease the number of viewers of its advertising, and the way to obtain such a decrease is by advertising more. Thus, an increase in the price of advertising per viewer leads to an increase in the demand for advertising.

This increase in advertising on one channel, following an increase in its advertising price per viewer, makes some of the viewers switch over to the other channel. However, this increase in viewers of the other channel induces an increase in the advertising in that channel in order for advertisers to get the number of viewers down to the level that they demand. The outcome of this regression is in equation (5) above. With advertising being priced per viewer, the effect on the TV audience of advertising is totally internalized in the price. This leaves advertising on one channel unaffected by both the other channel's advertising price, and the extent to which viewers switch channels when faced with differences in net quality, as measured by d.

In the case of a one-channel TV monopoly, the demand for advertising space on the only TV channel present is found, in the case of advertising being priced per slot, from the expression in (4) by putting $d = 0$. In the other case, advertising being priced per viewer, the demand is unrelated to d, and therefore the expression in (5) applies to the monopoly case as it is.

Stage 1: TV channels choose advertising prices and programming investments

A TV channel's profit is the difference between its revenue from advertising and its investments in programming. The latter is modeled as a cubic function of the program quality.[14] TV channel k's problem at Stage 1 is to maximize its profits with respect to its programming and its other strategic variable, either the quantity or the price of advertising.

The concepts of strategic complements and strategic substitutes, introduced by Bulow *et al.* (1985), are useful for understanding the nature of the competition in a market. Let TV channel k's profit be denoted H_k and a generic strategic variable for the TV channels be denoted u_k. The TV channels' us are *strategic complements* if channel k's marginal profits with respect to u_k is increasing in u_h, $k \neq h$, formally, if $\partial^2 H_k/\partial u_k \partial u_h > 0$, and they are *strategic substitutes* if the opposite relation holds, *i.e.*, if $\partial^2 H_k/\partial u_k \partial u_h < 0$. In most textbook models, prices are strategic complements and quantities are strategic substitutes [see, *e.g.*, Tirole (1988)]. This is not so in the present model. We have:

[14]This appears to be the simplest specification ensuring interior equilibrium levels of programming investments; in particular, a quadratic function is not convex enough. The cubic programming investment function is also used by Motta and Polo (1997a).

Proposition 2: *Strategic variables – prices and quantities*

(i) If advertising is priced per slot, then advertising prices are strategic substitutes and advertising quantities are strategic complements.

(ii) If advertising is priced per viewer, then both advertising prices and advertising quantities are strategic complements.

Proof: (i) In this case, advertising is priced per slot. The profit of TV channel k, $k \in \{1, 2\}$, is:

$$H_k = r_k \alpha_k - \frac{q_k^3}{3}. \qquad (7)$$

Suppose first that TV channels set prices in addition to program quality. From (4) and (6), we find TV channel k's residual demand for advertising as:

$$\alpha_k = \frac{n}{n+1}\left[q_k - \frac{r_k + d r_h}{K(1-d^2)} \right], \; k, h \in \{1, 2\}.$$

Inserting this into (7) and differentiating, we find that:

$$\frac{\partial^2 H_k}{\partial r_k \partial r_h} = -\frac{nd}{K(n+1)(1-d^2)} < 0.$$

Suppose next that TV channels set quantities of advertising in addition to program quality. The prices of advertising are those that clear the market, *i.e.* r_1 and r_2 must solve: $\alpha_k = n a_k$, $k \in \{1, 2\}$, with a_k given in (4). Thus, channel k's inverse residual demand for advertising is:

$$r_k = K\left[(q_k - d q_h) - \frac{n+1}{n}(\alpha_k - \alpha_h) \right], \; k, h \in \{1, 2\}. \qquad (8)$$

Inserting this into (7) and differentiating, we now have:

$$\frac{\partial^2 H_k}{\partial \alpha_k \partial \alpha_h} = \frac{K(n+1)d}{n} > 0$$

(ii) In this case, advertising is priced per viewer, and the advertising price of TV channel k is denoted ρ_k. First, let us suppose that TV channels set prices in addition to program qualities. From (2), (5), and (6), we find how a TV channel's audience depends on the TV channels' prices and program qualities:

$$v_k = q_k - na_k - d(q_h - na_h) = \frac{1}{n+1}\left[(q_k - dq_h) - \frac{n}{K}(\rho_k - d\rho_h)\right] \qquad (9)$$

With advertising priced per viewer, channel k's profit in this case equals:

$$H_k = \rho_k v_k - \frac{q_k^3}{3}. \qquad (10)$$

Inserting (9) into this expression and differentiating, we have:

$$\frac{\partial^2 H_k}{\partial \rho_k \partial \rho_h} = \frac{nd}{K(n+1)} > 0.$$

Suppose next that TV channels set advertising quantities rather than prices. Now, the advertising prices per viewer at the two channels are such that the market for advertising clears; *i.e.*, ρ_1 and ρ_2 must solve: $\alpha_k = na_k$, $k \in \{1, 2\}$, with a_k now given in (5). We obtain:

$$\rho_k = K\left[\frac{n+1}{n}\alpha_k - q_k\right] \qquad (11)$$

Inserting (2) and (11) into (10) and differentiating, we have:

$$\frac{\partial^2 H_k}{\partial \rho_k \partial \rho_h} = \frac{K(n+1)d}{n} > 0. \qquad \textit{QED.}$$

We know from Proposition 1(i) that advertising in the two channels are complementary goods when advertising is priced per slot. This feature of the competition between the TV channels in the price-per-slot case explains why prices are strategic substitutes and quantities are strategic complements in that case.[15]

When advertising is priced per viewer, on the other hand, the demand for advertising in the two channels is independent. This has the effect that a TV channel's gross revenue is independent of whether the TV channels compete in prices or in quantities. Naturally, the two strategic variables have the same property in this case. It also follows that price and quantity competition in this case produces exactly the same equilibrium outcome, an observation that simplifies the subsequent analysis of this case.

An interesting feature of the model is that a TV channel's two strategic variables reinforce each other: An increase in one makes it profitable for the TV channel also to increase the other.

Proposition 3: *Strategic variables – reinforcement*

A TV channel's two strategic variables are reinforcing each other, *i.e.*,

$$\frac{\partial^2 H_k}{\partial q_k \partial u_k} > 0, \quad k \in \{1, 2\},$$

where $u_k \in \{r_k, \rho_k, q_k\}$, depending on what is the TV channel's other strategic variable in addition to program quality.

Proof: Follows from straightforward differentiations in each case. *QED.*

[15]Results on strategic substitutes and strategic complements are regularly reversed when we have complementary rather than substitute products. In particular, with price competition and complementary

To illustrate the mechanism reported in the Proposition, consider the case of a positive, exogenous shift in the total number of viewers in the TV market. This would trigger more investment in programming in each TV channel in order to capture a larger share of the viewers and then, in turn a larger share of the advertising on TV. By also increasing the price per advertising slot (or per viewer), each TV channel can then increase both the quantity and the price of advertising.

The equilibrium outcome can, in each of the cases considered here, be found by solving the system of first-order conditions for the two channels. Details of this calculation and the various equilibrium expressions can be found in the Appendix (Proposition A1). Here, we note some overall features of the equilibrium outcomes.

The equilibrium variables of interest are:[16] the price of advertising, whether it is per slot, r, or per viewer, ρ; the programming investment of each TV channel, represented by the program quality, q; the quantity of advertising on each channel, α; the number of viewers on each channel, v; the profits earned by each TV channel, H; and the profits earned by each advertiser, π. While prices are not comparable, the other variables are, whether advertising is priced per slot or per viewer and whether TV channels compete in prices or in quantities. Define $X := \{q, \alpha, v, H, \pi\}$ as this list of comparable variables. Let a subscript, V or S, denote whether advertising is priced per viewer (V) or per advertising slot (S); and let a superscript, P or Q, denote whether TV channels compete in prices or in quantities.

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products, prices are typically strategic substitutes. For more details, see Vives (1999, Section 6.3).

Proposition 4: *Comparing outcomes.*

(i) All comparable variables are higher when advertising is priced per slot, than when it is priced per viewer: $x_S^z > x_V^z$, $x \in X, z \in \{P, Q\}$.

(ii) If advertising is priced per slot, then all variables are higher when TV channels compete in prices, than when they compete in quantities: $r^P > r^Q$ and $x_S^P > x_S^Q$, $x \in X$.

(iii) If advertising is priced per viewer, then the equilibrium outcome is unaffected by whether TV channels compete in prices or in quantities: $\rho^P = \rho^Q$ and $x_V^P = x_V^Q$, $x \in X$.

Proof: Follows from straightforward comparisons of expressions in Proposition A1 in the Appendix. *QED.*

Note that it is not clear how the choice variables or the choice of pricing schedule affect the toughness of competition between the TV channels. To illustrate this, take the case where advertising is priced per slot. Both prices per advertising slot as well as investment in programming are higher with price setting than with quantity setting. Thus, price setting results in more intense rivalry on programming and less intense rivalry on prices per slot of advertising than what is the case with quantity setting.

[16]Again, we focus on the symmetric equilibrium.

3. COMPARING TV MONOPOLY AND TV DUOPOLY

An important policy issue in broadcasting in many countries is whether to allow further entry into the TV industry by advertising-financed TV stations. Our model is suitable for performing an analysis of the effects of such an entry. In order to illustrate this, we discuss here how a TV monopoly fares relative to a TV duopoly. The TV monopoly we focus on is one with one TV channel.[17] Moreover, we stick, from now on, to the assumption that TV channels set prices per advertising slot.

We introduce subscripts M and D to capture the distinction between a TV monopoly (M) and a TV duopoly (D): α_s, q_s, v_s, and H_s (A_s, Q_s, V_s, and TH_s) denote equilibrium per-channel (total) spending on advertising, program quality (representing investments in programming), total viewer attendance, and TV-channel profit, respectively, in the industry, when the TV market structure is s, $s \in \{M, D\}$. Moreover, let r_s denote equilibrium price per advertising slot, $s \in \{M, D\}$. Finally, each producer's gross profit per channel (in total) is denoted π_s (Π_s), $s \in \{M, D\}$. Note that, in the duopoly case, $A_D = 2\alpha_D$, $Q_D = 2q_D$, $V_D = 2v_D$, $TH_D = 2H_D$, and $\Pi_D = 2\pi_D$.

It is straightforward to establish that a TV monopolist sets a higher price, invests more in programming, obtains more advertising and more viewers, and earns more profit, than does each TV duopolist. However, in assessing the two TV-market structures, what we need to know is whether *total* programming investment, advertising, and so on, is higher in a monopoly than in a duopoly. We have:

[17]This seems the relevant policy question in countries, like Norway, where entry into the TV industry is regulated. In other circumstances, the relevant question may concern a merger between already established TV channels. When this is the case, the relevant comparison will be between a two-channel TV duopoly and a two-channel TV monopoly.

Proposition 5: *Comparing TV monopoly and TV duopoly.*

Suppose advertising is priced per slot and TV channels, in case of a duopoly, compete in prices. Then:

(i) $r_M > r_D$;

(ii) $q_D < q_M$, and $Q_M <$ [>] Q_D, if $d <$ [>] $d_Q \cong 0.59$;

(iii) $\alpha_D < \alpha_M$, and $A_M <$ [>] A_D, if $d <$ [>] $d_A \cong 0.48$;

(iv) $v_D < v_M$, and $V_M <$ [>] V_D, if $d <$ [>] d_V, where $2/5 < d_V < 1/2$;

(v) $H_D < H_M$, and $TH_M <$ [>] TH_D, if $d <$ [>] $d_H \cong 0.19$; and

(vi) $\pi_D < \pi_M$, and $\Pi_M <$ [>] Π_D, if $d <$ [>] $d_\Pi \cong 0.20$.

Proof: See the Appendix.

We see, from this Proposition, that the price of advertising is always lower with duopoly than with monopoly in this TV market. This should be no surprise: The introduction of a second TV channel results in rivalry on prices.

There are two effects on total investments in programming from adding a second TV channel. On the one hand, a second channel triggers competition on prices for the advertising slots and thereby reduces the incentives to invest in programming. On the other hand, a second channel introduces a business stealing effect: Higher own programming investment will not only increase the total number of viewers in the market, but also shift some viewers from watching the rival's programs to a channel's own programs. We find that the business-stealing effect dominates for sufficiently low values of d, causing total investment in programming to rise as a result of the introduction of a

second TV channel. However, each duopoly channel's investment in programming is always lower than the monopoly channel's investment.

The total number of viewers may drop following the introduction of a second TV channel. To see this, consider the intermediate case of $d = 1/2$. If now a second channel enters, its investment in programming merely duplicates the first channel's investment, seen from the viewers' point of view. If $d = 1/2$, and the entering channel has the same programming investment and advertising amount as the incumbent, then the entry of a new channel does not affect the total number of TV viewers. In such a case, therefore, total programming investment in the industry must be more than doubled following the introduction of a second channel for the number of viewers to increase. However, each duopoly channel's programming investment is lower than that of a monopoly channel in this case. Therefore, the total number of viewers drops when a second channel enters. On the other hand, if the second channel is independent of the first channel ($d = 0$), it is as if you have two monopoly channel, and the introduction of a second channel will surely increase the total number of viewers. By continuity, then, there must be some critical value of d between 0 and 1/2 at which the total number of viewers is equal among monopoly and duopoly. The Proposition above finds that this critical value, which depends on n, the number of advertisers, is somewhere between 2/5 and 1/2.

Surprisingly, the total spending on advertising may drop when a second TV channel is introduced. All else equal, a lower price per advertising slot will result in more advertising. On the other hand, as explained above, the total number of viewers may drop as a result of entry. If d is sufficiently high, then the reduction in the total number of viewers is so large that it offsets the effect of lower price on advertising.

Finally, we see that, even if total investment in programming increases and price per advertising slot drops as a result of an introduction of a second TV channel, producers may be better off with a monopoly than with a duopoly in the TV industry. Interestingly, this occurs when the viewers are sufficiently prone to switch channels (a high d). When this is the case, the number of viewers on each of the two channels is low, and therefore the producers advertise less. Despite a lower advertising price when the TV channels are close substitutes, the combined effect is a preference for a TV monopoly among advertising firms, even at a modest degree of channel substitutability. The driving force is the reduction in the number of viewers following a transition from a monopoly to a duopoly TV industry.

4. THE PRODUCT MARKETS

Let us now extend the basic model to take into account the rivalry in the product markets. We assume that all product markets are identical, with the same demand conditions and the same number of producers. In the next Section, we relax this assumption by letting product markets differ with respect to the number of firms.

There are a total of m product markets, with f firms in each, $m \geq 1$ and $f \geq 2$, so that the total number of advertisers is: $n = mf$. Furthermore, we assume that the products sold in each market are identical, and we let p denote the price per unit. By way of normalization, we set production costs equal to zero.

In general, both price and advertising are expected to affect sales in the product market: A price reduction expands sales, and so does an increase in advertising. However, it is not obvious how price and advertising interact. On the one hand,

advertising may increase each existing consumer's loyalty to one's product, or increase the number of loyal consumers relative to that of other consumers. If so, a producer's optimal response to more own advertising may be to raise price to exploit the loyal consumers. On the other hand, advertising makes consumers aware of one's product. To the extent this is the case, we may observe more intense rivalry on prices because the informed consumers are able to pick from all those offers that they are aware of. Hence, in theory, advertising has an ambiguous effect on prices. Empirical studies report ambiguous effects of advertising as well.[18] We side-step from the question of whether advertising has a price-increasing or price-reducing effect by developing here a model where a firm's advertising in equilibrium affects its sales only, not the price.

Although prices are not affected by the amount of advertising, the number of firms in the product market may affect product prices. We find it difficult to argue that one particular price regime is more plausible than any other regime. Therefore, we investigate two different price regimes: Cournot competition, and collusion on prices (semi-collusion). As it turns out, those two regimes are sufficient to show that the market outcome depends crucially on the toughness of price competition.[19]

[18]Eckard (1991) studies the effect of the 1970 ban on TV advertising for cigarettes in the US and concludes that the ban had an anti-competitive effect, implying that TV advertising as such would have increased price rivalry. Also Leahy (1991) reports a negative relation between TV advertising and prices. Kanetkar, *et al*. (1992) examine how TV advertising affects consumers' price sensitivity for two frequently purchased consumer goods. They find that, for high levels of advertising exposure, price sensitivity drops, while the opposite is true for lower levels of advertising exposure. This implies that, at high levels of TV advertising, further advertising dampens price competition, while the opposite is true for lower levels. According to their study, then, there is a U-shaped relation between the level of advertising and the product price. Moreover, studies of advertising in general find ambiguous results as well. See, for example, Vakratsas and Ambler (1999) for a review of the marketing literature.

[19]Our modeling approach shares some similarities with Schmalensee (1992), who develops two simple models complementing the analytical framework introduced in Sutton (1991). He does not insist on a particular price regime. In one model, he uses a parameter to capture the degree of price competition. In

Cournot competition

Each viewer of channel *k* has the following individual inverse demand in each product market:

$$p_k = 1 - \frac{1}{B}\sum_i \left(\frac{y_{ik}}{a_{ik}} \right), \tag{12}$$

where y_{ik} is the per-capita quantity offered by firm *i* to viewers of channel *k*, with $Y_k := \sum_i y_{ik}$ being the total sales in each product market. The parameter *B* can be interpreted as a scale parameter. Recall that a_{ik} denotes producer *i*'s advertising on channel *k*.

With this formulation, we allow for prices offered to consumers to differ according to which TV channel the consumers are viewing. We also allow a firm's advertising to affect demand: The more a producer advertises, the less sensitive is the market price to an increase in its offered quantity. However, despite the heterogeneity created in cases of asymmetric advertising, the product sold in this market is homogeneous, in the sense that there is one price per market segment for all firms.

Firm *i*'s per-capita profit, gross of advertising costs, equals $p_k y_{ik}$ among channel *k*'s viewers, since production costs are assumed to be zero. This gives rise to the following first-order condition for firm *i* with respect to its offered quantity:

$$\left[1 - \frac{1}{B}\sum_i \left(\frac{y_{ik}}{a_{ik}} \right) \right] - \frac{y_{ik}}{a_{ik} B} = 0.$$

Summing over all *f* firms' first-order conditions in each market, we obtain:

$$f\left[1 - \frac{1}{B}\sum_i \left(\frac{y_{ik}}{a_{ik}} \right) \right] - \frac{1}{B}\sum_i \frac{y_{ik}}{a_{ik}} = 0,$$

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another model, he solves the model assuming collusive prices, and then shows that his result still holds if

implying that, in equilibrium,

$$\frac{1}{B}\sum_i\left(\frac{y_{ik}}{a_{ik}}\right)=\frac{f}{f+1}.$$

Thus, the equilibrium price in each market does not depend on how much firms advertise or which channel consumers are viewing:

$$p_k=1-\frac{1}{B}\sum_i\left(\frac{y_{ik}}{a_{ik}}\right)=\frac{1}{f+1},\ k\in\{1,2\}.$$

There are two effects of a firm's advertising: Its sales increases, leading to an increase in total sales and thus a reduction in price. But this, in turn, entails a reduction in the sales of rival firms, which leads to an increase in price. The two effects balance each other off exactly in this particular model.

The above expression may be inserted in each firm's first-order condition to obtain the firm's equilibrium per-capita sales among viewers of channel *k*:

$$y_{ik}=\frac{Ba_{ik}}{f+1}.$$

The per-capita gross profits of firm *i* among the viewers of channel *k* amount to:

$$Z_{ik}=Ka_{ik}=\frac{B}{(f+1)^2}a_{ik}. \qquad (13)$$

Thus, *K*, the marginal gross profits per viewer with respect to a firm's advertising, is a specific decreasing function of the number for firms in the product market.

We are now in a position to investigate how the equilibrium outcome is affected by a change in the number of advertisers, *n*. This number may increase, either through an

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price is below the collusive level.

increase in the number of firms in each market, *i.e.*, a decrease in market concentration throughout the economy, or through an increase in the number of product markets.

Proposition 6: *The effect of changing the number of advertisers: Cournot competition.* Suppose advertising is priced per slot, that TV channels compete in prices if there is a TV duopoly, and that each advertiser competes in quantities with other advertisers in the same product market. Then equilibrium variables in the market for TV advertising decrease if the number of firms in each product market, f, increases, and increase if the number of product markets, m, increases:

$$\frac{\partial x}{\partial f} < 0 < \frac{\partial x}{\partial m},$$

where $x \in \{r_s, q_s, \alpha_s, v_s, H_s, \pi_s\}$, and $s \in \{M, D\}$.

Proof: In the equilibrium values shown in Proposition A1(i), in the Appendix, we substitute: $K = B/(f + 1)^2$, and $n = mf$. Now, the results can easily be verified. *QED.*

According to this Proposition, total spending on advertising *increases* as a result of a reduction in the number of firms, keeping constant the number of product markets. Note that there are two opposing forces at work. On the one hand, a reduction in the number of firms makes each remaining firm more concerned about the fact that own advertising tends to reduce the number of viewers. This dampens the incentive for each firm to increase advertising, and would all else equal result in a reduction in total advertising. On the other hand, fewer firms result in a higher price-cost margin. This would encourage firms to advertise more. The latter effect turns out to dominate, and it is

reinforced by the TV channels' responses. They invest more in programming, thereby attracting more viewers and even more advertising. The result is that both total advertising and total investment in programming increase following a reduction in the number of firms.

Note also that the total number of viewers increases following a reduction in the number of firms. Since advertising increases as well, which tends to reduce the number of viewers, the driving force behind this result is the TV channel's increased investment in programming. Finally, note that the price per advertising slot also increases. This follows directly from the fact each TV channel's two choice variables mutually reinforce each other (see Proposition 3).

However, total spending on advertising can also *increase* as a result of an increase in the number of advertising firms, if this latter increase is solely due to an increase in the number of product markets. In such a case, price-cost margins are unaffected by a change in the number of firms. Now, an increase in the number of firms makes each firm less concerned about own advertising's effect on the number of viewers. This spurs an increase in total advertising. Again, the TV channels' response reinforces the initial effect. They invest more in programming, thereby increasing the total advertising even more.

Semi-collusion

Suppose now that firms collude on prices at stage 4. The collusion is restricted to the pricing, though; thus, ours is a case of semi-collusion, with firms colluding on price while

behaving non-cooperatively in their stage-2 advertising decisions, foreseeing the collusion in price further on.[20]

Suppose each viewer on channel k has the following demand function:

$$Y_k = (1 - p)B\alpha_k \qquad (14)$$

where, as above, α_k is total advertising on channel k and B is a scale parameter. Maximizing their total profits pY_k on each viewer, the colluding firms set $p = 1/2$, so that $pY_k = B\alpha_k/4$. Note that the collusive price at stage 4 is independent of the amount of advertising. The sale of each firm is assumed to be determined by its amount of advertising. In particular, we assume that each member of the colluding group of firms obtains a market share equal to its share of total advertising. It follows that, in this case of semi-collusion, $Z_{ik} = Ba_{ik}/4$. Thus, $K = B/4$; *i.e.*, the marginal gross profit from advertising is now independent to the number of firms in each market, contrary to the case of Cournot competition above. We have:

Proposition 7: *The effect of changing the number of advertisers: Semi-collusion.*

Consider the same situation as in Proposition 6, except that the product markets are characterized by semi-collusion, as outlined above. In this case, the effect of an increase in the number of advertiser is to increase equilibrium variables in the market for TV, irrespective of whether it is the number of firms in each product market, f, or the number of product markets, m, that increases:

[20]Since prices are more flexible than most other choice variables, it is easier to collude on prices than on other variables. Therefore, most of the literature on semi-collusion assumes collusion on prices and competition along another dimension, such as for example advertising, capacity, or location. For a review of the semi-collusion literature, see Phlips (1995).

$$\frac{\partial x}{\partial f} = \frac{\partial x}{\partial m} > 0,$$

where $x \in \{r_s, q_s, \alpha_s, v_s, H_s, \pi_s\}$, *and* $s \in \{M, D\}$.

Proof: In this case, K is substituted with $B/4$, and, as in the case of Proposition 6, n is substituted with mf in the equilibrium values in Proposition A1(i), in the Appendix. The results are now easily verified. *QED.*

The results concerning f, the number of firms in each market, are now reversed compared to the case of Cournot competition. A reduction in the number of firms results in lower prices on advertising, less total advertising, less investment in programming, and fewer viewers. The main distinction between this pricing regime and Cournot competition is that, now, product prices are unaffected by a reduction in the number of firms. The incentive to increase advertising and, in turn, sales, due to higher product prices, is no longer present. The driving force now is that fewer firms result in less intense rivalry on advertising. A reduction in the amount of advertising dampens the TV channels' incentives to invest in programming. To prevent a substantial reduction in the amount of advertising, the TV channels set a lower price on each advertising slot. Both prices and quantities of advertising drop as a result of a reduction in the number of firms. Note also that a lower investment in programming reduces the number of viewers, despite the fact that the amount of advertising also is lower.

Finally, let us examine how the toughness of price competition affects the market outcome. We do this by comparing our two cases of Cournot competition and semi-

collusion. Let superscripts *S* and *C* denote the semi-collusion and Cournot regime, respectively.

Proposition 8: *The toughness of price competition*

All equilibrium values are higher with semi-collusion than with Cournot:

$$x^S > x^C$$

where $x \in \{r_s, q_s, \alpha_s, v_s, H_s, \pi_s\}$, *and* $s \in \{M, D\}$.

Proof: K enters as a multiplicative term in all the equilibrium values in Proposition A1(i) in the Appendix. We know that $K = B/(1+f)^2$ with Cournot competition and $K = B/4$ with semi-collusion. It follows straightforwardly that the equilibrium values are always higher with semi-collusion than with Cournot competition, since $f \geq 2$. *QED.*

There is a larger profit potential in the product market under collusive price setting than under Cournot competition. Each TV channel exploits this by setting a higher price per slot of advertising, and by increasing its investment in programming, thereby attracting more viewers.

Also advertising is higher under price collusion than what is the case when Cournot competition prevails. This is not obvious. In a TV duopoly, price collusion results in more investment in programming and a higher price of advertising. Programming and the price of advertising have opposite effects on each producer's choice concerning the amount of advertising. Since we find that less rivalry on prices in the product market results in more spending on advertising, it shows that the effect of

higher price on each advertising slot is not large enough to offset the effect of more investment in programming.

Note also that the number of viewers is higher under price collusion than under Cournot competition. There is more advertising in semi-collusion, which tends to reduce the number of viewers. On the other hand, the large investment in programming in collusion attracts viewers. According to the Proposition, the latter effect dominates.

The results reported here indicate that there are two successive battles over profit potentials in the product markets, and that these two battles may mutually reinforce each other. An escalation of advertising by the producers spurs more investment in programming, and vice versa.

5. WHO ARE THE ADVERTISERS?

In reality, of course, the product markets that advertising firms operate in differ, particularly with respect to their profitability. In order to get an understanding of the importance of this asymmetry, we extend our model to consider a case of two product markets, with marginal gross profits K_1 and K_2, respectively, and with the numbers of firms equal to f_1 and f_2. Thus, the total number of advertising firms is $n = f_1 + f_2$.

We continue our focus on the case of advertising being priced per slot and TV channels competing in prices. In addition, we now concentrate on the case of a TV duopoly. At stage 2, solving for the firms' demand for advertising in the two channels, invoking symmetry among firms in each market, involves a system of four equations. Let now a_{ik} denote the amount of advertising on channel k demanded by each firm in market i, $i, k \in \{1, 2\}$. Under the assumption that all firms advertise in equilibrium, we find:

$$a_{ik} = \frac{1}{f_1 + f_2 + 1}\left[q_k - \frac{K_j\left(f_j + 1\right) - K_i f_j}{K_i K_j\left(1 - d^2\right)}\left[r_k + dr_h\right]\right], \qquad (15)$$

$$i, j \in \{1, 2\},\ i \neq j,\ k, h \in \{1, 2\},\ k \neq h.$$

In the symmetric case of $f_1 = f_2$ and $K_1 = K_2$, we are back to equation (4).

Interestingly, asymmetry may cause firms in one of the markets to have a demand for advertising that is increasing in price. An inspection of the above expression reveals that this happens for firms in market *i* when

$$\frac{K_i}{K_j} > \frac{f_j + 1}{f_j}.$$

The right-hand side of this condition is greater than 1. Advertising can therefore only increase in price among firms in the more profitable product market, and it will always be decreasing in price in the other market. Thus, the firms in the less profitable product market invariably respond to a price increase with a decrease in their advertising demand. This decrease reduces the congestion of advertising on the TV channels, since this reduced advertising attracts more viewers. If the firms in the more profitable product market have a sufficiently high profitability relative to the other firms, then the negative impact of a price increase is more than compensated by the increased inflow of viewers following the other firms' reduction in advertising.

As the above condition indicates, there does not have to be much asymmetry between the product markets for this phenomenon to occur. In order to be specific, let us consider the case of Cournot competition, in which $K_i = B/(f_i + 1)^2$, $i \in \{1, 2\}$. We have:

Proposition 9: *Who are the advertisers?*

Suppose advertising is priced per slot, and that there are two TV channels competing in prices. There are two product markets, with f_1 and f_2 firms each, respectively, and Cournot competition in each market. If $f_1 > f_2$, so that market 2 is the more concentrated one, then:

(i) Conditioned on all firms advertising, the demand for advertising is decreasing in price in market 1 but increasing in price in market 2.

(ii) In equilibrium, only firms in the more concentrated market 2 advertise.

Proof: (i) The demand for advertising on channel k from each firm in market i now becomes, from (15):

$$a_{ik} = \frac{1}{f_1 + f_2 + 1}\left[q_k - \frac{\left(f_j + 1\right)\left[\left(f_i + 1\right)^2 - f_j\left(f_j + 1\right)\right]}{B\left(1 - d^2\right)}\left(r_k + dr_h\right)\right], \quad (16)$$

$$i, j \in \{1, 2\},\ i \neq j;\ k, h \in \{1, 2\},\ k \neq h.$$

Inspection of the square-bracketed term in this expression reveals that advertising demand among firms in market i is decreasing in price if $f_i \geq f_j$, but is increasing if $f_i < f_j$, $i \neq j$. Of course, f_1 and f_2 can only take integer values. What need to be checked, therefore, is that the expression within square brackets is positive for $f_1 \geq f_2$ but negative for $f_1 \leq f_2 - 1$. As long as there is *any* asymmetry among the two markets, therefore, the firms in the more concentrated market have a demand for advertising that is increasing in price.

(ii) The proof is by contradiction. Suppose that all firms advertise in equilibrium. In stage 1, TV channels determine advertising prices and investments in program quality. Channel k now maximizes:

$$r_k\left(f_1 a_{1k} + f_2 a_{2k}\right) - \frac{q_k^3}{3},$$

with a_{1k} and a_{2k} given in (16). Solving for the equilibrium values, still under the assumption that all firms advertise in equilibrium, we have:

$$r = \frac{B^2\left(f_1 + f_2\right)^3\left(1 - d^2\right)^2}{\left[f_1\left(f_1 + 1\right)^2 + f_2\left(f_2 + 1\right)^2\right]^2\left(f_1 + f_2 + 1\right)\left(d + 2\right)^2},$$

$$q = \frac{B\left(f_1 + f_2\right)^2\left(1 - d^2\right)}{\left[f_1\left(f_1 + 1\right)^2 + f_2\left(f_2 + 1\right)^2\right]\left(f_1 + f_2 + 1\right)\left(d + 2\right)}.$$

Inserting these values back into the expression for the advertising by each firm in market *i*, we obtain (dropping the subscript *k* because of symmetry):

$$a_i = \frac{B\left(f_1 + f_2\right)^2\left(1 - d^2\right)\left[f_1\left(f_1 + 1\right)^2 + f_2\left(f_2 + 1\right)^2 + f_j\left(f_j - f_i\right)\left(f_1 + f_2 + 1\right)\left(f_1 + f_2 + 2\right)\left(d + 1\right)\right]}{\left[f_1\left(f_1 + 1\right)^2 + f_2\left(f_2 + 1\right)^2\right]^2\left(f_1 + f_2 + 1\right)^2\left(d + 2\right)^2} \tag{17}$$

We can again make use of f_1 and f_2 being integers: While the above expression is clearly positive if $f_j \geq f_i$, it is negative for any combination of *f*s such that $f_j \leq f_i - 1$. It suffices to show that the expression is negative for $f_1 = f$ and $f_2 = f - 1$. Substituting this into the crucial square-bracketed term in the numerator of the expression in (17), we find that the latter now equals $-f[f(2f + 1)(2d + 1) - 1]$, which is negative for any $f \geq 1$. Since advertising cannot be negative, the above cannot be an equilibrium, except in the symmetric case. *QED*.

The firms in the product market with many firms choose not advertise in equilibrium. The driving force is that the product price is lower in the market with many

firms, and those firms generate a lower revenue from advertising on TV than what is the case for the firms in the product market with few firms. The firms in the market with many firms respond to an increase in the price of advertising by reducing their demand for advertising. This reduces the congestion of advertising on TV and attracts new viewers. More viewers induce the firms in the market with few firms to advertise more. The TV channels exploit the 'perverse' demand curve by those firms by increasing its price of advertising. In equilibrium, the price of advertising is set so high that the firms in the market with many firms decide not to advertise at all.

The result, although merely suggestive in nature, highlights an important aspect of the link between the market for viewers, the market for TV advertising, and the product markets: When viewers dislike advertising, there are negative externalities among advertisers. These negative externalities may magnify even small asymmetries among advertisers to such an extent that only the more profitable ones find it in their interest to do any advertising.

Descriptive data suggests that few product categories dominate the market for TV advertising. For example, in the US in 1999 the TV advertising for automobiles accounts for almost one fifth of all advertising on TV. The TV advertising for the top six product categories adds up to more than half of all TV advertising.[21] Firm-specific data for the US further illustrates the high concentration in the market for TV advertising. The top 10 advertisers account for 25 % of total advertising on network TV and 16 % of total advertising on spot TV.[22] In other countries it might be even higher concentration in the

[21]The figures are calculated from the data on www.adage.com/dataplace/archives/dp394.html.
[22]The figures reported here are calculated from the data on www.adage.com/dataplace/archives/dp385.html and www.adage.com/dataplace/archives/dp386.html.

TV advertising market. In Norway, for example, two corporations had in 1999 almost half the total TV advertising on TV2, the dominant TV-advertising channel.[23]

6. CONCLUDING REMARKS

Despite its obvious importance, there are surprisingly few studies in the economics literature of the TV industry. In particular, there are few studies of the two-fold role of the TV industry as both a provider of entertainment and a transmitter of advertising. To help fill this gap, we have presented a stylized model that encompasses some of the TV industry's idiosyncratic characteristics. Most importantly, we assume that viewers are attracted by TV channels' investments in programming but dislike their advertising, and we model advertising as a link between the product markets and the TV market.

Since the TV industry has some idiosyncratic features, it is of interest to elaborate on some of the basic mechanisms that are in force. It turns out that the strategic interaction in this particular industry can be distinctly different from other industries. For example, we find that advertising prices are strategic substitutes when advertising is priced per slot. Moreover, we find that price, instead of quantity, as a choice variable can trigger more intense rivalry on programming but less intense rivalry on prices of advertising. This suggests that one should be careful with applying standard IO results to the TV industry, but rather draw conclusions only from models that are tailor-made for it.

We have applied our model to three different issues, the first one being how rivalry in the TV market affects the market outcome. By comparing monopoly and duopoly in the TV market, we found that rivalry between TV channels can lead to a

[23]They are Orkla and Landbruket, both selling food and other consumer goods products. The figure is reported in the Norwegian journal *Propaganda*; see http://www.propaganda-as.no/tekst.cfm?id =9420.

reduction in the total number of viewers. The reason is that the TV channels partly duplicate each other's programming investments, and each duopoly TV channel invests less in programming than a monopoly TV channel. If the viewers' propensity to switch TV channels is high enough, then the total increase in the investment in programming is not large enough to offset the duplication of programming investments among the TV channels, and the number of viewers drops. The amount of advertising may drop as well. This happens if the effect on advertising of a reduction in the number of viewers offsets the effect of a reduction in the prices of advertising slots.

The second issue is how product-market competition affects the equilibrium outcome. We showed that the profit potential in the product market is of importance for the amount of programming investments as well as for the amount of advertising and the price per advertising slot. The less intense product-price rivalry is, the larger is the potential revenue generated by advertising. A TV channel exploits this in two ways. First, it sets a higher price per slot of advertising. Second, it invests more in programming to attract more viewers and thereby to encourage the producers to advertise more. As a result, a relaxation of price competition in the product markets results in higher prices of advertising, more advertising, and more investment in programming. This suggests that there are two successive battles over the profit potential in the product markets. An escalation of advertising by the producers spurs more investment in programming, and vice versa.

Product market competition may also be affected by a change in the number of firms. We found that the effect of increasing the number of advertising firms depends on whether the increase is by increasing the number of firms in each market, making the

markets less concentrated, or by increasing the number of markets. The former way of increasing the number of advertising firms reduces the price-cost margin and thereby the profit potential in the product markets. Thus, while there now are more firms demanding advertising, they also earn less from advertising. When firms compete a la Cournot in the product market, we find that the latter effect dominates. In that case, total advertising drops when the number of firms in each market increases. We showed that the investment in programming drops as well, something that, in turn, reduces the number of viewers.

The result with Cournot competition is reversed if the firms in each market are able to collude on price, and/or if the number of advertising firms increase through an increase in the number of product markets. In those two cases, there are no price effect in the product market due to a change in the number of firms. More firms would then trigger more intense rivalry on advertising, increasing the total amount of advertising.

Our third and final issue is how asymmetries between product markets affect the equilibrium outcome. We found that even small asymmetries may have dramatic effects. In the case of two identical product markets where one product market has more firms than the other and Cournot competition prevails, the firms in the product market with many firms choose not to advertise. The crucial feature of our model producing this result is that TV viewers dislike advertising, entailing congestion among advertisers. At an increase in the price of advertising, the firms in the market with many firms would, as expected, reduce their demand for advertising. This would, in turn, reduce the congestion of advertising on TV and thereby attract more viewers. The firms in the market with few firms would respond to an increase in the number of viewers by increasing their demand for advertising, despite the price of advertising having increased. The TV channels

exploit those firms' 'perverse' demand by increasing their price so that, in equilibrium, the firms in the market with many firms decide not to advertise at all on TV.

A topic left unexplored in this paper is the welfare properties of an unregulated market for TV advertising and how, if necessary, regulation should be done. In Norway and France, for example, there are regulations on the amount of TV commercials.[24] In the U.S., there used to be a similar regulation, self-imposed by the TV industry itself, through the National Association of Broadcasters. In the early 1980's, however, the U.S. Department of Justice filed an antitrust suit against the N.A.B. code, and its restrictions on the amount of TV advertising was lifted.[25] As far as we know, Anderson and Coate (2000) and Gabszewicz *et al*. (2000) are the only studies that discuss the question whether there is too much or too little TV advertising. Because we feel that aspects of TV advertising left out of their analysis, such as the roles of programming investments and advertisers' profits, we believe applying our model to the welfare issue would provide more insight into the question whether an unregulated market for TV advertising provides an efficient outcome.

APPENDIX

Proposition A1: *Equilibrium outcomes in TV duopoly*.

(i) If advertising is priced per slot and TV channels compete in prices, then the equilibrium outcome is given by:

[24]In Norway, TV commercials are restricted to a maximum of 12 minutes per hour and to a maximum of 15% of daily transmission time. There are also restrictions on how various programs can be interrupted by commercial breaks (see http://www.smf.no/4.2.0.asp for details). In France, TV commercials are also restricted to a maximum of 12 minutes per hour (Desmoulins, 1998).

[25]*U.S. v. National Association of Broadcasters*, 553 F. Supp. 621 (1982). Descriptions of the case can be found in Hull (1990) and Owen and Wildman (1992, ch. 5).

$$r = \frac{K^2 n(1-d^2)^2}{(n+1)(d+2)^2};$$

$$q = \frac{Kn(1-d^2)}{(n+1)(d+2)};$$

$$\alpha = \frac{n}{n+1}\left[q - \frac{r}{K(1-d)}\right] = \frac{Kn^2(1-d^2)}{(n+1)^2(d+2)^2};$$

$$v = (1-d)(q-\alpha) = \frac{Kn(1-d)^2(d+1)[(d+1)(n+1)+1]}{(n+1)^2(d+2)};$$

$$H = r\alpha - \frac{q^3}{3} = \frac{K^3 n^3 (1-d)^4 (1+d)^3}{3(n+1)^3 (d+2)^4};$$

$$\pi = \frac{\alpha(Kv-r)}{n} = \frac{K^3 n^2 (1-d)^3 (1+d)^2}{(n+1)^4 (d+2)^4}.$$

(ii) If advertising is priced per slot and TV channels compete in quantities, then the equilibrium outcome is given by:

$$r = K(1-d)\left[q - \frac{n+1}{n}\alpha\right] = \frac{K^2 n(1-d)^2}{(n+1)(2-d)^2};$$

$$q = \frac{Kn(1-d)}{(n+1)(2-d)};$$

$$\alpha = \frac{Kn^2(1-d)^2}{(n+1)^2(2-d)^2};$$

$$v = (1-d)(q-\alpha) = \frac{Kn(1-d)^2[n+2-d]}{(n+1)^2(2-d)^2}$$

$$H = r\alpha - \frac{q^3}{3} = \frac{K^3 n^3 (1-d)^3 (1-2d)}{3(n+1)^3 (d-2)^4};$$

$$\pi = \frac{\alpha(Kv - r)}{n} = \frac{K^3 n^2 (1-d)^5}{(n+1)^4 (d-2)^4}.$$

(iii) If advertising is priced per viewer, then the equilibrium outcome, whether TV channels compete in prices or in quantities, is given by:

$$\rho = \frac{K^2 (1-d)^2}{n^2 (n+1)(2-d)^2};$$

$$q = \frac{K(1-d)}{n(n+1)(2-d)};$$

$$\alpha = \frac{n(Kq + r)}{K(n+1)} = \frac{K(1-d)[(n+1)(1-d)+n]}{n(n+1)^2 (2-d)^2};$$

$$v = (1-d)(q-\alpha) = \frac{K(1-d)^2}{n(n+1)^2 (2-d)^2}$$

$$H = \rho v - \frac{q^3}{3} = \frac{K^3 (1-d)^3 (1-2d)}{3(n+1)^3 (d-2)^4};$$

$$\pi = v\left(K\frac{\alpha}{n} - \rho\right) = \frac{K^3 (1-d)^3}{n^2 (n+1)^4 (d-2)^4}.$$

Proof of Proposition 5: By differentiations in the expressions in Proposition A1(i), we obtain:

$$\frac{\partial r}{\partial d} = -\frac{2K^2 n(1-d^2)(d^2+4d+1)}{(n+1)(d+2)^3} < 0;$$

$$\frac{\partial q}{\partial d} = -\frac{Kn(d^2+4d+1)}{(n+1)(d+2)^2} < 0;$$

$$\frac{\partial \alpha}{\partial d} = -\frac{2Kn^2(2d+1)}{(n+1)^2 (d+2)^3} < 0;$$

$$\frac{\partial v}{\partial d} = -\frac{Kn(1-d)\left[2(n+1)d^3 + (10n+11)d^2 + (10n+17)d + 2(n+3)\right]}{(n+1)^2(d+2)^3} < 0;$$

$$\frac{\partial H}{\partial d} = -\frac{K^3 n^3 (1-d)^3 (1+d)^2 \left(d^2 + 5d + 2\right)}{(n+1)^3 (d+2)^5} < 0;$$

$$\frac{\partial \pi}{\partial d} = -\frac{K^3 n^2 (1-d)^2 (1+d)\left(d^2 + 11d + 6\right)}{(n+1)^4 (d+2)^5} < 0.$$

Since monopoly corresponds to a duopoly with $d = 0$, the inequality in part (i) and the first inequality in each of parts of (ii)-(vi) follow from the above expressions. Furthermore, using the expressions in Proposition A1(i), we have that:

$$Q_M - Q_D = \frac{Kn(4d^2 + d - 2)}{2(n+1)(d+2)} = 0 \text{ for } d = \frac{\sqrt{33}-1}{8} \cong 0.593.$$

$$A_M - A_D = \frac{Kn^2(9d^2 + 4d - 4)}{4(n+1)^2(d+2)^2} = 0 \text{ for } d = \frac{2(\sqrt{10}-1)}{9} \cong 0.481.$$

$$V_M - V_D = \frac{Knd\left[4(n+3) + (9n+14)d - 4d^2 - 4(n+1)d^3\right]}{2(1+n)^2(2+d)^2} = 0 \text{ for a value of } d \text{ which}$$

depends on n but which is always within (2/5, 1/2).

$$H_M - TH_D = \frac{K^3 n^3 \left(-32d^7 + 32d^6 + 96d^5 - 95d^4 - 88d^3 + 120d^2 + 64d - 16\right)}{48(n+1)^3 (d+2)^4} = 0 \text{ for } d$$

$\cong 0.192$.

$$\Pi_M - \Pi_C = \frac{K^3 n^2 (32d^5 - 31d^4 - 56d^3 + 88d^2 + 64d - 16)}{16(n+1)^4 (d+2)^4} = 0 \text{ for } d \cong 0.202.$$

Recall from the above that X_D is decreasing in d for all $d \in (0, 1)$ and for $X \in \{Q, A, V, TH, \Pi\}$. Since the monopoly variables are independent of d, there is therefore at most one value of $d \in (0, 1)$ for which each difference is zero, and if such a critical value exists, then the difference is negative for d below this value and positive above it. *QED*.

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