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

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Abstract

This paper empirically investigates the advertising competition in the free-broadcast TV industry within a two-sided market framework. A structural model of oligopoly competition is fitted to a unique dataset on the French broadcast television market, allowing us to exhibit the significance and the magnitude of the network externalities between TV viewers and advertisers and to confirm the two-sidedness nature of this industry. After having validated the conjecture that the competition in the TV advertising market is of the Cournot type, we provide empirical evidence that the price-cost margin, which does not account for the feedback loops between the two sides of a market, is not a proper indicator of market power of firms operating in two-sided markets. Finally, we conduct counterfactual simulations of a merger in French TV market approved by the competition authority under the behavioral remedy which consists in maintaining independent the advertising sales house of the merged TV channels. We show that the behavioral remedy was unnecessary, due to the two-sidedness nature of the market.

JEL Classiffication: D22, D43, K21, L11, L13, L22, L41, M37

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1 Introduction

Observing that the advertisers' willingness to pay increases with the viewership, TV channels broadcast TV programs free-to-air to the viewers but charge heavily the advertisers.[1] The price of watching TV being nil, the viewers apparently pay below the broadcasting cost. Based on Rochet and Tirole (2008), the economic rationale of this framework, which challenges the traditional view of competition law prohibiting the below cost selling, can be attributed to the two-sidedness nature of TV channels behaving as platforms that enable interactions between viewers and advertisers.

This paper aims to provide an empirical evaluation of the significance and the magnitude of two-sided network externalities in broadcast TV industry. More specifically, we identify the shape of the feedback loop between viewers and advertisers and clarify the conduct of TV channels in the advertising market. Our final objective is to provide a credible evaluation of the traditional economic tools implemented by competition authorities in this market.

Indeed, the study 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) has authorized the acquisition of two free broadcast TV channels TMC and NT1 by the media-holding company, TF1 Group, subject to various conditions. Before the acquisition, the TF1 Group, as the most active media group in the French free broadcast TV industry, already enjoyed a dominant position in the national TV advertising market by holding approximately $40\% - 50\%$ of the market. The acquisition of two channels in addition can even strengthen the Group's market position. The AdC worries that, if all the three channels (i.e., TF1, TMC and NT1) offer their advertising spaces through one common advertising sales house, the operation would lessen the degree of competition in the advertising market. For this reason, the AdC has approved the acquisition only under behavioral remedies including the maintenance of separation in advertising offers of TF1 on the one hand, and TMC and NT1 on the other hand.[2]

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 the advertiser willingness to pay for advertising spaces; however, the TV viewers may be adaverse, 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, one may conjecture that the feedback loop plays a role 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 spaces 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

[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.

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; Filistrucchi, Klein, and Michielsen, 2012; Fan, 2013), magazines (Kaiser and Wright, 2006), yellow pages (Rysman, 2004), and radios (Jeziorski, 2014; Berry, Eizenberg and Waldfogel, 2016). 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 suggest 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).[3] 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.

Free-broadcast 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), Ekelund *et al.* (2000) and Crawford *et al.* (2017), have estimated the price-elasticity of advertising demand in model frameworks that ignore 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 in a two-sided market framework using a unique monthly dataset on 21 French national free TV channels from March 2008 to December 2013. 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 common to assume Bertrand competition; however, in the context of broadcasting markets, Cournot competition is often considered. Since broadcast TV stations have limited capacities (24 hours of broadcasting time per day), there is a strong presumption that the Cournot assumption is appropriate. To confirm this conjecture, we implement a simple procedure to test for the market conduct of French free broadcast TV channels by comparing the estimated marginal costs under the two alternative conduct assumptions.

Once identified the exact conduct of TV channels in the advertising market, we are in the position to perform competitive analysis of the market that we investigate. We first provide empirical evidence that the price-cost margin is not a good indicator of market power of firms operating in two-sided markets. We show empirically how the share of advertising prices that is committed to compensating viewers for the adverse effect of advertising

[3]Ivaldi and Muller (2018) estimate the different effects of advertising on readership of newspapers and entertainment magazines with French market data. They find that readers appreciate advertising on entertainment magazines but dislike advertising on newspapers.

is important, more precisely between 5% and 16% for the public TV stations and between 21% and 52% for the private TV stations, while this share determines the departure of the price-cost margin from the Lerner Index which measures the market power of TV channels in the advertising market. In fact, following Rochet and Tirole (2006), the Lerner Index of a two-sided market platform should take into account the network externalities between the two sides of a market and therefore can not be simply the price-cost margin of one side of the market.[4] This result is suggestive to the competition law and policy. Secondly, we measure by counterfactual simulation the effect of merger of advertising sales houses of three channels belonging to a big TV group. Our counterfactual experiment avoids the conventional criticism against merger simulation which ignores the efficiency gains of merger and acquisition, because we observe a specific period (01/2010-12/2013) during which the acquisition has occurred but the advertising sales houses of the three channels were maintained independent. As we simulate the merger of advertising sales houses in this background, we systematically take into account the efficiency gains of the acquisition. Our results suggest 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 applies and the counterfactual scenario where the remedies have not been implemented. This means that, with or without remedies, the market outcomes are equivalent. In fact, the channels' potential benefit from a cooperation among advertising sales houses is defeated by the viewers' adverse taste for advertising, i.e., by the effect of the feedback loop between viewers and advertisers. This result invites us to conclude that the behavioral remedy imposed by the French competition authority when approving the operation of acquisition under investigation were not necessary.

The remainder of this paper is structured as follows. In Section 2, we present the market characteristics and data sources. In Section 3, we propose a structural model for the free-broadcast TV industry. Section 4 is devoted to the econometric specification. Section 5 presents the estimation method and results. In section 6, we do empirical analysis to determine, in particular, the conduct of TV channels in the advertising market. In Section 7, we conduct competitive analysis to assess the importance of the two-sided network externalities in market competition, and to discuss the counterfactual experiment which aims at evaluating the impact of a merger of advertising sales houses 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 has gradually replaced the aged analogue broadcasting mode of the 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.

[4] We provide the expression of Lerner Index of a broadcast TV station in section 7.1.

[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.

Currently, French households have access to a total of 22 free broadcast 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, we provide comparative statistics of *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.

Table 1: Audience shares and advertising revenues of incumbent versus new channels

Year	Channel seniority	Audience shares		Advert revenue shares	
		Mean	Std.Dev.	Mean	Std.Dev.
2008	Incumbent	13.2%	0.074	17.0%	0.189
	New	1.0%	0.006	1.5%	0.006
2009	Incumbent	12.7%	0.071	15.7%	0.188
	New	1.3%	0.006	2.2%	0.010
2010	Incumbent	12.1%	0.067	14.8%	0.174
	New	1.7%	0.008	2.6%	0.013
2011	Incumbent	11.6%	0.063	13.7%	0.160
	New	1.9%	0.008	3.2%	0.015
2012	Incumbent	11.5%	0.060	13.2%	0.158
	New	2.0%	0.008	3.4%	0.016
2013	Incumbent	11.2%	0.060	12.8%	0.152
	New	1.4%	0.010	2.4%	0.018

Among these 22 free TV channels, 17 channels are private and 5 are publicly owned. Fourteen 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 5 in Appendix 1, 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 private), and TV group membership.

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 are, in turn, valuable for advertisers. Contrary to pay TV channels which 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

[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 advertising 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.

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. The ASHs charge the advertisers a cost per thousand (CPT), which corresponds to the value of reaching 1000 viewers, for each ad-slot. 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 rarely occurs. In contrast, the contents of 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 6 in Appendix 1 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 the differences in their viewership.

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.[7] As we use monthly average level of advertising herein, what matters is whether the regulation caps on maximum minutes of advertising per day is binding. In Table 7 in Appendix 1, 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.[8]

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.[9] 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 audimeters (depending on how many pieces of equipment they have) fitted with a remote control with individual keys, which

[7]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.

[8]The restrictions on advertising minutes is an important issue, though our data do not allow for exploring its effect. This topic is studied in Zhang (2016) and Crawford *et al.* (2017).

[9]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%.

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.[10] 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 an aggregate variable as we do not have detailed per channel data.

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. We compute the number of advertising spots by dividing the number of advertising minutes by the standard length of an advertising spot, which is 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 market prices established 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 total amount of advertising expenditures 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.[11] 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 8 in Appendix 1.

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 operators face two interacting groups of consumers: TV viewers and advertisers. 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 TV viewers which is specified by a nested-logit model; the demand of advertisers which is an adaptation of the model of Rysman (2004) to broadcast TV market and is consistent with the other studies in broadcasting market such as Wilbur (2008) and Eizenberg and Waldfogel (2016); the advertising supply of TV channels is under oligopoly competition, we test the channels' conduct under Cournot assumption versus Bertrand assumption.

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

[11] 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.

3.1 Demand of TV viewers

We here adopt a nested logit model to specify the demand of TV viewers in the aim of controlling for the change in notoriety of different TV stations. 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 DTTV channels were made accessible to the French households progressively during the entire period of our observation.[12] Those who get used to watching the incumbent channels do not switch to the new channels immediately, as the latter lack notoriety.

Let I be the potential market size corresponding to the total French population having access to a TV service.[13] 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). 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. 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.[14] 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

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

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 $\bar{V}_j$ 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

[12]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.

[13]We will perform robustness check later on by using different values of the market size for the estimation.

[14]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.

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 to the same category from the TV viewers' point of view. As σ approaches one, the TV viewers substitute significantly between channels within the same category g, 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.

Notice that there is no price in this model because watching broadcast TV channel is free of charge. In fact, the quantity of advertising plays the role of price in the usual differentiated-products oligopoly model. However, 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., $\delta_0 = 0$, and the demand of viewers is specified as

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

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 an 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 the advertiser j pays for reaching an audience of 1000 individuals. The scale factor λ_j is at least larger than one because advertisers buy an advertising space only when their expected benefit exceeds the cost. 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 $p = (p_1, p_2, \ldots, p_j, \ldots, p_J)$ and $a = (a_1, a_2, \ldots, a_j, \ldots, a_J)$ be, respectively, the vectors of per minute price of advertising and the average duration of an individual advertising spot of different TV channels. We specify the representative advertiser's profit function as:[15]

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

In practice, CPT_j (or C_j) is determined on the basis of four variables: 1) the average duration of an advertising message, 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,

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

where v_2, v_3 and v_4 measure, respectively, the return of large advertisement, the "business stealing effect" and 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.[16,17]

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

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

As we consider an average advertiser who chooses its optimal amount of advertising to broadcast on each channel j, we have $A_{jt} = \bar{m} a_{jt}$, where $\bar{m}$ is the market size of advertising.[18] 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:

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

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 they sell advertising spaces to the advertisers. Channels within the same media group maximize jointly their profits taking account 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

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

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

[16]The "business stealing effect" refers to the fact that an advertisement is ignored in a broadcast network with a massive amount of advertisements.

[17]The return of large advertisement is expected to be decreasing because 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.

[18]Consider a continuum of advertisers indexed by $l \in [0, \bar{m}]$ distributed as $f(l)$. Denote the advertising choice of advertiser l on the channel j as a_{jl}, then $A_j(P_1, ..., P_J) = \int_0^{\bar{m}} a_{jl}(P_1, ..., P_J) f(l) dl$.

where c_j and F_j are, respectively, the marginal and fixed costs of channel j. TV stations broadcast their programs free-to-air but essentially cover their programming costs from advertising revenues. The fixed cost F_j measures the sunk investment of channel j on the acquisition of the broadcasting right of its programs. The marginal costs of advertising include mainly the management of advertising spaces but also the discounts proposed by the TV channels to the advertisers. In practice, at the beginning of every year, the TV stations propose a discount to each of their potential advertisers for the advertisers' advertising messages during the year. Such a practice consists in a marketing strategy of TV stations to capture future clients. We do not have any additional information on the value of discounts except that there are specified between each TV channel and advertiser. In other words, the value of the discounts indeed varies with time and channels.

The conduct of TV channels affects the way the feedback loop works between TV viewers and advertisers. Under Cournot competition, a TV channel losses ad-adverse viewers y_j when its advertising quantity A_j increases; by consequence, the price of each advertising minute p_j diminishes. In the case of competition à la Bertrand in the advertising market, advertisers' demand A_j decreases with the per minute price of advertising p_j, which may attract additional ad-adverse TV viewers y_j to the channel. However, an increase in viewership y_j would rise up the channel's advertising prices p_j, which encourages the channel to 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,

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

where $p_j\,[A_j, y_j(A)]$ 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,

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

where $A_j\,[p_j, y_j(A)]$ 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 similarly to Equation (14).

We will test which assumptions (Cournot versus Bertrand) fit better with the data in Section 6.2, in order to conclude on the nature of competition in the French broadcast TV industry.

4 Econometric specification

We specify here the key variables of the theoretical model presented above to derive the econometric model for estimation.

4.1 Demand of TV viewers

The deterministic part $\bar{V}_j$ of the indirect utility of consumers, defined in Equation (2) and appears in the equation of demand of TV viewers (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 of the demand of viewers: Yearly dummies capture the potential changes in policy, fluctuations of the economic climate and the generalization of the digital TV technology, while monthly dummies capture the seasonality of TV viewing.

Our definition on 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 the media marketing companies such as Mediametrie, is measured in terms of *the total population who watch TV over a market.* Here, we allow for consumers to select an activity other than watching free TV, which includes the possibility to watch a pay TV channel or to enjoy other entertainments, such as going to a movie theater or reading a newspaper. To do so, we consider 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 $s_{jt} = (y_{jt}/Y_t)$.[19]

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

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

where

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

The term $\log[v_2\lambda_{jt}D^{v_1}_{jt}\bar{m}^{(1-v_2)}]$ in Equation (9) includes information on the demographics of TV viewers and on the size of advertising market, which are channel specific and are time

[19]As using the size of the population having access to a TV service to measure the total population watching TV is 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.

specific. We approximate it 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 for channel, monthly, and annual fixed effects. Note that $\theta = \nu_2 + \nu_3 - 1$ captures the joint effect of business stealing and decreasing return to scale of advertising, and v_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 v_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. We explain now 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 either the result of changes in channels' characteristics or the result of 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 for.

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 expenditure in the cinema market* and *the total quantity of advertising 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 advertising quantities because the demand for advertising has seasonality. Broadly speaking, we notice picks in advertising quantities during October - December, but drops in advertising quantities during July - August. The unit of advertising quantity in cinema market is very different to the unit of advertising quantity in broadcasting market. We therefore choose to use the total advertising expenditure per month in the cinema market. The seasonality of advertising demand as well as the correlation between TV advertising quantities, radio advertising quantities and total advertising expenditure in the cinema market are displayed in Figure 1- 3 in Appendix 3. We are confident to believe that *the total amount of advertising expenditure in the cinema market* and *the total quantity of advertising in the radio market* are exogenous in Equation (15), because it is unlikely that consumers switch from TV to Radio or Cinema due to the quantity of advertising.

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 must broadcast more than 40% of French audiovisual programs within some particular hours of the day; the incumbent channels must accomplish this obligation within the 5 hours in the evening, from 18:00 to 23:00, while the new digital TV channels are allowed to satisfy the same obligation within a day, from 01:00 to 23:59. 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., 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 prime time 20:30 – 22:30* to instrument $\bar{s}_{jt/g}$. We expect that their variations identify the demand for channels between the nests of our model (i.e., between the incumbent and new channels). As we control for channel-, month- and year- fixed effects in our estimation, the error term ξ_{jt} consists of unobserved specific shocks on the quality of channel j within month-year t.

We are confident that the two instrumental variables (*the total number of hours of French audiovisual programs* and *the number of films broadcast during the the prime-time 20:30 – 22:30*) are not correlated with ξ_{jt} for three reasons: First, the variables are observed annually while our model is defined on a monthly basis; second, their value are stable over the years as it can be observed from Table 2); third, these two variables do not vary significantly in channel within the same nest (i.e. neither within the incumbents nor within the new channels). In Table 2, we report the means and standard deviations of these two variables within each nest year by year. Note that the values of the standard deviations are much smaller than the values of their respective means. Moreover, we observe that the incumbent channels broadcast on average more French audiovisual programs each year, while the new channels broadcast more movies during the prime time. In other words, these two instrumental variables are indeed correlated with $\bar{s}_{jt/g}$.[20]

In the equation of demand of advertisers (Equation 16), the variations in the advertising prices $\ln(p_{it})$ of TV channels over time corresponding to variations in the channels' viewership $\ln(y_{it})$ identify the value of v_4, while the variations in advertising prices $\ln(p_{it})$ of TV channels over time corresponding to variations in the channels' advertising quantities during the same period $\ln(A_{jt})$ identify the value of θ. However, the variables $\ln(A_{jt})$ and $\ln(y_{jt})$ may be endogenous in Equation (16).

Advertisers request audiences to TV channels but generally do not choose the programs

[20] One may think about 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.

Table 2: Variability of French audiovisual programs and films during prime time

Year	Channel seniority	French audiovisual programs		Films during prime time	
		Mean	Std.Dev.	Mean	Std.Dev.
2008	Incumbent	57.64	6.46	46.40	21.08
	New	40.61	21.42	86.90	57.02
2009	Incumbent	58.76	6.72	45.40	22.45
	New	41.66	22.18	91.00	55.14
2010	Incumbent	59.14	8.81	42.60	22.46
	New	42.97	22.92	95.60	56.57
2011	Incumbent	60.72	10.65	40.80	20.01
	New	44.26	23.87	100.10	53.19

on which those adverts are shown as scheduling the broadcasting of adverts are indeed the task of TV channels. The latter have inside informations on their quality of programs and take them into account both when determining their advertising quantities and when scheduling the different adverts. As we do not observe these informations as econometricians, one must recognize that Equation (16) entails endogeneity problems. Likewise, the unobserved informations ξ_{jt}^{A} may be correlated with the viewership of TV channels $\ln(y_{it})$ as well.

To address these problems, we use *the number of films broadcast during prime time*, *the total amount of French audiovisual programs being broadcast during the year*, *the total quantity of advertising on the radio market*, and a published indicator called *the average watching time per day per individual* as instrumental variables. Both films and audiovisual programs are genres of programs that have important heterogeneities in quality. Moreover, as explained previously, their broadcasting quantities are more the consequence of regulation than the profit maximizing choices of TV stations. These factors guarantee the exogeneity of *the number of films broadcast during prime time* and of *the total amount of French audiovisual programs being broadcast during the year* in Equation (16). The variable *average watching time per day per individual* measures the average number of minutes per day that an individual spends on 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 $\ln(y_{it})$.[21] 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.

To validate our choice of instruments, we conduct statistical tests for weak instruments and overidentification of the IV estimations of Equations (15) and (16). The results are reported in Table 9 in Appendix 1 for different values of the market size M_t. As we use the total population having access to a TV service to approximate the total population watching television, we indeed need to check how the estimations are robust to this approximation. 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

[21]Notice that this variable is not a simple transformation of the viewership of broadcast TV. It takes into account the consumption demand for pay TVs as well.

levels. In other words, our instruments are statistically meaningful.

5.2 Estimates

The estimation results of Equations (15) and (16) are separately reported in Tables 10 - 11 in Appendix 1. Notice 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 who watch TV.

For the viewers' demand, both the coefficient on the advertising $\hat{\alpha}$ and on the within-nest shares $\hat{\sigma}$ 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 value 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 12 in Appendix 1. 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 for. 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, but it is respected when we control for the endogeneity problem.

For the advertisers' demand, the coefficient $\hat{\theta}$ associated with the logarithm of the advertising quantity $\ln(A_{it})$ is estimated to be significant at 5% significance level, and the coefficient $\hat{\nu}_4$ associated with the logarithm of the audience level $\ln(y_{it})$ is estimated to be significant at 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 13 in Appendix 1. 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.

6 Empirical analysis

6.1 Demand elasticities

The estimated elasticities of demand of TV viewers are reported in Tables 14 - 16 in Appendix 1. On average, the TV viewers dislike advertising: A 1% increase in advertising reduces the audience of a TV channel by 0.5%. Notice that the TV viewers are more sensitive to ads of the new digital channels than to the ads of the incumbent channels. Moreover, the viewers' adverseness to advertising has increased in time, which may be due to the increase in broadcast TV service offers in the 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.

The estimates on the viewers' cross-advertising elasticities of demand indicate that an increase in the advertising quantity of a TV channel has non-negligible positive effect on the audience of the other TV channels. On average, 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.

The estimates of the inverse-demand curve of advertisers suggest that a 1% increase in viewership increases the average per minute price of advertising by 0.6%, while a 1% increase in the advertising quantity decreases the average per minute price of advertising by 0.4%.

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 both under Cournot and under Bertrand competition, which correspond to Equation (12) and Equation (14). We take into account the ownership of TV channels for this purpose. The 21 TV channels in our data set belong separately to 10 different TV groups, among which 9 groups have each one a unique advertising sales house for all their channels. The exceptional case is the TF1 Group. Channels TMC and NT1 have managed their advertising offers through an advertising sales house (ASH) independent of the ASH of TF1 Group during the entire period of observation. We therefore specify TMC and NT1 as belonging to a different entity than TF1 Group, which maximizes the joint profit of channel TMC and NT1.

A comparison of estimated marginal costs under the two alternatives is provided in Table 3. 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.[23]

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.

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

[23] 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.

Table 3: 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	146	5829
2011	5315	1541	-4996
2012	5600	1618	-1173
2013	4179	1087	15562

Under the Cournot assumption, we assume

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

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

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

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

The Davidson and MacKinnon (1981) J test consists first in estimating by OLS regression a linear model 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.[24] The results of the test are provided in Table 17 in Appendix 1. 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.

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.

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

7 Competitive analysis

In this section, we show that it is crucial to account for the two-sidedness nature of the TV market to properly measure the market power of channels and the impact of mergers.

7.1 Lerner Index versus price-cost margins

Consider 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.[25] Due to the unobserved discounts, our estimated price-cost margins are potentially overestimated. However, we can show that the Lerner Index, which is the correct measure of market power, always takes lower values than the corresponding price-cost margin, for any given level of marginal cost.

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

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

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, the first term 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.

To show how important it is to account for two-sidedness in this market, 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. Detailed ratios p^v/p by channel are provided in Table 4. In sum, this ratio can be ranked in two levels: $5\% - 16\%$ for the public channels and $21\% - 52\%$ for the private channels, which are high enough to show evidence that the price-cost margins is not a good indicator of the market power of TV channels.

The analysis above can be applied to any other two-sided markets.

[25] More disaggregated price-cost margins are available from the authors upon request.

Table 4: Lerner Indexes in the broadcast TV market

Channel	p^v/p		Channel	p^v/p		Channel	p^v/p	
	Mean	Std.Dev.		Mean	Std.Dev.		Mean	Std.Dev.
TF1	35.28%	0.04	NT1	41.02%	0.08	D17	27.72%	0.07
M6	36.44%	0.06	W9	32.43%	0.10	D8	34.42%	0.09
F2	15.71%	0.02	I-Télé	49.92%	0.13	RNJ12	39.68%	0.13
F3	10.86%	0.02	BFM	52.27%	0.13	Gulli	20.77%	0.11
F4	11.91%	0.03	RMC	31.17%	0.06	Chérie25	24.34%	0.08
F5	4.97%	0.02	Numéro23	24.90%	0.10	HD1	36.77%	0.09
TMC	41.39%	0.07	6ter	21.47%	0.03	Équipe21	50.98%	0.12

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 behavioral remedies. One of the main concerns of the AdC was that the TF1 group could abuse its dominant position on the advertising market to raise unilaterally either its advertising spot prices or the number of advertising minutes. According to the AdC, the TF1 group could have forced the advertisers, who were fighting for the advertising spaces of the TF1 channel, to buy advertising spaces of the TMC and NT1 channels at the same time, and by so doing, could have manipulated the advertising market equilibrium (in terms of price and quantity). Therefore, as one of the established behavioral remedies to approve the merger, the AdC required the independence of advertising offers, i.e., the independence of ads-sales houses, between the TF1 channel and the TMC and NT1 channels.

Given the network externalities between TV viewers and advertisers, the merger effect of ads-sales houses on the quantity of advertising supply is indeterminate in theory. 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.

One cannot conclude that the remedy, i.e., the independence of ads-sales houses, has been effective simply from the historical change in consumer surplus. Indeed, the consumer surplus computed from our demand specification has kept increasing after the French competition authority's decision.[26] However, this result could be due to either the remedy or other effects, such as the extension of the digital market.

It is then required to compare the observed situation with a counterfactual experiment, where the merger would have been fully approved, including the merger of the ad-sales houses and 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 now made by one unique entity. It is noteworthy to mention that our counterfactual experiment avoids the conventional criticism against merger simulation which ignores the efficiency gains of merger and acquisition, because we observe a specific period (01/2010-12/2013), during which the acquisition has

[26] Based on our demand specification, the surplus of TV viewers can be computed using the formula $CS\_{viewers} = -\frac{1}{\alpha} ln[1 + \sum_g [\sum_{j \in C_g} exp(\frac{\delta_{jt}}{(1-\sigma)})]^{(1-\sigma)}]$. (See Williams, 1977 and Small and Rosen, 1981.) We establish detailed evolution of the viewers' surplus during 2008-2013 in Figure 4 in Appendix 3.

occurred but the advertising sales houses of the three channels are maintained independent. As we simulate the merger of advertising sales houses in this background, we systematically take into account the efficient gains of the acquisition.

Comparing the observed and simulated situations provides a clear conclusion: The merger of the two advertising agencies does not affect significantly the market equilibrium outcomes in terms of advertising quantities and prices. More precisely, merging the advertising sales houses would have increased the total advertising quantity in the market only by 3%, and would have decreased the average advertising prices of the market only by 0.8%. This suggests that, with or without the remedy, the market outcomes are almost equivalent. In fact, the channels' potential benefit from a cooperation among advertising sales houses is defeated by the viewers' adverse taste 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 impact of cooperation among advertising sales houses.[27]

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

8 Conclusion

This paper provides an empirical evaluation of the significance and the magnitude of two-sided network externalities in the French broadcast TV market. We identify the shape of the feedback loop between TV viewers and advertisers and clarify the conduct of TV channels on the advertising market. Our results suggest that the nature of competition between TV channels in the advertising market is of Cournot type, and that the 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 estimated to be very large.

We also provide a credible evaluation of the traditional economic tools implemented by competition authorities in this market. We first show how the values of Lerner Index, which measures the market power, depart from the corresponding price-cost margins in the TV advertising market. We next examine the effectiveness of a recent decision of the French competition authority which approves for acquisition of two broadcast TV channels by the large TV group only under behavioral remedies, including the maintenance of an independent advertising sales house of the two acquired channels.

Our analysis provide empirical evidence that the price-cost margin is not a good indicator of market power of firms operating in a two-sided market. We also show by counterfactual simulation that merging the advertising sales houses of different TV channels of a big TV group would not significantly affect the equilibrium outcomes in this market because of the strong network externalities between TV viewers and advertisers. In other words, we conclude that the implemented behavioral remedies is 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; the discounts on the advertising prices are linear. Relaxing these assumptions calls for further research to develop an extensive analysis of the functioning of TV markets and advertising competition.

[27]Detailed comparisons of the market equilibrium levels of advertising quantity and price with and without merging the ads-sales houses of the three channels are provided in Figure 5 in Appendix 3.

APPENDIX 1: Tables

Table 5: 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	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	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

Table 6: Means and standard errors of advertising prices and quantities

	Average price per spot of advert		Numbe of spots per channel per month	
	Mean	Std.Dev.	Mean	Std.Dev.
2008	4938.52	7912.97	5388.85	2345.24
2009	4843.78	7268.86	5850.02	2738.66
2010	4984.39	7103.38	6657.89	2978.17
2011	5315.10	7403.49	7101.16	3155.22
2012	5599.90	7401.01	6899.92	3239.77
2013	4179.09	6473.68	7168.19	3196.28

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

Table 7: 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 launched in 2012	Channel 6	43.2%	50.5%	66.6%	68.1%	61.9%	81.1%
	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 launched in 2012	Channel 16						29.3%
	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 8: 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 9: 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 10: 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)
Channel FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
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 11: 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)
Channel FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
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 12: Estimation of the TV viewers' demand (*No. of observations: 689*)

	OLS	IV
Quantity of advertising (α)	0.342*** (0.116)	-0.551** (0.251)
Within-nest share (σ)	1.030*** (0.142)	0.367** (0.184)
Channel FE	Yes	Yes
Month FE	Yes	Yes
Year FE	Yes	Yes
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 13: Estimation of advertisers' demand (*No. of observations: 689*)

	OLS	IV
Log(Quantity of advertising) (θ)	-0.261* (0.126)	-0.373** (0.153)
Log(No. of viewers) (v_4)	0.723*** (0.149)	0.606** (0.149)
Channel FE	Yes	Yes
Month FE	Yes	Yes
Year FE	Yes	Yes
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 14: Own-advertising-elasticity of audience of incumbents versus new arrivals

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

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

Table 15: Own-advertising-elasticity of audience

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

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

Table 16: Cross-advertising-elasticity of audience

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

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

Table 17: 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* (0.001)	-0.002* (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 $\hat{\gamma} = \hat{\mu}$.

APPENDIX 3: Figures

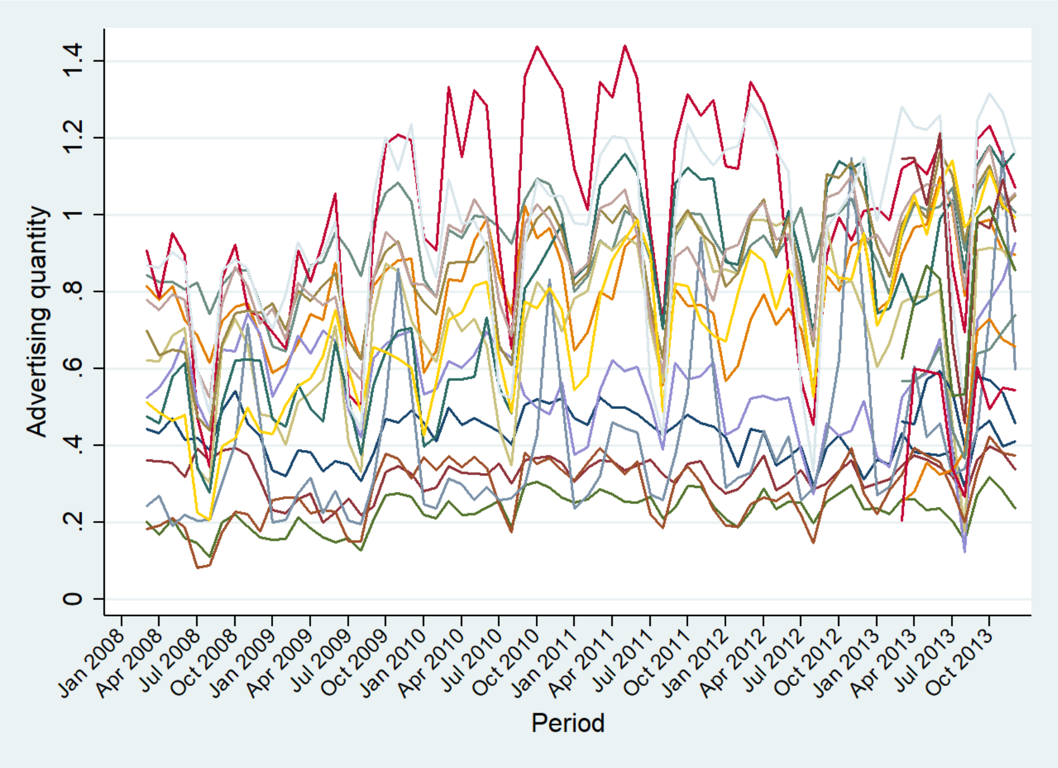

Figure 1: Seasonality of TV Ad Quantity

Each line represents one channel, we do not mention their names for confidentiality reason.

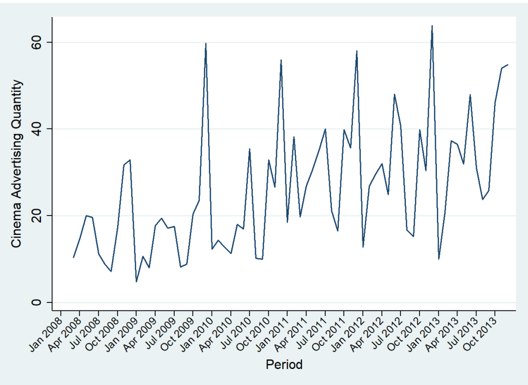

Figure 2: Cinema Ad Expenditure

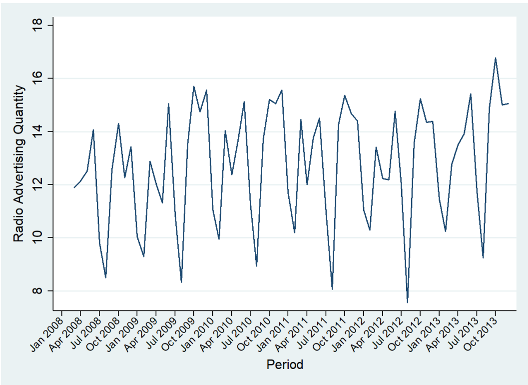

Figure 3: Radio Ad Quantity

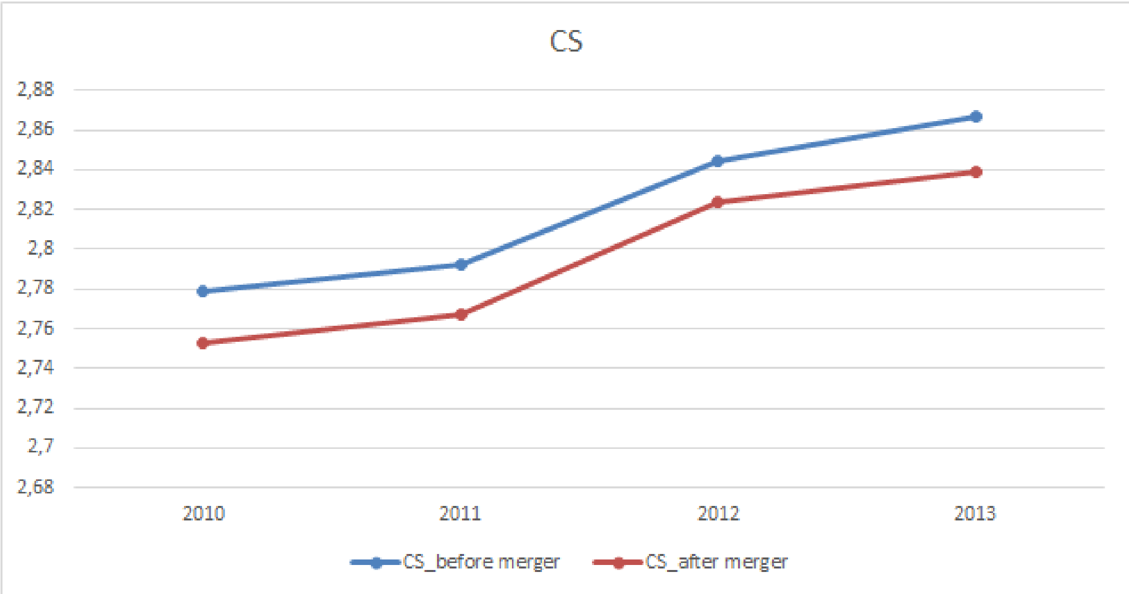

Figure 4: Evolution of the viewers' surplus during 2008-2013.

(*Note that we cannot convert units into euros without observing the viewers' paying to remove advertising. The numbers on the "Y-axis" have no direct interpretation. However, for the purpose of our analysis, what matters is the trend of evolution of the line.*)

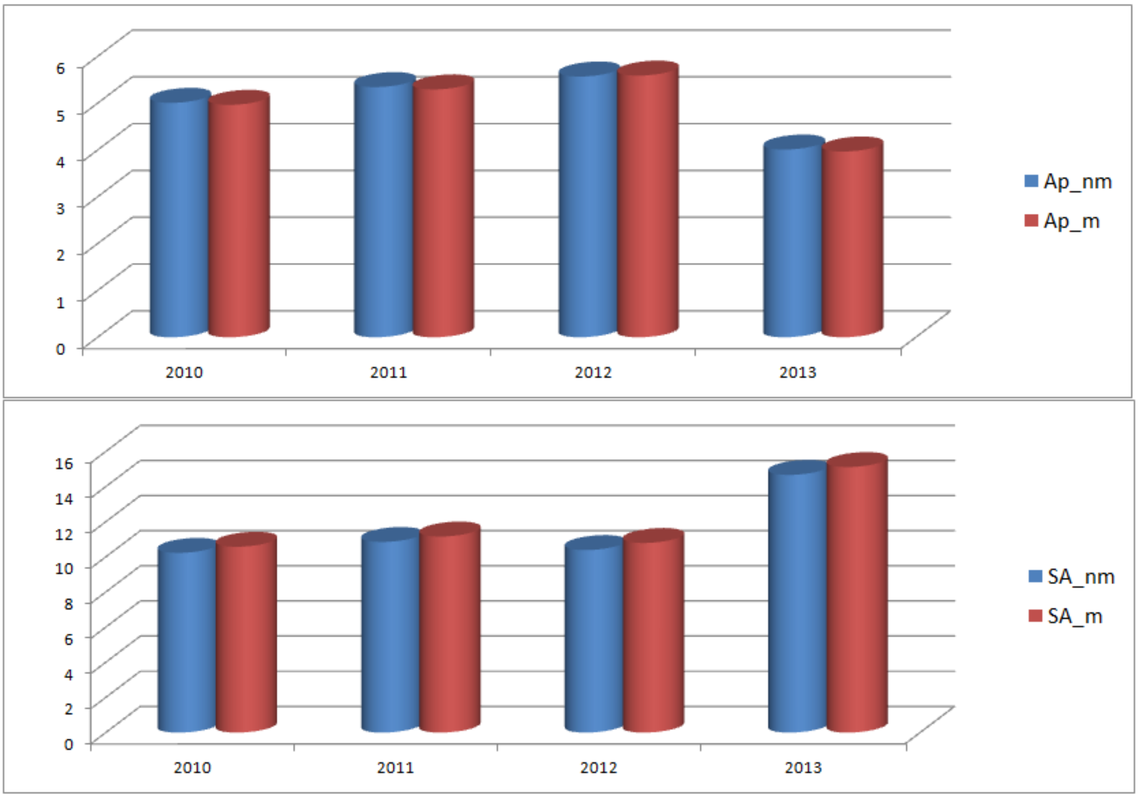

Figure 5: Comparison of advertising quantities and prices with and without merging the ads-sales houses of TF1, TMC and NT1

(*Note: SA_m and SA_nm represent the total advertising quantity in the market with and without the merger. Ap_m and Ap_nm represent the average advertising prices in the market with and without the merger. The advertising quantities are measured in thousands of spots. The units of prices are scaled down for confidentiality reason.*)

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