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Advertising Competition in the Free-to-Air TV Broadcasting Industry

Abstract

This paper empirically investigates the advertising competition in the French broadcast television industry within a two-sided market framework. We use a unique dataset on the French broadcast television market including audience, prices, and quantities of advertising of twenty-one TV channels from March 2008 to December 2013. We specify a structural model of oligopoly competition and identify the shape and magnitude of the feedback loop between TV viewers and advertisers. We also implement a simple procedure to identify the conduct of firms on the market. We find that the nature of competition in the French TV advertising market is of the Cournot type. Further, we provide empirical evidence that the price-cost margin is not a good indicator of the market power of firms operating on two-sided markets. Finally, we provide a competition analysis. The counterfactual simulation suggests that the merger of advertising sales houses would not have significantly affected the equilibrium outcomes in this industry because of the strong network externalities between TV viewers and advertisers. These results provide a critical evaluation of the 2010 decision of the French competition authority to authorize the acquisition of two broadcast TV channels by a large media group under behavioral remedies.

JEL-Codes: D220, K210, L130, L220, L410, M370.

Keywords: advertising, competition, media, TV, two-sided market, market conduct.

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1. Introduction

Consider a platform which provides two goods (or services) to two distinct but interrelated groups of consumers. By using the platform, each group generates either positive or negative externalities to the other groups of consumers. When one group of consumers is desirable (undesirable) to another group, the platform can strategically decrease (increase) the fee charged to the desirable (undesirable) group, thereby increasing the willingness to pay of the other group. In the case of free TV, the platforms (i.e., the TV channels) enable interactions between two groups of end users, namely the viewers and the advertisers; more precisely, they broadcast TV programs free-to-air to the TV viewers but charge the advertisers, observing that the advertisers' willingness to pay increases with the viewership of TV channels. In other words, the broadcast TV market is a particular two-sided market.[1] As explained in Rochet and Tirole (2008), taking into account the two-sidedness of markets can challenge the usual tests in competition analysis since the pricing strategies of two-sided platforms differ to those of firms operating on one-sided markets. This paper aims to provide an empirical evaluation on the significance and the magnitude of two-sided network externalities in a two-sided market. More specifically, we explore the two-sidedness of the broadcast TV industry in order to identify the shape of the feedback loop between TV viewers and advertisers, to clarify the conduct of TV channels on the advertising market, and to provide a credible evaluation of traditional economic tools implemented by competition authorities on this market.

Our work is motivated by a recent acquisition case in the French broadcast TV industry. On 26 January 2010, the French competition authority (Autorité de la concurrence, AdC) authorized the acquisition of two free broadcast TV channels TMC and NT1 by the media-holding company, the TF1 Group, subject to various conditions. Before the acquisition, the TF1 Group, as the most active media group in the French free TV broadcasting industry, already enjoyed a dominant position on the national TV advertising market by holding approximately $40\% - 50\%$ of the market. The acquisition of these two free channels strengthens the Group's position. If all three channels (i.e., TF1, TMC and NT1) could offer their advertising spaces through one common advertising sales house, the operation could lessen the degree of competition in the advertising market. For this reason, the AdC approved the acquisition only under behavioral remedies, among which the preservation of the separation in advertising offers of TF1 on the one hand, and TMC and NT1 on the other hand.[2]

Behavioral remedies are usually difficult to administer, and the non-discriminatory firewalls are best implemented when the firms involved are subject to the scrutiny of the industry regulator (See Motta, 2004). Being aware of this fact, the practice of the TF1 Group was monitored by the Conseil supérieur de l'audiovisuel (CSA)

[1] Note that this situation is similar to the case of internet. Indeed users search on the web free of charges; however, when they click on specific hyperlinks, they also trigger ads which generate revenues for the owner(s) of web browsers.

[2] See the AdC's decision at
http://www.autoritedelaconcurrence.fr/pdf/avis/10DCC11decisionversionpublication.pdf.

for five years, i.e., from 26 January 2010 to 26 January 2015, during which time the remedies should have been respected.[3] According to the CSA, the commitments have been respected, particularly because TMC and NT1 on one side and TF1 on the other side have managed their advertising offers through independent advertising sales houses. It remains to be seen whether the aim of the remedies has been achieved, i.e., whether the implemented remedies have been efficient in protecting the consumer surplus.

This evaluation exercise is not straightforward, as the decision of the authority coincided with the launch of the digital terrestrial TV (DTTV) in 2005 and with the extension of its coverage over the French territory until 2012.[4] This new technology has boosted the audience for TVs; thus, without market concentration, the surplus of French households' free TV consumption would have been expected to rise over the period. At the same time, the acquisition could allow the TF1 Group to broadcast the same TV programs on the different channels of the Group through a coherent programming, which may contribute to a widening of the audience. To decipher the role of respective determinants in the change in consumer surplus following the adoption of the above behavioral remedies, a complete market analysis is required.

Contrary to pay TV channels for which the subscription fees of TV viewers represent a significant share of income, the TV channels broadcasting free-to-air draw their revenue only from advertising. Their business model is distinctive in the sense that the demand of TV viewers can affect their revenues only indirectly through its interaction with the demand of advertisers. The larger the audience size of a TV channel, the higher advertiser willingness to pay for advertising spaces; however, the TV viewers may be ad-averse, in which case, the larger the quantity of advertising, the higher the risk that the audience size of the TV channel shrinks. In other words, the free TV channels experience a feedback loop between viewers and advertisers. If these network externalities are identified to be significant, it is necessary to consider the feedback loop in the analysis of competition outcomes.

This calls for considering the free TV channels as two-sided platforms selling two distinct products: TV programs to viewers on the one side and advertising slots to advertisers on the other side. A first econometric task here amounts to specifying a structural model of oligopoly competition among free TV channels and identifying the two-sided nature of this industry.

Rochet and Tirole (2003) and Armstrong (2006) provide a framework for analyzing two-sided markets. Based on this approach, theoretical articles by Anderson and Coate (2005), Cunningham and Alexander (2004), and Nilssen and Sørgard (2000), among others, have addressed TV advertising competition by assuming that the ads are a nuisance to TV viewers and the TV channels compete by setting advertising quantity. However, only a few empirical analyses use this approach. Until now, the empirical studies have examined the two-sided structure of the industries of newspapers (Chandra and Collard-Wexler,2009; Argentesi and Ivaldi, 2007; Argentesi and Filistrucchi, 2007), magazines (Song, 2011), yellow pages (Rysman, 2004),

[3] The Conseil Supérieur de l'audiovisuel is an independent authority whose main objective is to protect audiovisual communication freedom.

[4] See the details on the launching of DTTV channels in France below.

and radios (Jeziorski, 2014). Wilbur (2008) used the two-sided concept to analyze the importance of TV viewers' and advertisers' preferences in driving TV channels' programming choices and the impact of ad-avoidance technology on TV channels' advertising revenues with data of six US TV channels. Previous empirical findings suggested that the attitudes of the audience (readers/viewers/listeners) toward advertising vary by industry: The audience tends to appreciate advertising in magazines, yellow pages, and certain types of newspapers, but it dislikes advertising in broadcasting industry (radio and TV). Hence, it is an empirical issue to identify the sign of the network effects between the two sides of the market, and this is crucial because depending on this sign, one can expect from the theory that it impacts the pricing of the distinct product on each side of the market.

Broadcasting TV channels constitute the most important medium for advertising. However, only a few papers have empirically analyzed the advertising competition in this industry. Some, such as Masih (1999) and Ekelund *et al.* (2000), have estimated the price-elasticity of advertising demand, but in models that do not account for the feedback loop between TV viewers and advertisers. Our paper contributes to this literature by investigating the advertising competition in the French free TV industry cast in a two-sided market framework using a unique monthly dataset on 21 French national free TV channels from March 2008 to December 2013. Estimating the demand of both sides (viewers and advertisers) of TV channels, our estimation results suggest that the TV viewers dislike advertising on TV and that the network effects between TV viewers and advertisers are significant.

To perform the competitive analysis raised by the merger between the channels TF1, TMC, and NT1 in this setup, it is necessary to well identify the conduct of TV channels. In quantitative analysis for competition policy, it is usual to assume Bertrand competition; however, in the context of broadcasting markets, Cournot competition is often considered. In the French case, because of some regulatory rules limiting TV advertising, there is a strong presumption that the Cournot case is well adequate. To confirm this conjecture, we implement a simple procedure to test for the market conduct of French free broadcast TV channels by checking for the realism of estimated marginal costs that we derive from the estimates of our model under the two alternative conduct assumptions.

We are in the position to perform a competitive analysis of the outcomes in the French broadcast TV industry after the merger that we propose to investigate. Our results show that, everything else being equal, there is no significant difference in terms of advertising quantities between the observed situation under which the remedies imposed by the competition authority apply and the counterfactual scenario where the remedies have not been implemented. This means that, with or without remedies, the market outcomes are equivalent. This result is mainly explained by the fact that the effect of a higher level of cooperation among advertising sales houses is defeated by the viewers' adverse taste for advertising.

This paper is organized as follows. In Section 2, we present the market characteristics and data sources. In Section 3, we propose a structural model for the TV industry. Section 4 is devoted to the econometric specification, Section 5 to the estimation method and results, and Section 6 to the economic analysis of our estimated model to determine, in particular, the conduct that provides the best representation

of the data generating process. The competitive analysis is carried out in Section 7 to assess the market power of TV channels and to discuss the counterfactual experiment aimed at evaluating the impact of a merger between advertising agencies in the French TV market. We then conclude in Section 8. representation of the data generating process. The competitive analysis is carried out in Section 7 to assess the market power of TV channels and to discuss the counterfactual experiment aimed at evaluating the impact of a merger between advertising agencies in the French TV market. We then conclude in Section 8.

2. Market and data analysis

2.1. Market characteristics

Digital terrestrial television (DTTV) was formally introduced in France in the beginning of 2005 and gradually replaced the aged analogue broadcasting mode of free TV.[5] This new technology offers more broadcasting capacity, and its implementation stimulated the arrivals of several new TV channels. Before the commercial launch of DTTV, there were only five national TV channels broadcasted free-to-air in France. After the CSA officially allowed and promoted the adoption of DTTV, 11 new free-broadcast TV channels were launched at once. Later, in December 2012, six additional channels were initiated. Currently, French households have access to a total of 22 free broadcasting TV channels.[6]

The newly launched DTTV channels, as entrants in the national TV market, do not enjoy the same market position as the five incumbent channels. In Table 1 and Table 2, we provide comparative statistics on *audience shares* and *advertising revenue shares* of the incumbent channels versus the new arrivals. The market shares of new entrants are remarkably lower than the incumbents on both sides.

[INSERT Tables 1 – 2][7]

Among these 22 free TV channels, 17 channels are private and 5 are publicly owned. Fifteen of them are general, offering a wide range of program genres and targeting a large audience. Aside from these, two channels are specialized in news broadcasting, one in music, one in children's programs, one in documentaries, one in films and another in sports. Many of these channels belong to the same TV group. In Table 3, we provide a list of TV channels in our dataset with their type (generalist, news, music, movie, sport, child, or documentary), ownership nature (public or

[5] With DTTV, households can receive many more channels than with a traditional TV aerial, all in digital quality. To switch to DTTV, households need an adapter (a set top box) for their television and to adapt their aerials.

[6] Notice that our analysis only focuses on the free-broadcast TV market. Pay TV channels are included in the outside goods of our econometric model below. During the period of observation (2008–2013), while there are between 184 and 207 pay TV channels available in France, their cumulated audience share amounts to not more than 10% in total, and their cumulated revenue share is approximately 16% to 18%. The individual market share of any of these pay TV is then negligible, and statistics on the market share of each pay channel are not available.

[7] All tables are collected in Appendix 1.

private), and TV group membership.

[INSERT Table 3]

Broadcast TV stations are two-sided platforms connecting TV viewers to advertisers. TV viewers value the media content and are willing to pay for it. As they watch TV, they generate audiences that, in turn, are valuable for advertisers. Contrary to pay TV channels that charge subscription fees to viewers, the broadcast TV stations only require the viewers to bear the advertising.

On the advertising market, advertisers look for audiences, and TV channels supply them. Advertisers value audience for the ability to inform and/or persuade viewers on the merits of products or services they have to commercialize. The TV channels sell their advertising spaces through advertising sales houses (ASHs). In general, each TV group that holds several TV channels owns or cooperates with one ASH. In practice, each TV group determines the capacity of advertising spaces for all of its channels based on their program schedules and communicates the various advertising spots to its ASH. Advertisers search for ad-spots that match their expected audience (in terms of number of viewers and their demographics) from different ASHs. Advertisers and ASHs agree, for each ad-slot, on a cost per thousand (CPT), which corresponds to the value of reaching 1000 viewers. A channel's revenue from an advertising spot is equal to the spot's CPT *times* the number of viewers of the spot. On this basis, we derive the average price per minute of an advertising spot by dividing the observed revenue by the corresponding number of advertising minutes.

In France, TV programs are published one month prior to the broadcasting time; last minute adjustment occurs rarely. In contrast, the advertising campaigns are adjusted in real time to reach the desired effects.

We notice from our data that the number of advertising spots does not vary much from one channel to another, while there is a large difference in the prices of the advertising spots of incumbent channels and new entrants (See Table 4 for details on the standard errors of advertising prices and quantities). The prices considered in this study are average prices of an advertisement but are not on a per-viewer basis. Differences in the prices of advertising spots between two categories of TV channels reflect differences in their viewerships.

[INSERT Table 4]

In France, the number of advertising minutes on TV is regulated. The CSA imposes double caps on different TV channels on the basis of clock hours and daily average levels.[8] As we use monthly average level of advertising herein, what mat-

[8] The average time per hour per day devoted to advertising must not exceed 6 minutes for public TV channels, 9 minutes for the incumbent private channels, and 12 minutes during the first 7 years of broadcasting for the new channels launched in 2005 and 2012. Moreover, the advertising time cannot exceed 12 minutes within any given clock hour for the private TV broadcasters and 8 minutes for the public TV broadcasters. (Source: https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000019986596dateTexte.)

ters is whether the regulation caps on maximum minutes of advertising per day are binding. In Table 5, we compare the observed advertising minutes to the maximum minutes authorized by the CSA. Note that the regulation constraints (at monthly average level) are never binding over the entire period of observation.[9]

[INSERT Table 5]

2.2. Data

The CSA has given us access to a first dataset consisting of information on audience, gross advertising revenues and advertising quantities. This dataset covers detailed monthly information on 21 free TV channels in France from March 2008 to December 2013.[10]

The broadcasting data come originally from Médiamétrie, which provides a measurement on the television audience, based on a panel of households equipped with one or more TV sets in their main residence. This panel has been built to account for both the socio-demographic characteristics of households in metropolitan France and the structure of the television supply. It is made up of nearly 4,300 households, which corresponds to approximately 10,500 individuals aged 4 and over. In each home, Médiamétrie installs one or more (depending on how many pieces of equipment they have) audimeters fitted with a remote control with individual keys, which constantly record all uses of the television set(s) in the household and all the viewing habits of each member of the household and their guests.[11] This survey gathers information of the audience shares, the total population having access to TV services (all reception modes together) in metropolitan France, and the average watching time per day per individual. The average watching time per day per individual is at aggregate level, as we do not have detailed per channel data for this variable.

The advertising data are measured by Kantar Media. We have access to the number of advertising minutes and the gross advertising revenues per month of different TV channels. From these data, we construct the number of advertising spots and their corresponding prices. The number of advertising spots is obtained by dividing the number of advertising minutes by the standard length of an advertising spot, which lasts for 30 seconds. The price of an advertising spot is calculated by dividing the gross advertising revenues by their corresponding numbers of advertising spots. The prices calculated in such a way correspond to the equilibrium prices established on the market on the basis of the channels' audience performance and quantities of advertising supply.

In addition to the dataset provided by CSA, we collected complementary information from published reports of the Centre national du cinéma et de l'image animée (CNC), Kantar Media and different TV channels. The list of variables include the

[9] The restrictions on advertising minutes is an important issue, though our data do not allow exploration of its effect. This topic is studied in Crawford *et al.* (2012) and Zhang (2016).

[10] Our sample excludes Arte, the Franco-German public channel, because we have no information on its advertising revenues. Nevertheless, this should not affect the significance of our results because the audience share of this channel is very small, less than 2%.

[11] Source Médiamétrie: http://www.mediametrie.fr .

total amount of advertising investment in the cinema market, the total quantity of advertising on radio, the total number of hours of French audiovisual programs broadcast during the year, the number of movies broadcast during the prime time (20:30 - 22:20), the amount of subsidies allocated to the public broadcasters, the financial participation of each channel in the production of movies and French audiovisual programs, and the total number of employees of each TV group.[12] These data either serve as instrumental variables or as components of cost equations at the estimation stage. Their units, periodicities, and means are provided in Table 6.

[INSERT Table 6]

3. Structural model

We specify a structural model of oligopoly competition for the French broadcast TV industry. There are J channels belonging to K owners that each broadcast 24 hours per day free-to-air. The TV channel operators face two interacting markets: a market for broadcasting and a market for advertising. The TV viewers watch the programs for free, so there is no direct profit generated from the broadcasting market. However, the audience of free channels affects the demand of advertisers. By allowing the channels to compete on the advertising market through audience, our model specification explicitly captures the interactions between viewers and advertisers. This model setting comprises three parts: the demand of audience, the demand of advertisers, and the supply of TV channels.

3.1. Demand of TV viewers

Let I be the potential market size corresponding to the total French population. At each point in time, an individual $i = \{1, ..., I\}$ chooses to watch one and only one of the broadcasting channels $j = \{1, ...J\}$, or to exercise an outside option (like watching a pay channel, reading a magazine, going to a cinema, or another substitutable activity). As, in the empirical analysis, we consider the national TV channels for six calendar years only, the too weak variability in individual demographics at this level for such a short period of time cannot allow us to identify the heterogeneity of viewers' tastes. This is why we here adopt a nested logit model to specify the demand of TV viewers.[13]

As already mentioned in Section 2.1, French households certainly differentiate between watching an incumbent and a newly launched channel. The implementation of DTTV service has been achieved region by region, and the newly launched

[12] Many channels in our sample share a common ownership, i.e., belong to the same media group. It is impossible to distinguish the number of employees of different channels in the same media group.

[13] Grigolon and Verboven (2014) address the issue about whether and when the logit and nested logit (NL) models can be used as reasonable alternatives to the computationally more demanding random coefficient logit (RC) model and find that the specific distributional assumptions of the RC and NL models regarding the evolution for the group dummy variable (i.e., the variable that characterizes the different nests) do not matter much.

DTTV channels were made accessible to the French households progressively during the entire period of our observation.[14] Those who get used to watching the incumbent channels do not switch to the new channels immediately, as the latter lack notoriety. To account for the difference in notoriety between the incumbent and entrant channels denoted by m and n respectively, we classify them into two separate nests. Then, in what follows, we assume that a TV viewer first chooses among three categories $g = \{m, n, 0\}$, where 0 stands for the outside option that corresponds to all the activities other than watching the free TV; second, (s)he decides to watch a channel $j \in C_g$, where C_g refers to the set of channels belonging to the category g.[15] Finally, to account for a change in notoriety over time, we introduce time specific effects at the empirical stage below.

At each given period t, the indirect utility of consumer i from watching channel j, belonging to the category g, is given by

$$U^i_{jgt} = \delta_{jt} + \zeta^i_{jgt}, \tag{1}$$

with

$$\delta_{jt} = \bar{V}_{jt} + \alpha A_{jt} + \xi_t + \xi_{jt}, \tag{2}$$

and

$$\zeta^i_{jgt} = \varepsilon^i_{gt} + (1-\sigma)\varepsilon^i_{jt}, \tag{3}$$

where δ_{jt} represents the mean utility level of TV viewers from watching channel j at time $t$and ζ^i_{jgt} captures the departure of consumer i's preference from the common utility level. The component $\bar{V}_{jt}$ is a deterministic part that depends on the idiosyncratic characteristics of channel j, A_{jt} represents the quantity of advertising at channel j and time t, ξ_{jt} is a time specific component, ξ_{jt} is a random term reflecting the effect of unobserved factors of channel j at time t on the mean utility of TV viewers. The parameter of interest to be estimated, i.e., α, measures the audience's attitude towards advertising. The error term ζ^i_{jgt} is specified as a weighted sum of two unobserved variables: ε^i_{gt}, which affects the individual i's preferences common to all channels belonging to category g, and $(1-\sigma)\varepsilon^i_{jt}$, which impacts the individual i's preferences specific to product j. The error terms ε^i_{gt} and ε^i_{jt} are distributed in such a way that the individual preferences have an extreme value distribution and are allowed to be correlated across channels j (See MacFadden *et al.*, 1978 and Williams, 1977). The parameter of interest to be estimated, $\sigma \in [0, 1)$, measures the degree of substitutability of TV channels belonging the same category from the TV viewers' point of view. As σ approaches one, the different channels within the category g are perceived as highly substitutable for TV viewers, while as σ decreases, the correlation of preferences for channels within a same category decreases. Typically, $\sigma = 0$ signifies that the TV viewers are equally likely to switch between channels in different categories as between channels in the same category.

[14] At the moment where the DTTV was formally adopted in 2005, only 35% of the French population was covered by its service. This coverage rate has been gradually raised to 85% in 2007 and to 97% by the end of 2011.

[15] We tested more complex specifications by adding nests according to the channels' type, nature, and group membership. None of them allow us to obtain economically meaningful models and/or to identify the corresponding parameters of the additional nests.

Note that there is no price in this model because watching TV is free. In fact, the quantity of advertising plays the role of price in the usual differentiated-products oligopoly model. However, here, the parameter α can be either positive or negative according to the attitude of viewers towards advertising: If α is positive, viewers value ads positively; if it is negative, they dislike advertising.

Following Berry (1994), the mean utility level for the outside good is normalized to 0, i.e., $\delta_0 = 0$, the demand of viewers is specified as

$$ln(s_{jt}) = \bar{V}_{jt} + \alpha A_{jt} + \sigma ln(\bar{s}_{jt/g}) + ln(s_{0t}) + \xi_t + \xi_{jt}, \tag{4}$$

where s_{jt} (s_{0t}, respectively) is the probability that an individual chooses to watch channel j (to take the outside option) at time t. The probability s_{jt} is decomposed as the product of two probabilities: the probability $\bar{s}_{jt/g}$ of watching channel j given that channel j belongs to category g and the probability $\bar{s}_{gt}$ that the individual chooses to watch channels of category g. This decomposition matters because of the different accessibility of incumbent and new DTTV channels.

Given that we assume a representative consumer, the choice probabilities s_{jt}, $\bar{s}_{jt/g}$, s_{0t} coincide at the aggregate level with the market share of channel j, the market share of channel j within its category and the market shares of the outside goods, respectively. If, at time t, Y_t is the market size (that we precisely define later) and if y_{jt} is the number of TV viewers watching TV j, the market share of channel j and its market share within its category are measured as $s_{jt} = y_{jt}/Y_t$ and $\bar{s}_{jt|g} = s_{jt} \Big/ \sum_{j \in C_g} s_{jt}$, respectively, while the market share of the outside good is obtained as $s_{0t} = 1 - \sum_j s_{jt}$.

From Equation (4), we define the number of viewers as $y_{jt} = s_{jt} Y_t \equiv y_{jt}(A)$, where $A = \{A_1, \ldots, A_j, \ldots, A_J\}$ is the vector of advertising quantities of all channels.

3.2. Demand of advertisers

In the spirit of the model in Rysman (2004), we consider a representative advertiser whose expected revenue per viewer from an advertising spot on channel j, denoted by r_j, is such that $r_j = \lambda_j (CPT_j/1000)$, where CPT_j measures how much (s)he received from reaching an audience of 1000 individuals and where λ_j is a scale factor at least larger than one.[16] In what follows, for simplicity of notation, we consider the vector $c = (c_1, c_2, \ldots, c_j, \ldots, c_J)$, where $c_j = CPT_j/1000$. Let $p = (p_1, p_2, \ldots, p_j, \ldots, p_J)$ be the vector of per minute price of advertising spots of different TV channels. We specify the representative advertiser's profit function as[17]

$$\Pi^A = \sum_{j=1}^{J} (\tau_j C_j - p_j a_j). \tag{5}$$

[16] It is appropriate to assume that the willingness to pay of the advertisers (CPT_j) represents only a fraction of their expected benefit from advertising (r_j).

[17] We drop the time index t in what follows, as it does not generate misunderstanding.

On the advertising market, TV stations and the advertiser agree on a CPT_j (or c_j) based on four variables: 1) the length of advertising messages, a_j; 2) the total capacity of channel j, A_j; 3) the viewership of channel j, y_j, and 4) the decomposition of audience, D_j, in terms of socio-demographic characteristics. We thus specify the market-determined c_j using a Cobb-Douglas form, namely,

$$c_j = D_j^{v_1} a_j^{v_2} A_j^{v_3} y_j^{v_4}. \tag{6}$$

Specifically, v_2 measures the decreasing return of large advertisement,[18] v_3 captures the "business stealing effect,"[19] and v_4 measures the sensitivity of advertisers to the viewership of TV channels. We expect the value of v_2 to be between 0 and 1, the value of v_3 to be negative, and the value of v_4 to be positive.

Replacing the expression (6) into Equation(5) and maximize Π^A over a_j, we obtain the inverse demand of advertising as:

$$p_j = v_2 \tau_j D_j^{v_1} a_j^{(v_2-1)} A_j^{v_3} y_j^{v_4}. \tag{7}$$

Denote the size of advertising market to be $\bar{m}$, then $a_j = Aj/\bar{m}$, thus,

$$p_j = v_2 \tau_j D_j^{v_1} \bar{m}^{(1-v_2)} A_j^{(v_2+v_3-1)} y_j^{v_4}, \tag{8}$$

which yields, with time index and in logarithmic form:

$$\log p_{jt} = \log[v_2 \tau_{jt} D_{jt}^{v_1} \bar{m}^{(1-v_2)}] + (v_2 + v_3 - 1) \log A_{jt} + v_4 \log y_{jt}. \tag{9}$$

The final empirical specification of this inverse demand function is discussed below.

3.3. Supply of TV channels

The J free-broadcast TV channels belong to K different media groups on the French market. Each media group owns or cooperates with a private advertising sales house through which its channels exchange with the advertisers. Channels within the same media group maximize jointly their profits taking account of the strategic reactions of other groups.

The profit function of a media group G_k, $k = \{1, ..., K\}$ from selling advertising spaces is given by

$$\Pi_{G_k} = \sum_{j \in G_k} \Pi_j = \sum_{j \in G_k} \left[(p_j - c_j) A_j - F_j \right], \tag{10}$$

where c_j and F_j are the marginal and fixed costs of channel j, respectively. TV stations broadcast their programs free-to-air but mainly cover their programming costs from advertising revenues. The fixed cost F_j measures the sunk investment of

[18] It is expected that a long advertising message has more chance to be remembered by the TV viewers, but the viewers may get tired of the same ad in time. Therefore, the advertiser's willingness to pay takes parabola form with respect to the length of the advertising message.

[19] That is to say, the fact that an advertisement is easily ignored in a broadcast network with a massive amount of advertisements.

channel j on the acquisition of its programs' broadcasting right. The variable costs of advertising include mainly the management cost of advertising and fixed discounts proposed by the TV channels to the advertisers. In practice, at the beginning of every year, the TV stations agree with each of their potential advertisers on a discount for the advertisers' advertising messages during the year. Such a practice consists in a marketing strategy of TV stations to capture future clients. Because the discount is specific between each channel and advertiser, it varies with time and channels.

The conduct of TV groups affects the way the feedback loop between TV viewers and advertisers works. Under Cournot competition, when a media group raises the advertising quantity broadcast for one of its channels, the prices of advertising spots on this channel drop, and the channel attracts less ad-averse TV viewers; as a consequence of the loss in audience, the advertisers' willingness to pay for ads on this channel diminishes. In the case of competition à la Bertrand on the advertising market, when a TV group raises the advertising prices for one of its channels, some advertisers will drop their advertising, while some of ad-adverse TV viewers will be attracted. However, as this attracts more viewers because of the lower quantity of advertising, advertisers' willingness to pay for advertising on this channel will rise, so the channel will advertise more. This will in turn affect viewership and subsequently advertising, and so on.

Formally, under Cournot competition, each group G_k determines the optimal advertising quantities of channels within the group $(A_{jk},\ j \in G_k)$, taking the advertising quantities of other groups as given, namely,

$$\max_{A_{jk};j\in G_k} \{\Pi_{G_k}|A_{-j}\} = \max_{A_{jk};j\in G_k} \sum_{j\in G_k} \{[p_j\left[A_j, y_j(A)\right] - c_j]\, A_j|A_{-j}\}, \tag{11}$$

where $p_j\left[A_j, y_j(A)\right]$ is the inverse-demand curve of advertisers and A_{-j} is the set of strategic advertising decisions of all channels other than j. The associated first-order condition is obtained as

$$(p_j - c_j) + A_j\frac{\partial p_j}{\partial A_j} + A_j\frac{\partial p_j}{\partial y_j}\frac{\partial y_j}{\partial A_j} + \sum_{i\neq j, j\in G_k} A_i\frac{\partial p_i}{\partial y_i}\frac{\partial y_i}{\partial A_j} = 0, \forall j \in G_k. \tag{12}$$

The advertising quantity affects the market clearing price through two ways: directly, by the standard price response to the advertising quantity supplied, which is given by the second term on the left-hand side of Equation (12), and indirectly, by the network effect between viewers and advertisers, represented by the third and fourth terms.

Under Bertrand competition, each group G_k determines the optimal spot price of advertising of channels within the group $(A_{jk},\ j \in G_k)$, taking the pricing of the other groups as given, namely,

$$\max_{p_{jk};j\in G_k} \{\Pi_{G_k}|p_{-j}\} = \max_{p_{jk};j\in G_k} \sum_{j\in G_k} \{(p_j - c_j)A_j\left[p_j, y_j(A)\right]|p_{-j}\}, \tag{13}$$

where $A_j\left[p_j, y_j(A)\right]$ is the direct demand curve of advertisers, and p_{-j} is the set of advertising prices of all channels other than j. The associated first-order condition

is

$$A_j + (p_j - c_j)\frac{\partial A_j}{\partial p_j} + (p_j - c_j)\frac{\partial A_j}{\partial y_j}\frac{\partial y_j}{\partial A_j}\frac{\partial A_j}{\partial p_j} + \sum_{i \neq j, i \in G_k} (p_i - c_i)\frac{\partial A_i}{\partial y_i}\frac{\partial y_i}{\partial A_j}\frac{\partial A_j}{\partial p_j} = 0, \forall j \in G_k. \tag{14}$$

The explanation of the different terms of Equation (12) applies here for Equation (14), as well.

In Section 6.2, we conduct a test on the estimated marginal costs to conclude on the nature of the competition in the French broadcast TV industry.

4. Econometric specification

4.1. Demand of TV viewers

The deterministic part of the indirect utility of consumers $\bar{V}_{jt}$ in Equation (4) is specified as a linear combination of channel-fixed effects, i.e., dummies for all channels. In addition, two types of temporal effects are considered through the term ξ_t in Equation (4), which is composed with dummies for each year and for each month: the yearly dummies capture potential changes in policy, fluctuations of the economic climate and the generalization of the digital TV technology, while the monthly dummies capture the seasonality of TV advertising.

Here, the market share of TV channel j, s_{jt}, differs from the so-called *audience share*, q_{jt}, used in the jargon of media marketing. The audience share, which is directly available from media marketing companies such as Mediametrie, is measured in terms of *the total population watching the TV over a market*. Here, for any given period of time, we consider the French population choosing to watch a free TV channel (j) or to select an activity other than watching free TV, which includes the possibility to watch a pay channel or enjoy other entertainments, such as going to a movie theater or reading a newspaper. To do so, we consider, for each period, the total population having access to a TV service, M_t, and we derive the augmented audience y_{jt}, i.e., the total number of TV viewers watching channel j as $y_{jt} = q_{jt}M_t$. Then, if Y_t denotes the size of the French population at period t, we estimate the market share of channel j as $s_{jt} = (y_{jt}/Y_t)$.[20]

Finally, from Equation (4), the TV viewers' demand function to be estimated is given by

$$ln(s_{jt}) - ln(s_{0t}) = \alpha A_{jt} + \sigma ln(\bar{s}_{jt/g}) + X_{jt}\beta + \xi_{jt}, \tag{15}$$

where X_{jt} includes all the dummy variables mentioned above.

4.2. Demand of advertisers

From Equation (9), we specify the inverse demand of advertisers to be estimated as

$$ln(p_{jt}) = \theta ln(A_{jt}) + \nu_4 ln(y_{jt}) + X^A_{jt}\beta^A + \xi^A_{jt}, \tag{16}$$

[20] As using the size of the population having access to a TV service to measure the total population watching TV is indeed an approximation, we implement a robustness check by estimating the model for different values of M_t. The details are presented in the next section.

where

$$\theta \equiv \nu_2 + \nu_3 - 1. \tag{17}$$

In other words, we approximate the term $\log[\upsilon_2 \tau_{jt} D_{jt}^{\upsilon_1} \bar{m}^{(1-\upsilon_2)}]$ by $X_{jt}^A \beta^A + \xi_{jt}^A$ by $X_{jt}^A \beta^A + \xi_{jt}^A$, where X_{jt}^A and ξ_{jt}^A represent, respectively, the observable and unobservable characteristics of channel j at time t that impact the demand of advertisers. We specify X_{jt}^A as a linear combination of dummies to identify channel, monthly, and annual fixed effects. Note that $\theta = \nu_2 + \nu_3 - \mu^{-1}$ captures the joint effect of business stealing and decreasing return to scale of advertising, and υ_4 measures the sensitivity of advertisers to the viewership of TV channels as discussed in the model above. We expect the estimated value of θ to be negative and the estimated value of υ_4 to be positive.

5. Estimation

The demand of TV viewers (Equation (15)) and the demand of advertisers (Equation (16)) are separately estimated using the two-stage least squares (2SLS) estimator. Because both equations encounter problems of endogeneity, an IV method is required; below, we explain our choice of instrumental variables for each equation.

5.1. Identification

Equation (15) entails two identification problems. The first one concerns the parameter σ. Conceptually, observing the viewers' switch between channels within the same category (i.e., incumbent, entrant, or outside channels) over time should allow for identification of σ, as it involves changes in the conditional probabilities of choosing the same category. These variations can be the result of either changes in channels' characteristics or changes in the number of channels operating on the market. However, there is a potential endogeneity problem if viewers switch a channel because of some unobserved changes in the characteristics of the TV channel. Indeed, in Equation (15), when ξ_{jt} is high, the market share s_{jt} is high, but the conditional market share, $\bar{s}_{jt/g}$, is also high, not only because of the viewers' switch from channels of its own category but also because of some viewers that have switched from channels of other categories. For instance, when an incumbent TV channel j increases the quality of its broadcasting content during period t, it attracts additional viewers both from other incumbent channels and from the new channels. We do not observe this change in the quality of channel j, which is captured by ξ_{jt}; however, we observe an increase in its market share s_{jt} and its conditional market share $\bar{s}_{jt/g}$. As a consequence, the estimate of σ could be biased upwards unless $\bar{s}_{jt/g}$ is properly instrumented.

The second issue of identification comes from the fact that the market shares of TV channels s_{jt} and the advertising quantities A_{jt} are determined simultaneously. The random term ξ_{jt} includes characteristics of channel j during period t that are unobserved by econometricians but are likely to be observed by the TV stations. The equilibrium level of advertising A_{jt} should be high (or low) if the TV operator anticipates that its viewership (its market share s_{jt}) will be high (or low). Hence, without controlling for this fact, the estimate of α would be biased upward (or downward, respectively).

Data on advertising in markets other than the free TV market can be used to instrument the advertising quantity of TV channels, A_{jt}. Variables such as the total amount of advertising investment in the cinema market and the total quantity of advertising (in number of advertising spots) in the radio market are available on a monthly basis and constitute the best candidates to instrument A_{jt}. Indeed, they are correlated with the quantities of TV channels' advertising because of competition across media for advertising. However, as it is unlikely that consumers switch from radio or cinema to TV because of the advertising on these two media, these two variables are potentially exogenous with respect to the number of TV viewers.

To instrument the channel's audience share within its own category, i.e., $\bar{s}_{jt/g}$, we need variables reflecting the status of TV channels in their own categories. In France, the broadcasting contents of TV channels are partially regulated. French law stipulates that TV channels broadcast more than 40% of French audiovisual programs within some particular hours of the day; the incumbent channels mush accomplish this obligation within the 5 hours in the evening, from 18:00 to 23:00, while the new digital TV channels must satisfy the obligation within the day. As a consequence, we expect the incumbent channels to broadcast more French audiovisual programs. In addition, as a policy intended to protect the French cinema sector, the capacity of TV channels to broadcast movies is restricted, especially during the prime time (i.e., the time slot between 20:30 and 22:30). However, this constraint is somehow less stringent for the new digital channels. Hence, we use the total number of hours of French audiovisual programs and the number of films broadcast during the slot 20:30 – 22:30 to instrument $\bar{s}_{jt/g}$. We expect that their variations identify the demand for channels within the nests (incumbent and new). The quantity of French audiovisual programs and the number of movies during prime time do not determine the global demand for a TV channel during one month, i.e., these two variables should be exogenous in Equation (15) In Tables 7 and 8. We provide a comparison on how these two measures vary both between and within the nests.[21] As expected, we observe, from the means reported on column 5 of Tables 7 and 8, that the incumbent channels broadcast on average more French audiovisual programs each year, while the new channels broadcast more movies during the prime time. From the values of standard deviations on column 6, we conclude that the regulation rules result in more important variations within the incumbent nest than within the new channels nest.

[INSERT Tables 7 – 8]

In Table 9, we report the OLS regression results of the instrumented variables on the instrumental variables to get a clearer idea of their explanatory relationships. Note that all of the four instrumental variables explain the quantity of advertising and the number of movies, while the quantity of French audiovisual programs ex-

[21] A referee has suggested using the "characteristics (type of programs) of other channels within the same group" as an alternative instrument. However, it is practically impossible to collect such information for the period under investigation.

plains the channels' audience share within the nest.

[INSERT Table 9]

The variables $\ln A_{jt}$ and $\ln y_{it}$ may be endogenous in Equation (16). While the fact that the analysts do not observe the quality of programs is taken into account through the unobserved component ξ^A_{jt}, the advertising agencies and the TV channels have more information on their respective qualities. In particular, they may anticipate when peaks (or drop) in audience on channel j at time t could happen. In this case, the advertisers are willing to pay more (or less) for the corresponding advertising spaces, while channel j sets more (or fewer) ads during time period t, as well. Then, $\ln A_{jt}$ and ξ^A_{jt} are correlated. Now, if $\ln A_{jt}$ is positively (negatively) correlated with ξ^A_{jt}, the estimate of θ is biased upwards (downwards). Likewise, the quality of programs (in terms of attractiveness of audience) is unobserved by the econometricians but is likely to be observable by the advertising agency. That is, $\ln y_{it}$ is correlated either positively or negatively with ξ^A_{jt}. Without controlling for this potential endogeneity problem, the estimate of parameter v_4 would be biased either upward or downward.

Summing up, the number of films broadcast during prime time, the total amount of French audiovisual programs broadcast, and the total quantity of advertising on the radio market are used to instrument $\ln A_{jt}$. To instrument the number of TV viewers of TV channels, $\ln y_{it}$, we use a published indicator called the average watching time per day per individual. This variable measures the average number of minutes per day that an individual spent watching either a broadcast or a pay TV in France. It is an indicator of the change in consumption demand for TV; so, it is clearly correlated with the audience of any TV channel $\ln y_{it}$. However, this variable does not reflect the particular quality of any broadcast TV channel; therefore, it should be considered as exogenous in the equation of demand of advertisers. For the viewers' demand, in Table 10, we report the OLS regression results of the instrumented variables on the instrumental variables to get a clearer idea of their explanatory relationships.

[INSERT Table 10]

To validate our choice of instruments, we now proceed to the IV estimation of Equations (15) and (16) and conduct statistical tests for weak instruments and overidentification, which are reported in Table 11. Recall that, as using the size of the population having access to a TV service to measure the total population watching TV is indeed an approximation, we estimate the model for different values of the market size, M_t. For both equations and for all values of M_t, the Kleibergen-Paap rk LM statistic rejects the null of under-identification at the 1% significance level; the Stock-Yogo weak instrument test suggests the instruments are strong, while the Hansen J statistic does not reject the null hypothesis that the instruments are valid at the 5% and 10% significance levels. In other words, our instruments are statistically acceptable.

[INSERT Table 11]

5.2. Estimates

The estimation results of Equations (15) and (16) are now separately reported in Tables 12 and 13. Note that scaling down the value of M_t does not significantly affect the estimated coefficients. This means that our estimates are robust and that, for the sequel, we can choose any market size. In practice, we use the total population watching TV.

[INSERT Tables 12 – 13]

For the TV viewers' demand, both the coefficient of advertising and of within-nest shares are significant at the 5% significance level. As expected, the TV viewers respond to an increase of advertising by reducing their watching demand, i.e., $\hat{\alpha} < 0$. The estimate $\hat{\sigma}$ is significantly less than 1, indicating that there exists competition between the five incumbents and the new channels; however, the significance level of $\hat{\sigma}$ suggests that there is segmentation between categories.

To determine whether the instruments used in the estimation are helpful in fixing the endogeneity bias, we compare the results from the IV estimation with those from OLS in Table 14. We observe that the parameter estimates associated with the advertising quantity and the within-nest share in the viewers' demand function strongly differ under the two types of estimation. Without controlling for the endogeneity bias, the quantity of advertising reflects the quality of TV channel and is estimated to have a positive effect on the audience of the channel. The disutility effect of advertising can be isolated from the quality of the TV channel only if the endogeneity bias is properly controlled. Moreover, with the nested-logit model specification, the value of $\hat{\sigma}$ should be between 0 and 1. This constraint is not satisfied by the OLS estimation, though it is respected with the instruments described above.

For the advertisers' demand, the coefficient $\hat{\theta}$ associated with the logarithm of the advertising quantity is significant at the 5% significance level, while the coefficient associated with the logarithm of the audience level $\hat{\nu}_4$ is significant at the 1% significance level. The estimated results are consistent with our expectation in theory: the parameter $\hat{\nu}_4$ is positive, which suggests that advertisers' willingness to pay increases with the viewership of TV channels. The negative sign of $\hat{\theta}$ reflects the combined effect of business stealing and decreasing return to scale of advertising.

As for the demand of TV viewers, we compare the results from the IV estimation with those from OLS in Table 15. We observe that the IV estimates are not significantly different from the OLS estimates. Our results suggest that the endogeneity problems in Equation (16) are not statistically significant. In the sequel, we adopt the IV estimates, while the results below would not change significantly by using the OLS estimates.

[INSERT Tables 14 – 15]

6. Empirical analysis

6.1. Demand elasticities

The estimated elasticities of demand of TV viewers are reported in Tables 16–18. On average, the TV viewers dislike advertising. It is estimated that a 1% increase in advertising reduces the audience of a TV channel by 0.5%. The TV viewers are more sensitive to ads on the new digital channels than on the incumbent channels. Moreover, we notice that the viewers become more and more sensitive to ads over time, i.e., their adverseness to advertising increases with time. This is may be due to the greater number of offers on the TV market. Finally, we observe that the own-advertising-elasticities of audience differ according to the nature of the TV channel: public channels, private news channels, and other private channels.

[INSERT Tables 16 – 18]

Looking at the viewers' cross-advertising elasticities of demand between pairs of TV channels, the estimates indicate that an increase in the advertising quantity of one TV channel has a non-negligible positive effect on the audience of the other TV channels. On average, a 1% increase in the advertising quantity of a TV channel raises the audience of another TV channel by 0.03%.[22] Overall, it seems more likely to observe a raise in the audience of other channels when an incumbent channel increases its advertising quantity.

Considering the side of advertisers, the own price elasticity is on average equal at 2.7. However, as shown by Huang (2007), this value is biased because it is derived from advertiser's inverse demand function.[23] Nonetheless, given the high value obtained, one can reasonably suspect that the advertisers' demand is rather elastic, which is a sign that the advertising market is competitive. However, this invites further investigation of the degree of competition in this market.

By estimating the inverse demand of advertisers, we can estimate *the flexibility of advertising prices*.[24] The ad-price flexibility with respect to audience and advertising can be directly obtained from their associated parameters in Equation (16), i.e., θ and ν_4. From the estimates, a 1% increase in the audience of a TV channel increases the ad price by 0.6% on average, while a 1% increase in the ad quantity of a TV channel decreases its average ad price by 0.4%.

[22] More disaggregated cross-advertising elasticities of audience are available from the authors upon request.

[23] Gregory Crawford et al. (2012) refer to Huang's article, where it is shown that the price elasticity derived from an inverse demand elasticity can be biased upward or downward as the projection of one variable on another is not the inverse of the projection of that variable on the first one. Note that it is not straightforward to determine the sign of the bias.

[24] The *price flexibility* is the percentage change in the price of a commodity associated with a 1% increase in the quantity demanded of that commodity or a related variable, all else remaining constant." (See Houck, 1965).

6.2. Marginal costs and market conduct

To derive the values of marginal costs of different TV channels, we solve the first-order conditions associated with the profit maximization function of different TV groups, under either Cournot or Bertrand competition, namely, Equation (12) and Equation (14). To do so, we need to take into account the ownership of TV channels. The 21 TV channels in our data set belong separately to 10 different TV groups, and 9 groups of the 10 use one common advertising sales house for all channels within the groups. The exceptional case is the TF1 Group. The channels TMC and NT1 manage their advertising offers through an advertising sales house independent of that of the TF1 Group during the entire period of observation. We specify the four channels of the TF1 group as belonging to two independent entities, each with its own profit maximization problem.

A comparison of estimated marginal costs under these two alternatives is provided in Table 19. Clearly, the estimates under the Bertrand assumption do not sound economically meaningful, as they are either negative or much larger than observed prices. In practice, the quantities of advertising on TVs are at least physically constrained by the time of the day. In light of the literature on market conduct under capacity constraints, we conjecture that the channels compete in quantity setting on the advertising market.[25]

[INSERT Table 19]

To test this conjecture, we implement a variant of the Davidson and MacKinnon (1981) J test, which aims to select the specification of an econometric model in the presence of one or more alternative hypotheses that purport to explain the same phenomenon. In our context, it can be applied using the estimated marginal costs of TV channels to test between the null hypothesis H_0 of Cournot competition against the alternative hypothesis H_1 of Bertrand competition.

Let c_{co} (c_{be}) and MK_{co} (MK_{be}) denote the vectors of estimated marginal costs and estimated mark-ups under Cournot and Bertrand assumptions, respectively. Let p denote the vector of observed prices, and Z is a vector of variables affecting the marginal costs of different TV channels across different periods of time.

Under the Cournot assumption, we assume that

$$c_{co} = Z\mu + \varepsilon_1 \tag{18}$$

and $p = MK_{co} + c_{co}$, while under the Bertrand assumption,

$$c_{be} = Z\lambda + \varepsilon_2 \tag{19}$$

and $p = MK_{be} + c_{be}$, with ε_1 and ε_2 following centered normal distributions.

[25] On this point we refer to Kreps and Scheinkman (1983) who study a two-stage oligopoly game where, under a quantity precommitment, the Cournot outcome is the unique equilibrium solution of the price competition. In a related setting, Osborne and Pitchik (1986) show that, if capacities are chosen simultaneously before prices, the set of equilibrium capacities coincides with the set of Cournot quantities.

The Davidson and MacKinnon (1981) J test consists first in estimating by OLS a linear regression of the following form:

$$p = (1-\alpha)(MK_{co} + Z\mu) + \alpha(MK_{be} + Z\hat{\lambda}) + u, \tag{20}$$

where $\hat{\lambda}$ is the OLS estimate in Equation (19), and u is white noise. If $\alpha = 0$, the conduct is of the Cournot type, while $\alpha = 1$ corresponds to Bertrand competition. The value of remains to be tested by an asymptotic t-test.

In Appendix 2, we provide details on the test and prove that estimating Equation (20) is equivalent to estimate

$$c_{co} = \alpha(MK_{be} - MK_{co}) + Z\gamma + u. \tag{21}$$

We cannot reject Cournot competition if $\hat{\alpha} \approx 0$ and $\hat{\gamma} \approx \hat{\mu}$, where $\hat{\mu}$ is the OLS estimate in Equation (18).

To implement this procedure, we include in the vector Z the following variables: number of employees of different TV groups and dummies for controlling for channel and time fixed effects.[26] The results of the test are provided in Table 20. From column 2, we can conclude that we cannot reject H_0, i.e., we cannot reject that $\hat{\alpha} = 0$ and $\hat{\gamma} = \hat{\mu}$. In other words, we cannot reject the Cournot outcome as the best hypothesis to explain the data generating process.

[INSERT Table 20]

Equivalently, we could test Bertrand against Cournot by estimating the following equation:

$$p = (1-\beta)(MK_{be} + Z\lambda) + \beta(MK_{co} + Z\hat{\mu}) + v. \tag{22}$$

Our estimate of β is not significantly different from one, which allows us to reject the Bertrand assumption.

7. Competitive analysis

7.1. Lerner Index

Considering the estimated marginal costs under Cournot competition, we can compute the TV channels' price-cost margins on the advertising market. More specifically, the estimated profit margins of TV channels can be ranked in three levels: approximately $40\% - 50\%$ for the public channels, above 80% for the private new channels, and approximately $60\% - 80\%$ for the other private channels.[27]

Now, following Rochet and Tirole (2006), the Lerner Index of a TV channel can be expressed as follows:

$$\frac{p_j - (c_j + p_j^v)}{p_j} = -\frac{1}{E_{A_j,p_j}}, \tag{23}$$

[26] The number of employees is used here to approximate the size of TV groups.

[27] Disaggregated values on the margins are available upon request to the authors.

where E_{A_j,p_j} is the price elasticity of advertisers' demand and p_j^v, which represents the advertising cost on the viewers' side, is defined as

$$p_j^v = -p_j E_{y_j,A_j} E_{p_j,y_j} - \frac{1}{A_j} \sum_{i \neq j, i \in G_k} A_i p_i E_{p_i,y_i} E_{y_i,A_j}, \tag{24}$$

where E_{y_j,A_j} and E_{y_i,A_j} are the own- and cross- advertising elasticity of viewers' demand and E_{p_j,y_j} is the advertisers' willingness to pay for the TV channel's viewership.

In general, the sign of p_j^v is indeterminate. The first term on the right-hand side of Equation (24) $(-p_j E_{y_j,A_j} E_{p_j,y_j})$ is positive when viewers dislike advertising and negative in the opposite case. However, it always has an opposite sign to the second term $(-\frac{1}{A_j} \sum_{i \neq j, i \in G_k} A_i p_i E_{p_i,y_i} E_{y_i,A_j})$. In our case, as viewers dislike advertising, the second term (which is negative here) is always smaller than the first term in absolute value because of the small estimated values of the cross-advertising elasticity of TV viewers (E_{y_i,A_j}). Hence, the sign of p_j^v is positive for all the observations. In other words, as viewers dislike advertising, the disutility increases the effective marginal cost of advertising to TV channels.

Then, the "opportunity cost", namely, $c_j + p_j^v$, of an additional minute of advertising is positive and higher than the marginal cost (c_j), as it induces additional nuisance to TV viewers, and so a potential decrease in advertisers' willingness to pay. In this case, the Lerner index defined by Equation (23) is lower than the price-cost margins. In fact, the average estimated value of Lerner Index is equal to 37%, which is much less than the price-cost margins provided above. In other words, in such a two-sided market, the price-cost margin is not the right indicator of firms' market power.

To complement this point and to show how important it is to account for two-sidedness, we compute the ratio p^v/p to provide the share of advertising prices, which are, in some sense, devoted to compensating viewers for the adverse effect of advertising. The estimated ratio p^v/p can be ranked in two levels: $5\% - 16\%$ for the public channels and $21\% - 52\%$ for the private channels.[28]

It is noteworthy to mention that, despite the TF1 channel's important position on the advertising market (with approximately $40\% - 50\%$ of market share), its estimated Lerner index is not higher than that of the other private channels. That is, given the two-sided structure of the broadcast television industry, a stronger position on one side of the market does not necessarily imply a higher profit margin of a TV channel. A simple measurement of the firms' market shares is not enough to conclude on the degree of competition in a two-sided market. This should be taken into account in competition law and policy.

7.2. Evaluation of a merger between advertising sales houses

In 2010, the French competition authority (AdC) approved the acquisition of channels TMC and NT1 by the TF1 group under several behavior remedies. One of the main concerns of the AdC is that the TF1 group could abuse its dominant position on the advertising market to raise unilaterally either its advertising spot prices or

[28] Disaggregated values on the ratios are available upon request to the authors.

the number of advertising minutes. According to the AdC, the TF1 group could force the advertisers, who want the advertising spaces of the TF1 channel to buy the advertising spaces of the TMC and NT1 channels at the same time. Therefore, as one of the established behavioral remedies of the merger, the AdC requires the independence of advertising offers between the TF1 channel and the TMC and NT1 channels.

Given the network externalities between TV viewers and advertisers, the merger of ads-sales houses on the quantity of advertising supply is indeterminate. As discussed previously, a rise in the quantity of advertising could have a negative effect on the viewership of TV channels, which in turn would reduce advertisers' willingness to pay. Broadcasters could either increase or decrease their advertising supply to maximize their profits.

Looking at the historical change in consumer surplus on observed data, one cannot conclude that the remedies have been effective. Indeed, the consumer surplus keeps increasing after the French competition authority's decision, which could be due to either the remedies or other effects, such as the extension of the digital market.[29]

It is then required to be able to compare the observed situation with a counterfactual experiment, where the merger would have been fully approved, maintaining all else as equal. To do so, we insert the estimated demand side parameters in the supply equation to simulate the equilibrium outcome in a scenario where the supply decision of the three merging channels is made by one unique entity. We assume here that the merger of the two advertising agencies would not have brought about any additional efficiency gains on variable costs and that other trends are kept identical.

Comparing the observed and simulated situations provides a clear conclusion: the merger of the two advertising agencies does not affect the market equilibrium outcomes. There is no significant difference in terms of advertising quantities between the two situations. More precisely, under the merger, the advertising quantity slightly increases, but only by 3%. This means that, with or without remedies, the market outcomes are equivalent. In other words, the effect of a higher level of cooperation among advertising sales houses is defeated by the viewers' adverseness for advertising, i.e., by the effect of the feedback loop between viewers and advertisers. This feedback loop works like a countervailing power to the change in the level of cooperation among advertising sales houses.

These results provide evidence that the remedies imposed by the French competition authority in this concentration operation are basically unnecessary.

8. Conclusion

This paper investigated the advertising competition in the French TV broadcast industry. Following the approval of the acquisition of channels TMC and NT1 by the TF1 Group under behavioral remedies, we evaluate the impact of this acquisition on the consumer surplus. Given the two-sided nature of the free TV channels, we

[29] Detailed empirical and statistical results for this section are available from the authors upon request to authors.

specify a structural model of oligopoly competition and separately estimate the demands of TV viewers and of advertisers using French market data.

Our findings suggest first that the indirect network externalities between TV viewers and advertisers are significant and affect the competition outcomes at equilibrium: the fraction of profit margins as a result of these externalities among viewers and advertisers is very large. Thus, a strong position on the advertising market is not enough for a channel to enjoy a higher market power than its competitors because of the feedback loop between viewers and advertisers.

We then implement a simple procedure to test for the market conduct of the TV channels, and we identify the nature of competition in the French free TV industry to be of the Cournot type. Strong network effects between TV viewers and advertisers as well as the relatively small market size restricting the channels' capacity for advertising offers explain the Cournot nature of competition in the French free TV broadcasting industry.

Finally, we conduct a counterfactual experiment to simulate the market equilibrium outcome in a scenario where the advertising sales house of TF1 and that of TMC and NT1 merge at the moment of acquisition of TMC and NT1 by the TF1 Group. Comparing the result of this simulation to the observed situation, where the advertising sales houses are kept separate following the remedies imposed by the French competition authority to approve the acquisition of TMC and NT1 by the TF1 Group, shows that the merger of the advertising sales houses would have increased the total advertising spaces on the TV market but would have decreased the advertising prices on average. However, these effects are almost negligible. In other words, we can conclude that these behavioral remedies appear unnecessary in this context.

As usual, this paper opens new questions. In particular, our analysis is based on at least three assumptions: the quality of TV programs is exogenous, the link between advertising and the choice of TV programs is given, and the discounts on the advertising prices are linear. Relaxing these assumptions calls for further research to develop an extensive analysis of the working of TV markets and advertising competition.

APPENDIX 1: Tables

Table 1: Audience shares of incumbent channels versus new channels

Year	Channel seniority	Min	Max	Mean	Std.Dev.
2008	Incumbent	2.5%	25.8%	13.2%	0.074
	New	0.3%	2.2%	1.0%	0.006
2009	Incumbent	2.4%	25.0%	12.7%	0.071
	New	0.4%	2.7%	1.3%	0.006
2010	Incumbent	2.7%	23.3%	12.1%	0.067
	New	0.6%	3.4%	1.7%	0.008
2011	Incumbent	2.9%	22.7%	11.6%	0.063
	New	0.6%	3.6%	1.9%	0.008
2012	Incumbent	3.0%	21.9%	11.5%	0.060
	New	0.7%	3.4%	2.0%	0.008
2013	Incumbent	2.8%	22.2%	11.2%	0.060
	New	0.2%	3.4%	1.4%	0.010

Table 2: Advertising revenue shares of incumbent versus new channels

Year	Channel seniority	Min	Max	Mean	Std.Dev.
2008	Incumbent	0.4%	5.29%	17.0%	0.189
	New	0.4%	3.0%	1.5%	0.006
2009	Incumbent	0.3%	55.8%	15.7%	0.188
	New	0.5%	4.6%	2.2%	0.010
2010	Incumbent	0.3%	50.2%	14.8%	0.174
	New	0.2%	5.7%	2.6%	0.013
2011	Incumbent	0.3%	45.6%	13.7%	0.160
	New	0.3%	6.4%	3.2%	0.015
2012	Incumbent	0.3%	45.2%	13.2%	0.158
	New	0.3%	6.3%	3.4%	0.016
2013	Incumbent	0.2%	42.4%	12.8%	0.152
	New	0.2%	6.6%	2.4%	0.018

Table 3: List of TV channels

Channels	Type	Nature	Media Group membership
TF1	generalist	commercial	TF1 Group
M6	generalist	commercial	M6 Group
F2	generalist	public	FTV Group
F3	generalist	public	FTV Group
F4	generalist	public	FTV Group
F5	generalist	public	FTV Group
TMC	generalist	commercial	TF1 Group*
NT1	generalist	commercial	TF1 Group*
W9	semi-generalist	commercial	M6 Group
I-Télé	news	commercial	Canal plus Group
BFM	news	commercial	NextRadioTV Group
D17	music	commercial	Canal plus Group**
D8	generalist	commercial	Canal plus Group**
RNJ12	generalist	commercial	RNJ Group
Gulli	child	commercial	Lagardère Group
RMC Découverte	documentary	commercial	NextRadioTV Group
Numéro 23	semi-generalist	commercial	La télédiversité Group
6ter	generalist	commercial	M6 Group
Chérie 25	generalist	commercial	NRJ Group
HD1	film	commercial	TF1 Group
L'Équipe 21	sport	commercial	Amaury Group

Note: * Since 2010; ** Since October 2012.

Table 4: Means and standard errors of advertising prices and quantities

	Spot_price		Number_spots	
	Mean	Std.Dev.	Mean	Std.Dev.
2008	4.939	7.733	5.388	2.091
2009	4.831	7.096	5.850	2.379
2010	4.984	6.942	6.658	2.672
2011	5.315	7.235	7.101	2.860
2012	4.178	6.658	6.900	2.888
2013	4.015	6.358	7.093	2.906

Note: Units of prices are not reported for confidentiality reasons.

Table 5: Ratio of observed advertising quantities to authorized ceilings

		2008	2009	2010	2011	2012	2013
Incumbent Channels	Channel 1	50.9%	43.5%	53.6%	53.8%	43.3%	44.4%
	Channel 2	41.0%	29.9%	38.1%	38.6%	35.6%	39.1%
	Channel 3	20.0%	22.1%	28.2%	29.7%	27.6%	27.7%
	Channel 4	83.7%	56.9%	64.7%	58.3%	56.4%	70.1%
	Channel 5	92.6%	67.7%	73.6%	69.7%	71.6%	75.3%
Channels	Channel 6	43.2%	50.5%	66.6%	68.1%	61.9%	81.1%
launched in 2012	Channel 7	34.3%	35.3%	33.2%	30.5%	33.2%	43.4%
	Channel 8	33.0%	34.0%	37.8%	49.2%	62.5%	54.9%
	Channel 9	19.8%	29.8%	38.0%	35.3%	29.2%	37.6%
	Channel 10	18.3%	19.6%	20.2%	24.5%	31.6%	38.4%
	Channel 11	29.1%	31.4%	37.4%	58.0%	71.4%	72.1%
	Channel 12	36.6%	45.2%	48.7%	52.0%	70.0%	77.5%
	Channel 13	41.9%	44.3%	52.0%	50.1%	69.0%	77.9%
	Channel 14	23.5%	33.6%	39.6%	43.5%	59.0%	74.7%
	Channel 15	45.2%	51.0%	51.9%	58.0%	64.8%	85.0%
Channels	Channel 16						29.3%
launched in 2012	Channel 17						27.2%
	Channel 18						45.3%
	Channel 19						26.6%
	Channel 20						33.6%
	Channel 21						54.9%

Note: The names of TV channels are not reported for confidentiality reasons.

Table 6: List of additional variables

Variable name	Unit	Periodicity	Mean
Average watching time	Minutes per day per individual	monthly	217.65
Total amount of advertising investment in the cinema market	Millions of Euros	monthly	26798.182
Total quantity of advertising in the radio market	Number of spots	monthly	128071.7
Total amount of French audiovisual programs	Number of hours per channel	annually	48.010
Number of movies broadcast from 20h30-22h30	Per channel	annually	75.869
Financial participation on movie production	Per channel	annually	8.353
Financial participation on regulated audiovisual production	Per channel	annually	44.493
French population size	Millions	annually	62.97
Subsidy	Millions of Euros	annually	698.501
Employees	Per media group	annually	9712.947

Table 7: Number of broadcasting hours of French audiovisual programs by channel type

Year	Channel seniority	Min	Max	Mean	Std.Dev.
2008	Incumbent	49.6	64.5	57.64	6.46
	New	0	62.6	40.61	21.42
2009	Incumbent	50.1	68.7	58.76	6.72
	New	0	67.4	41.66	22.18
2010	Incumbent	49.3	72.5	59.14	8.81
	New	0	68.8	42.97	22.92
2011	Incumbent	48.6	76.5	60.72	10.65
	New	0	72.4	44.26	23.87

Table 8: Number of movies broadcast during prime time

Year	Channel seniority	Min	Max	Mean	Std. Dev.
2008	Incumbent	0	60	46.4	21.08
	New	0	147	86.9	57.02
2009	Incumbent	2	65	45.4	22.45
	New	0	145	91	55.14
2010	Incumbent	1	60	42.6	22.46
	New	0	143	95.6	56.57
2011	Incumbent	5	64	40.8	20.01
	New	0	146	100.1	53.19

Table 9: First stage estimation of viewers' demand (*No. of observations: 689*)

	Advertising quantity A_{jt}	**Logarithm of conditional market share** $\ln\left(\bar{s}_{jt\|g}\right)$
No. of movies during prime time	-0.002***	-0.003***
	(0.0004)	(0.0004)
No. of hours of French audiovisual programs	0.005***	-0.009***
	(0.002)	(0.002)
Advertising investment in the cinema market	0.002**	-0.0004
	(0.001)	(-0.001)
No. of advertising spots in the radio market	0.003***	0.0003
	(0.001)	(0.001)
R-squared	0.535	0.220

Note: Standard errors are in parentheses: * p<0.1, ** p<0.05, *** p<0.01.

Table 10: First stage estimation of advertisers' demand
(*No. of observations: 689*)

	Logarithm of advertising quantity $\ln(A_{jt})$	**Logarithm of number of viewers** $\ln(y_{jt})$
No. of movies during prime time	-0.003***	0.0002
	(0.001)	(0.001)
No. of hours of French audiovisual programs	0.009***	-0.010***
	(0.003)	(0.003)
No. of advertising spots in the radio market	0.004***	0.0003
	(0.001)	(0.002)
Average watching time x incumbent channel dummy	-0.004**	-0.006***
	(0.002)	(0.002)
Average watching time * new channel dummy	0.002	0.001
	(0.002)	(0.002)
R-squared	0.585	0.538

Note: Standard errors are in parentheses: * p<0.1, ** p<0.05, *** p<0.01.

Table 11: Tests for the validity of instruments

Market size	0.25 M_t	0.5 M_t	0.75 M_t	M_t
Test for the viewers' demand equation				
Kleibergen-Paap rk LM statistic (p-value)	0.000	0.000	0.000	0.000
Cragg-Donald Wald F statistic (p-value)	11.059	11.059	11.059	11.615
Hansen J statistic (p-value)	0.195	0.169	0.127	0.058
Test for the viewers' demand equation				
Kleibergen-Paap rk LM statistic (p-value)	0.000	0.000	0.000	0.000
Cragg-Donald Wald F statistic (p-value)	8.638	8.638	8.638	8.638
Hansen J statistic (p-value)	0.107	0.107	0.107	0.107

Table 12: Estimation of TV viewers' demand (*No. of observations: 689*)

Market size	0.25 M_t	0.5 M_t	0.75 M_t	M_t
Quantity of advertising (α)	-0.667**	-0.653**	-0.626**	-0.551**
	(0.274)	(0.272)	(0.270)	(0.251)
Within-nest share (σ)	0.359*	0.355*	0.347*	0.367**
	(0.186)	(0.186)	(0.184)	(0.184)
F-Statistic	41.04	42.76	46.12	59.44
R-Squared	0.421	0.433	0.456	0.545

Note: (i) $M_t$denotes the total French population having access to TV service; (ii) Estimations are performed by applying the two-step feasible GMM; (iii) Standard errors are in parentheses: ***p<0.01, **p<0.05,***p<0.1.

Table 13: Estimation of advertisers' demand (*No. of observations: 689*)

Market sizes	0.25 M_t	0.5 M_t	0.75 M_t	M_t
Log(Quantity of advertising) (θ)	-0.373**	-0.373**	-0.373**	-0.373**
	(0.153)	(0.153)	(0.153)	(0.153)
Log(No. of viewers) (v_4)	0.606***	0.606***	0.606***	0.606***
	(0.149)	(0.149)	(0.149)	(0.149)
F-Statistic	19.66	19.66	19.66	19.66
R-Squared	0.430	0.430	0.430	0.430

Note: (i) $M_t$denotes the total French population having access to TV service; (ii) Estimations are performed by applying the two-step feasible GMM; (iii) Standard errors are in parentheses: ***p<0.01, **p<0.05,***p<0.1.

Table 14: Estimation of the TV viewers' demand (*No. of observations: 689*)

	OLS	IV
Quantity of advertising (α)	0.342***	-0.551**
	(0.116)	(0.251)
Within-nest share (σ)	1.030***	0.367**
	(0.142)	(0.184)
R-Squared	0.795	0.545

Note: The dependent variable is log market share of a TV channel minus log market share of the outside goods (See Equation 16). In the table, we compare OLS estimates to the IV estimates. The robustness correction is applied to both estimations so that the standard errors are robust to the presence of arbitrary heteroskedasticity. The standard errors of estimates are in parentheses. The significant levels are such that ***p<0.01, **p<0.05, and ***p<0.1. The channel fixed effect, yearly dummies and monthly dummies are included in the regressions. Their estimates are not reported but are available upon request. All of these coefficients are statistically significant.

Table 15: Estimation of advertisers' demand (*No. of observations: 689*)

	OLS	IV
Log(Quantity of advertising) (θ)	-0.261*	-0.373**
	(0.126)	(0.153)
Log(No. of viewers) (v_4)	0.723***	0.606**
	(0.149)	(0.149)
R-Squared	0.433	0.430

Note: The dependent variable is log spot price of advertising (see Equation 17). In the table, we compare OLS estimates to the TV estimates. The robustness correction is applied to both estimations so that the standard errors are robust to the presence of arbitrary heteroskedasticity. The standard errors of estimates are in parentheses. The significant levels are such that ***p<0.01, **p<0.05, and ***p<0.1. The channel fixed effect, yearly dummies and monthly dummies are included in the regressions. Their estimates are not reported but are available upon request. The monthly dummies are very significant but the yearly dummies are not.

Table 16: Own-advertising-elasticity of audience of incumbents versus new arrivals

	2008	2009	2010	2011	2012	2013
Incumbent	-0.373	-0.365	-0.425	-0.409	-0.390	-0.430
	(0.234)	(0.229)	(0.266)	(0.256)	(0.240)	(0.269)
New	-0.465	-0.527	-0.593	-0.657	-0.641	-0.642
	(0.292)	(0.311)	(0.373)	(0.413)	(0.404)	(0.408)

Note: The standard errors computed by delta method are in parentheses.

Table 17: Own-advertising-elasticity of audience

	2008	2009	2010	2011	2012	2013
Public channels	-0.227	-0.216	-0.272	-0.272	-0.235	-0.258
	(0.143)	(0.136)	(0.172)	(0.171)	(0.112)	(0.163)
Private news channels	-0.668	-0.761	-0.887	-0.937	-0.846	-0.923
	(0.425)	(0.483)	(0.563)	(0.594)	(0.536)	(0.585)
Other private channels	-0.477	-0.523	-0.578	-0.625	-0.634	-0.638
	(0.299)	(0.327)	(0.361)	(0.391)	(0.397)	(0.402)

Note: The standard errors computed by delta method are in parentheses.

Table 18: Cross-advertising-elasticity of audience

	2008	2009	2010	2011	2012	2013
Incumbent	0.053	0.051	0.057	0.053	0.050	0.078
	(0.032)	(0.031)	(0.035)	(0.033)	(0.031)	(0.049)
New	0.011	0.013	0.017	0.020	0.020	0.017
	(0.009)	(0.011)	(0.014)	(0.016)	(0.015)	(0.013)

Note: The standard errors computed by delta method are in parentheses.

Table 19: Estimated marginal costs

Year	**Observed average price**	**Marginal cost under Cournot**	**Marginal cost under Bertrand**
2008	4939	1784	31241
2009	4844	1615	9060
2010	4844	1463	5829
2011	5315	1541	-4996
2012	5600	1618	-1173
2013	4179	1087	15562

Table 20: Test Cournot versus Bertrand (*No. of observations: 689*)

	Step one Estimation of Equation (18)	Step two Estimation of Equation (21)
Difference of mark-ups		0.0002*
		(0.0001)
No. of employees	-0.002*	-0.002*
	(0.001)	(0.001)
Fixed effects		
Channel	Yes	Yes
Month	Yes	Yes
Year	Yes	Yes
R-Squared	0.122	0.133

Note: The estimates of-fixed effects included in the regressions are not reported but are available upon request. The standard errors of estimates are in parentheses. The significant levels are such that ***p<0.01, **p<0.05, and ***p<0.1.

APPENDIX 2: Test Cournot versus Bertrand

We develop the expression of Equation (20) as follows:

$$p = MK_{co} - \alpha MK_{co} + (1-\alpha)Z\mu + \alpha(MK_{be} + Z\hat{\lambda}) + u.$$

Rearranging, one obtains

$$p - MK_{co} = \alpha(MK_{be} - MK_{co}) + Z(\mu - \alpha\mu + \alpha\hat{\lambda}) + u$$

and

$$c_{co} = \alpha(MK_{be} - MK_{co}) + Z\gamma + u,$$

where $\gamma = \mu - \alpha\mu + \alpha\hat{\lambda}$. If $\hat{\alpha} = 0$, we have $\hat{\gamma} = \hat{\mu}$.

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