Advertising competition in the French free-to-air television broadcasting industry *

Marc Ivaldi[†] Jiekai Zhang[‡]

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Abstract

This paper investigates empirically the advertising competition in the French free TV broadcasting industry in a two-sided framework. We specify a structural model of oligopoly competition of free TVs, and identify the shape and magnitude of the feedback loop between the TV viewers and the advertisers using French market data from March 2008 to December 2013. We contribute to the literature by implementing a simple procedure to test the conduct of TV channels, and identify that the nature of competition is of Cournot type on the French TV advertising market. In line with a decision of French anti-trust authority in 2010 which authorized the acquisition of two free broadcasting TV channels by a big media group under behavioral remedies, a series of competitive analysis has been conducted: We find firstly that the surplus of TV viewers keep raising after the decision of acquisition, suggesting that the implemented policy has been efficient in protecting the consumer surplus; Then, we find, by counterfactual simulation, that the merger of advertising agencies would not affect importantly the equilibrium outcomes in this industry, due to the strong network externalities between the TV viewers and the advertisers.

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

Keywords: Advertising, competition, media, TV, two-sided market, market conduct, behavioral remedies

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[†]Toulouse School of Economics and CEPR. E-mail: marc.ivaldi@tse-fr.eu

[‡]Corresponding author. MINES ParisTech, PSL- Research University, CERNA - Centre for Industrial Economics. E-mail: jiekai.zhang@mines-paristech.fr

1 Introduction

On 26 January 2010, subject to various conditions, the Autorité de la concurrence (AdC)[1] authorized the acquisition of two free broadcasting TV channels TMC and NT1 by the media holding company TF1 Group. Before the acquisition, TF1 Group, as the most active media Group in the French free TV broadcasting industry, enjoys already a dominant position on the national TV advertising market, with the TF1 channel along holding about $40\% - 50\%$ of the market. The acquisition of two free channels in addition can only strengthen the Group's position, and if the three channels (TF1, TMC and NT1) propose their offerings of advertising screens through one common advertising agency, the operation could entail the risk of raising the so-called "leverage effect" on the TV advertising market. For this reason, the AdC approved the acquisition only under several behavioral remedies, among which there is the maintenance of independence in the advertising offers between TF1, on the one hand, and TMC and NT1, on the other. 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 TF1 Group has been monitored by the Conseil supérieur de l'audiovisuel (CSA)[2] during the five effective years of the remedies (26 January 2010 - 26 January 2015). According to the CSA, the commitments have been respected, especially, the channels TMC and NT1 and the channel TF1 have managed their advertising offers through independent advertising agencies. It remains to verify if the aim of remedies has been achieved, are the implemented remedies efficient in protecting the consumer surplus?

It was expected that the audience of the newly launched digital terrestrial TV (DTTV) channels in 2005 (including TMC and NT1) continue to grow until 2012, with the increase in coverage area of the DTTV technology.[3] Thus, without market concentration, the surplus of French households on the free TV consumption is expected to rise from 2005 to 2012. The operation of acquisition allows the TF1 Group to improve the programming quality of the channels TMC and NT1 through reallocation of resources within the Group. However, it is not known if the potential gains in efficiency could be transferred onto the surplus of TV viewers. The increase in audience of TMC and NT1 may be accompanied with the increase in bargaining power of these two channels on the advertising market. Its result on the pricing and quantities of advertising at equilibrium remains unclear. In order to determine the evolution of consumer surplus following the adoption of above behavioral remedies, a complete market analysis is required. It is the task of this paper.

The free TV channels are two-sided platforms, connecting the TV viewers and the advertisers through indirect network externalities: The larger the audience size of a TV channel, the higher the willingness to pay of advertisers for its advertising screens; 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 feedback loop between viewers and advertisers. If these network externalities are identified to be significant, it is required to take the feedback loop into account in the analysis of competition outcomes. Different to pay TV channels for which the subscription fees of TV viewers represent a significant part of incomes, the TV channels

[1]The French anti-trust authority.
[2]The French regulator on television and radio.
[3]See section 2.1 for details on the launching of DTTV channels in France.

broadcasting free to air draw their revenues 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 demand of advertisers. This raises the question of the type of conduct of free TV channels on the advertising markets given these features. What are the respective roles of prices and quantities of advertising in achieving an equilibrium? In this paper, we specify a structural model of oligopoly competition of free TVs, using monthly data on 21 French national free TV channels from March 2008 to December 2013, we identify the two-sidedness and the competition nature of the industry, and conclude on the evolution of consumer surplus during the period of observation.

The theory initiated by Rochet and Tirole (2003) and Armstrong (2006) has provided a framework for the two-sided markets. Based on this approach, articles by Anderson and Coate (2005), Cunningham and Alexander (2004), Nilssen and Sorgard (2000) among others, have addressed the TV advertising competition by assuming the ads to be a nuisance to TV viewers and that the TV channels compete by setting advertising quantity. Still few empirical researches have kept place to support these theoretical analysis. Up to now, the empirical studies have examined the two-sided structure of industries of newspapers (Argentesi and Filistrucci, 2007; Argentesi and Ivaldi, 2007), magazines (Song, 2011), yellow pages (Rysman, 2004) and radios (Jeziorski, 2014). Wilbur (2008) used the two-sided concept in analyzing the importance of TV viewers' and of advertisers' preferences in driving the TV channels' programming choices, as well as the impact of ad-avoidance technology on TV channels' advertising revenues with data of 6 US TV channels. Previous empirical findings suggest that the attitudes of audience (readers/viewers/listeners) toward advertising varies with industries: The audience tends to appreciate advertising on magazines, yellow pages and certain types of newspapers, but dislikes advertising in broadcasting industry (radio, TV). The market conduct has been assumed to be either Cournot or Bertrand in previous empirical studies, but no paper has formally tested the nature of competition in the industry they studied.

Broadcasting TV channels constitute the most important medium for advertising. However, only few papers have empirically analyzed the advertising competition in this industry. Some like Masih (1999), Robert B *et al.* (2000), though, have estimated the price-elasticity of advertising demand without taking into account the feedback loop between TV viewers and advertisers. Our paper investigates the advertising competition in French free TV industry in a two-sided framework. By specifying a structural model of demand and supply, we estimate the demand of the both sides (TV viewers and advertisers) of the platforms (TV channels) using French market data. Our estimation results suggest that the TV viewers dislike the ads in general, thus conforming a finding of Wilbur (2008), and that the network effects between TV viewers and advertisers are significant.

Our paper contributes to the literature by implementing a simple procedure to test the market conduct of French free TV channels (which can be easily applied in others contexts). We firstly derive the estimated marginal costs of TV channels from the supply equations. Then, we test the channels' hypothetical market conduct based on their cost equations. The procedure allows to identify the nature of competition in this industry as of Cournot type. This is not surprising because it reflects the TV channels' limited capacity in advertising screens.

To conclude, we conduct a series of competitive analysis on the competition outcomes of the French free TV industry. We derive the Lerner Indexes of TV channels based on the knowledge about their ownership. The estimated profit margins (excluding fixed costs) in this industry are very high in general, consistent with the characteristics of the industry: high fixed cost, important economies of scales and non-substituable broadcasting contents. Moreover, we interestingly find that the dominant position of TF1 channel on the advertising market does not allow it to enjoy a higher market power than its competitor, due to the strong interactions between TV viewers and advertisers through feedback loop. Finally, regardless of the recent concentration of the industry, particularly related to the acquisition of TMC and NT1 by the TF1 Group, our estimation results suggest that the French households' consumption surplus from free TV broadcasting have kept rising during the entire period of observation, namely, 2008-2013. Moreover, we conduct a counterfactual experiment to simulate the equilibrium outcomes in case where the advertising agency of TF1 and that of TMC and NT1 merged at the moment of acquisition. Our model predicts that the merger drives down slightly the average spot price of advertising and increases the total capacity of TV advertising market, but the impacts should not be very considerable.

The reminder of this paper is organized as follows. In section 2, we discuss the market characteristics and data collection. In section 3, we introduce our structural modeling of the demand and supply. We present the econometric specifications and the estimation results separately in section 4 and 5, and the empirical analysis in section 6. In section 7, a series of competitive analysis are carried out to conclude on the market power of TV channels, the evolution of consumer surplus during the period of observation (2008-2013). In section 8, we present the main results of counterfactual experiment on the merger of advertising agencies. All the findings are summarized in section 9.

2 Market & data analysis

2.1 Market characteristics

The digital terrestrial television (DTTV) has been formally introduced in France at the beginning of 2005 and has gradually replaced the old analogue broadcasting mode of free TVs.[4] This new technology offers more capacity of broadcasting and indeed, its implementation was accompanied by arrivals of several new TV channels. Before 2005, there existed only five national TV channels broadcast free to air in France. At the moment when the CSA officially promoted the adoption of DTTV in France, eleven new free channels of DTTV were launched at the same time. In December 2012, six other free channels were launched in addition. In total, the French households have access today to twenty-two free broadcasting TV channels.

Being new arrivals on the national TV market, the newly launched DTTV channels do not enjoy the same market position as that of the five incumbent channels. In Figure 1, we compare separately the average audience shares and the average advertising revenue shares of these two categories of free channels. Unsurprisingly, we observe the audience shares of the 17 new DTTV channels remarkably lower than that of the five incumbent ones, the same being noticed for the shares on the advertising revenues. Furthermore, the

[4] The *digital terrestrial television* names a terrestrial implementation of digital television technology using an aerial to broadcast to a conventional television antenna instead of a satellite dish or cable television connection.

correlation between the average audience shares and the average advertising revenue shares equals to 0.817, suggesting a strong inter-evolution exists between the demand of audience and of advertisers.

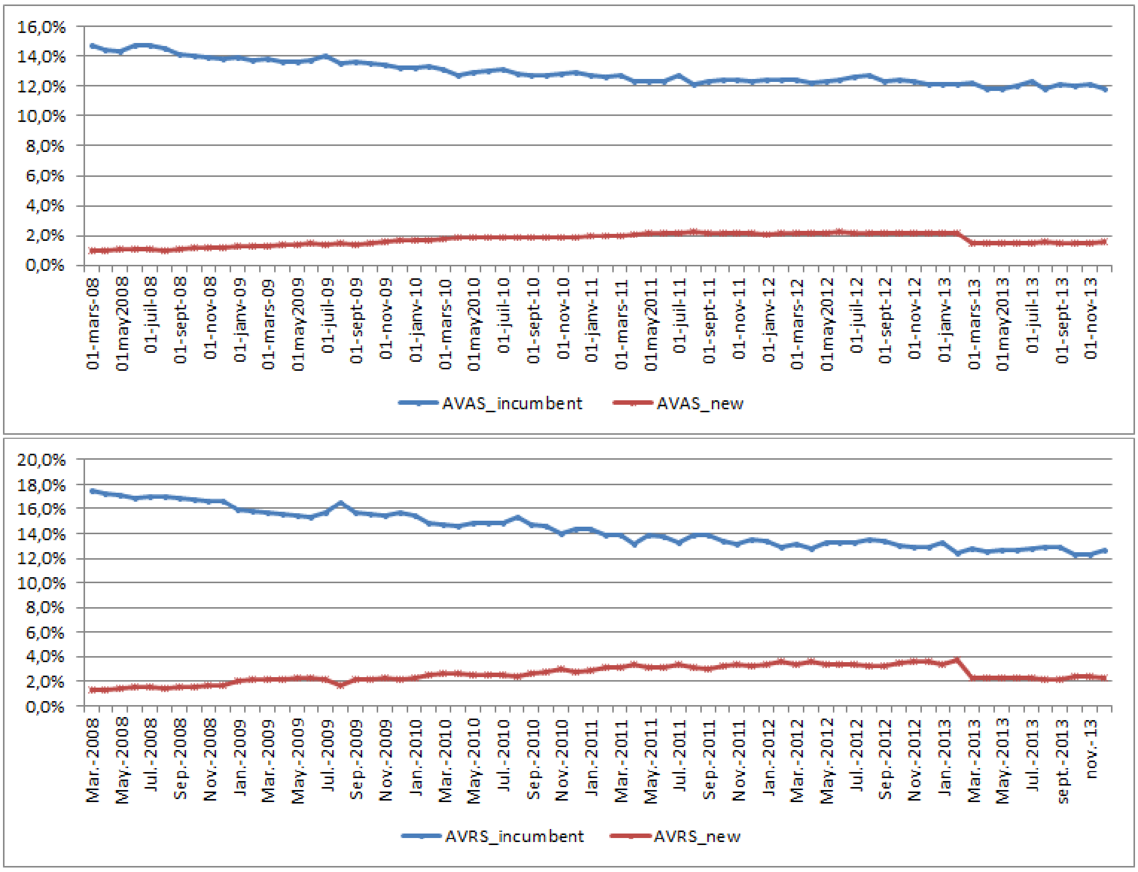

Figure 1: Comparison of audience shares and advertising revenues shares.

(***AVAS*** *denotes the average audience share,* ***AVRS*** *denotes the average advertising revenue share,* ***incumbent*** *for the 5 incumbent channels,* ***new*** *for the newly lunched ones*)

Among these twenty-two free TV channels, there are seventeen commercial channels and five public ones. Fifteen of them are generalist, offering a wide range of program genres and whose target audience is all people. Besides, two channels are specialized on news broadcasting, one on musics, one on children's programs, one on documentaries, one on films and another one on sports. Many of these channels share a common ownership, i.e., belonging to the same media group. In Table 10 (Appendix 1), we provide a list of the TV channels in our data set with their type (generalist, semi-generalist, news, music, film, sport, documentary), nature (public, commercial) and media group membership. The audience shares of TV channels are stable over time, except there is a tendency of growth in demand for the newly launched channels. (See Table 11 in Appendix 1 for details on the audience shares of TV channels.)

The advertising screens of TV channels are sold through advertising agencies. As mentioned above, many channels share common ownership in this industry. In general, each media group own or cooperate with one advertising agency, through which its channels exchange with the advertisers. The TV channels publish the different advertising screens on sells together with their prices three months in advance. The advertisers are in touch with different advertising agencies and choose the screens corresponding to their expected audience to buy. All the deals are established one month ahead of the broadcasting schedules. The last minute adjustment has rarely happened. We notice from our observations that the total quantity of advertising does not vary a lot from one channel to another, while there is a big difference in pricing of the incumbent channels to the newly launched ones. (See Table 12 in Appendix 1 for details on the standard errors of advertising prices and quantities.)

The quantity of advertising on TV is regulated in France. The CSA defines the maximum length of advertising per hour per day authorized for different TV channels. Precisely, double caps are imposed: First, limitation on 8 minutes maximum of commercial breaks per clock hour in 2008, then 12 minutes maximum since 2009; Second, limitation at daily average level, varies for different channels according to its nature (public, commercial), and category (incumbent channels, newly launched). Are the observed advertising quantities a result of market competition or instead, due to the regulation regime? To check this point, we compute the ratio of the observed quantities over the ceilings of advertising authorized for each channel at each period of observation. We notice that over the entire observation period, only the advertising quantities of two channels have approached to the regulated ceilings for a few times (computed ratios are around 96% to 98%), never once the regulation constrains have been bounded. (The yearly averages of these computed ratios are reported in Table 13 in Appendix 1.) This suggests that, regardless of the regulation, the observed advertising quantities are natural outcomes of the market competition.

2.2 Data

Our first data set consists of information on audience, gross advertising revenues, advertising quantities, and some observable characteristics of French TV market. It covers detailed monthly information on 21 free TV channels in France: from March, 2008 to December, 2013.[5]

The rating data come from Médiamétrie which provides a measurement on the television audience, based on the so-called Médiamat, that is to say, a panel of households equipped with one or more TV sets in their main residence. It has been specified to represent both the socio-demographic characteristics of households in metropolitan France and the characteristics of the different television offers. This panel is made up of nearly 4,300 households, which corresponds to around 10,500 individuals aged 4 and over. In each home which is part of the Médiamat panel, 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.[6] This survey allows to know the audience shares, the total population having access to TV services (all reception modes together) in metropolitan France, the total French population and the average watching time per day per individual. The average watching time per day per

[5]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 since the audience share of this channel is very small, more specifically less than 2%.

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

individual is at aggregate level, we do not have detailed per channel data for this variable.

The data on gross advertising revenues and quantities, measured by Kantar Media, are provided by CSA. In this study, we consider the average spot price of advertising and the number of advertisement spots of each free channel. The average spot price of advertising is calculated by dividing the channels' gross advertising revenues by its total amount of advertising (measured on second), then multiplying to the standard length of one spot of advertisement (30 seconds).[7] The number of advertisement spots is obtained by dividing the total amounts of advertising by 30 seconds.

The observable information of TV channels like: type, nature and media group membership are public knowledge. Details on the channels' ownership, their cooperation with different advertising agencies, as well as their regulated ceilings on advertising quantities are provided by the CSA.

In addition to this first data set, we have furthermore collected rich complementary information from the CNC and the published reports of TV channels and of different media advertising agencies. Details include the total number of advertisers, the total amount of advertising investments, the total quantities of advertising on the different media markets mentioned above; the sum of public funding allocated to the public channels, each free channel's financial participation on audiovisual production and on film production, the total number of employees of each media group;[8] the screening (total hours during a year) of French audiovisual programs on each channel, the screening of French audiovisual programs during the prime time of each channel,[9] the screening of films on each channel, the screening of films during 20h30-22h20 on each channel, the fraction of programs of each channel available as catch-up video on the internet. These data either serve as choices of instrumental variables or as variables in the cost equations at the estimation stage.

Table 1 provides a summary of statistics for the main variables included in this study. Table 2 list the selected instrumental variables for estimation and their variation in the dataset.

3 Structural model

We specify a structural model of oligopoly competition for the French free TV industry. There are J channels belonging to K owners that each broadcast 24 hours over 24 free to air. The operators of TV channels face two interacting markets: A market for

[7]The gross advertising revenues are established on the basis of list prices published by the advertising agencies. In practice, each TV channel offer its advertising screens through an advertising agency. The objective of the latter is to match the demand of advertisers with the offers of TV channels. For each deal completed, the advertising agencies recover a fraction of benefits from the TV operators. The prices we thus calculated corresponds to the average unique prices of one advertising spot, before the reduction of the advertising agencies' royalty. The discounts in prices are not taken into account since they are private information. However, we do know that the discounts are stable over time and specific to channels. As we adopt the channel-fixed effect in our estimation, we expect to have controlled the majority of bias of the listing prices.

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

[9]The definition of prime time varies according to channels.

Table 1: Summary statistics of main variables

Panel 1: monthly-channel					
Variable	Mean	Std. Dev.	Min.	Max.	N
Audience (in millions)	3.059	3.858	0.118	16.029	1110
Spot_price (in thousands €)	4.935	7.213	0.299	35.955	1109
Number_spots (in thousands)	6.577	3.049	0.819	14.405	1110
Panel 2: annually-channel					
Variable	Mean	Std. Dev.	Min.	Max.	
Financial participation - - on movie production	8.353	14.944	0	52.9	
Panel 3: annually-media group					
Variable	Mean	Std. Dev.	Min.	Max.	
Employees	9712.947	21528.024	25	104903.5	
Public funding (in millions)	698.501	1164.255	0	2796	
Panel 4: annual					
Variable	Mean	Std. Dev.	Min.	Max.	# years
TV_population (in millions)	58.481	0.623	57.245	59.23	6
French_population (in millions)	62.974	0.524	62.135	63.66	6

Table 2: Selected IVs

Variable	Variation
Number of films screened during 20h30-22h30	annually-channel
Total amount of French audiovisual programs screened (in hours)	annually-channel
Total amount of advertising investments on the cinema market (in millions)	monthly
Total quantity of advertising on the radio market (in number of spots)	monthly
Average watching time per day per individual (in minutes)	monthly

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: Demand of audience, based on the nested logit model;[10] demand of advertisers, following Rysman (2004); and a system of supplies of TV channels, derived from the Nash equilibrium concept.

3.1 Demand of TV viewers

Let I be the potential market size corresponding to the total number of 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 do an outside option (watch a pay channel, read a magazine, go to a cinema, etc.).

As already mentioned in section 2.1, the French households certainly make the difference between watching an incumbent and a newly launched channel. Especially, 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. At the moment where the DTTV was formally adopted in 2005, only 35% of French population are covered by its service. This coverage rate has been extended gradually to 85% in 2007, and to 97% at the end of 2011. In other words, the probabilities that a French household randomly chosen watches an incumbent or a newly launched channel were naturally different. Moreover, as it takes time for individuals to adapt the habits in general, those who get used to watch the incumbent channels do not switch to the new channels immediately. To account for these facts, we classify the channels of our sample set into two categories: incumbent(i) and new(n). In what follows, we assume that a TV viewer first chooses among three categories $g = \{i, n, 0\}$, where category 0 stands for the outside good which corresponds to all the activities other than watching the free TV. Second, he or she decides to watch which channel $j \in C_g$, where C_g refers to the set of channels belonging to the category g.[11]

At each given period t, the indirect utility of consumer i from watching channel j,

[10] We do not adopt the full random coefficient model because we focus on the national TV channels, so there is no variation of individual demographics at the market level. Moreover, our observation covers only six calender years, the individual's demographics during this short period of time do not vary very much, so we do not expect to have significant variability to identify the heterogeneity of the viewers' tastes. (See Berry *et al.*, 1995.) Girgolon 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 coefficients 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. Regarding to the random coefficient nested logit (RCNL) model proposed in their paper, their estimation results suggest that the nesting parameters may be a proxy for the random coefficients of some of the observed continuous characteristics but also capture other unobserved dimensions of consumer preferences.

[11] We have tried more sophisticated specifications by adding nests according to the channels' type, nature, and group membership. However, it is impossible to identify the corresponding parameters of the additional nests.

belonging to the category g, is given by:

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

and

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

where δ_{jt} represents the mean utility level of TV viewers from watching channel j at time t, 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_t 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. α measures the audience's attitude towards advertising and is a parameter of interest to be estimated.

The error term ζ^i_{jgt} is specified as a weighted sum of unobserved variables as follows:

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

where ε^i_{gt} measures individual i's preference, common to all channels belonging to category g and $(1-\sigma)\varepsilon^i_{jt}$ measures individual i's preference, 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 but are allowed to be correlated (in a restricted fashion) across channels j. (See Mcfadden, 1978 and Cardell, 1997.) The parameter $\sigma \in [0, 1)$ measures the degree of substitutability of TV channels belonging the same category from the TV viewers' point of view, and is a parameter to be estimated. 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.

We decompose the probability s_{jt} that individuals choose to watch channel j at time t 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 individuals choose to watch channels of category g. This decomposition matters given the different accessibility of the two categories (incumbent and new) of DTTV channels.

Formally, following Berry (1994), we specify the conditional probability of watching channel j as:

$$\bar{s}_{jt/g}(\delta, \sigma) = [exp(\delta_{jt}/(1-\sigma))]/D_{gt}, \tag{4}$$

where:

$$D_{gt} = \sum_{j \in C_g} exp[\delta_{jt}/(1-\sigma)]. \tag{5}$$

The probability that individuals watch channels of category g is defined as:

$$\bar{s}_{gt}(\delta, \sigma) = \frac{D_{gt}^{(1-\sigma)}}{[\sum_g D_{gt}^{(1-\sigma)}]}. \tag{6}$$

Finally the unconditional probability that an individual choose to watch channel j at time t is given by:

$$s_{jt}(\delta,\sigma) = \bar{s}_{jt/g}(\delta,\sigma)\bar{s}_g(\delta,\sigma) = \frac{exp(\delta_{jt}/(1-\sigma))}{D_{gt}^{\sigma}[\sum_g D_{gt}^{(1-\sigma)}]}. \tag{7}$$

Normalizing the mean utility level for the outside good to 0, i.e., $\delta_0 = 0$, and using some simple algebra transformations,[12] we obtain:

$$ln(s_{jt}) = \bar{V}_{jt} + \alpha A_{jt} + \sigma ln(\bar{s}_{jt/g}) + ln(s_{0t}) + \xi_t + \xi_{jt}, \tag{8}$$

where s_{0t} is the probability that individuals choose to do an outside option at time t.

Given that we assume a representative consumer, at the aggregate level, the choice probabilities s_{jt}, $\bar{s}_{jt/g}$, s_{0t} coincides 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.

3.2 Demand of advertisers

We follow Rysman (2004) to specify the demand of advertisers. This approach allows the advertisers to advertise on many different channels at the same time and is suitable to specify the demands of advertisers as continuous choices.

The model bears on two main assumptions:

- *"Single-homing" of TV viewers.*

  A TV viewer does not watch two channels simultaneously, this assumption is reasonable and consistent with our specification on the demand of TV viewers.

- *Advertiser profit per watch is constant.*

  We assume the advertiser's profit per watch on one channel does not depend on its profit per watch on another channel. That is, there is no cost-side reason why the advertising decision at one channel should affect the advertising decision on another channel.

Formally, there is a continuum of advertisers broadcasting their advertising messages on different TV channels, and we observe the total quantity of advertising of each channel A_j. We consider a representative advertiser who acts as a price taker and chooses its optimal amount of advertising to broadcast on different channel j a_j (a continuous choice variable), then $A_{jt} = \bar{m}a_{jt}$, where $\bar{m}$ is the market size of advertising.[13]

The profit of the representative advertiser from advertising on TV is:

$$\Pi_t = \sum_{j}^{J}[\tilde{\pi}_{jt}L_{jt} - p_j a_{jt}], \tag{9}$$

[12] See Appendix 2 for computational details.

[13] Let there be 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}, so $A_j(P_1, ..., P_J) = \int_0^{\bar{m}} a_{jl}(P_1, ..., P_J)f(l)dl$.

where $\tilde{\pi}_{jt}$ captures the profit to the advertiser from the number of views per person received from the channel j. As data on this variable are not available, we approximate it latter by some observable and unobservable characteristics of channel j, affecting the demand of advertisers. p_{jt} corresponds to the spot price of advertising at channel j and time t.

Let $L_{jt} = L(a_{jt}, A_{jt}, y_{jt})$ be the number of times an average TV viewer watches the representative advertisement, where y_{jt} is the number of viewers of channel j at time t. We specify $L(a_{jt}, A_{jt}, y_{jt})$ using the Cobb-Douglas form, i.e., $L_{jt} = a_{jt}^{\gamma_1} A_{jt}^{\gamma_2} (y_{jt})^{\gamma_3}$. The parameter γ_1 is expected to lie between 0 and 1, and to capture the decreasing return of massive advertising. The parameter γ_2 is expected to be negative, and to capture the "congestion effect" ("negative network effect"); Finally, the parameter γ_3 should be positive since more viewers increase the likelihood of reaching consumers with an advertisement ("network externalities of TV viewers to advertisers").[14]

Maximizing Π_t with respect to a_{jt} yields:

$$a_{jt} = [\frac{p_{jt}}{\gamma_1 \tilde{\pi} A_{jt}^{\gamma_2} (y_{jt})^{\gamma_3}}]^{1/(\gamma_1 - 1)}. \tag{10}$$

At the aggregate level,

$$A_{jt} = [\frac{p_{jt}}{\gamma_1 \pi_{jt} (y_{jt})^{\gamma_3}}]^{1/(\gamma_2 + \gamma_1 - 1)}, \tag{11}$$

where $\pi_{jt} = \bar{m}^{(1-\gamma_1)} \tilde{\pi}_{jt}$ and,

$$p_{jt} = \gamma_1 \pi_{jt} (y_{jt})^{\gamma_3} A_{jt}^{(\gamma_2 + \gamma_1 - 1)}. \tag{12}$$

Taking the logarithm of both sides of Equation 12, we obtain the inverse demand function of advertisers as:

$$ln(p_{jt}) = ln(\gamma_1) + ln(\pi_{jt}) + \gamma_3 ln(y_{jt}) + (\gamma_2 + \gamma_1 - 1) ln(A_{jt}). \tag{13}$$

3.3 Supplies of TV channels

There are J free channels belonging to K different media groups on the market. Each media group owns or cooperates with a private advertising agency, through which its channels exchange with the advertisers. As a matter of fact, 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 screens is given by (we drop the time index in this section for simplicity):

$$\Pi_{G_k} = \sum_{j \in G_k} \Pi_j = \sum_{j \in G_k} [(p_j - c_j) A_j - F_j], \tag{14}$$

where c_j and F_j define the marginal cost and the fixed cost of channel j relative to the TV advertising market, respectively.

The conduct of media groups (Cournot or Bertrand) matters for the way the market clears at equilibrium.

[14] See Rysman (2004) for the proof.

- If media groups compete à la Cournot, 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:

$$\max_{A_{jk};j\in G_k} \{\Pi_{G_k}|\mathbf{A}_{-j}\} = \max_{A_{jk};j\in G_k} \sum_{j\in G_k} [(p_j(A_j, y_j(\mathbf{A})) - c_j)A_j|\mathbf{A}_{-j}]. \tag{15}$$

  The associated first order condition is:

$$(p_j - c_j) + A_j\frac{\partial p_j}{\partial A_j} + A_j\frac{\partial p_j}{\partial y_j}\frac{\partial y_j}{\partial A_j} + \sum_{i\neq j, j\in G_k} A_i\frac{\partial p_i}{\partial y_i}\frac{\partial y_i}{\partial A_j} = 0, \forall j \in G_k. \tag{16}$$

  The advertising quantity affects the market clearing price through two arguments, directly, by the standard price response to the quantity supplied; and indirectly, by the network effect between audience and advertisers, represented by the third and fourth terms in Equation 16.

- If, instead, the media groups compete à la Bertrand, 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:

$$\max_{p_{jk};j\in G_k} \{\Pi_{G_k}|\mathbf{p}_{-j}\} = \max_{p_{jk};j\in G_k} \sum_{j\in G_k} \{(p_j - c_j)A_j(p_j, \mathbf{y}_j(\mathbf{A}))|\mathbf{p}_{-j}\}. \tag{17}$$

  The associated first order condition is:

$$A_j + (p_j - c_j)\frac{\partial A_j}{\partial p_j} + (p_j - c_j)\frac{\partial A_j}{\partial y_j}\frac{\partial y_j}{\partial A_j}\frac{\partial A_j}{\partial p_j} + \sum_{i\neq j, i\in G_k} (p_i - c_i)\frac{\partial A_i}{\partial y_i}\frac{\partial y_i}{\partial A_j}\frac{\partial A_j}{\partial p_j} = 0, \forall j \in G_k. \tag{18}$$

  The prices affects the market clearing quantities of advertising through two arguments, directly, by the standard demand response to the market price; and indirectly, by the network effect between audience and advertisers, represented by the third and fourth terms in Equation 18.

In section 5.3, we conduct a test on the cost equations to conclude on the nature of the competition in the French free 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 8 is specified as a linear combination of "channel-fixed effect" and all the observable characteristics of TV channels, including type (generalist, semi-generalist, news, music, film, sport, documentary), nature (public, commercial) and media group membership.

Two types of temporal effects are considered in the estimation. The term ξ_t in Equation 8 is composed with dummies for each year and for each month. The yearly dummies capture the potential policy changes, fluctuation of economic climates and the generalization of the digital TV technology. The monthly dummies capture the seasonality of TV advertising. (See Figure 2.)

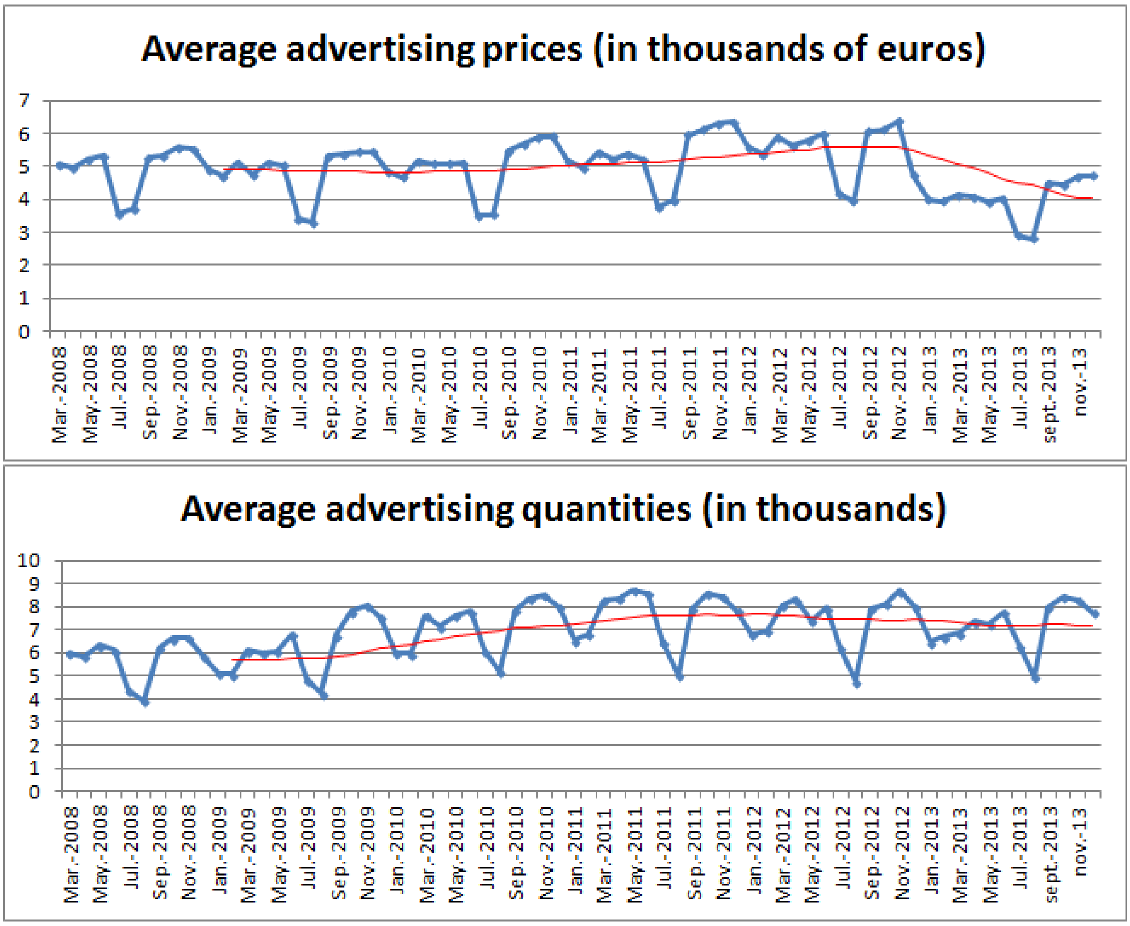

Figure 2: The average advertising prices and quantities of TV channels.

(*The blue line shows the movement per month; the red one shows the yearly trend.*)

We define the market share s_{jt} in this paper differently to the "audience shares" q_{jt} used on media marketing. On TV advertising, marketers usually use the "audience shares", measured by some specialized media marketing companies like Médiamétrie in France. These published "audience shares" are measured in terms of "the total population watching the TV over a market". For the purpose of our study, we need to consider, for any given period of time, the size of the French population choosing to watch a free TV channel (j), and the size of the French population preferring an alternative to watching the free TV. The latter allows us to take into account not only the possibility that the individuals watch a pay channel, but also the potential competition from other entertainments, like 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" during the corresponding periods and derive the "augmented audience measuring the total number of TV viewers of each free channel y_{jt}": $y_{jt} = q_{jt} M_t$. Then if T_t denotes "the total number of French population during period t", we can calculate the market share of channel j as $s_{jt} = \frac{y_{jt}}{T_t}$, the market share of channel j within its category as $\bar{s}_{jt/g} = \dfrac{s_{jt}}{\sum_{j \in C_g} s_{jt}}$ and the market share of the outside good as $s_{0t} = 1 - \sum_j s_{jt}$. We recognize that our measure of "the total population watching the TV" by "the total population having access to a TV service M_t" is not exact. In Appendix 3, we proceed a robustness check by scaling down the value of M_t. The results suggest that our measurement choice does not affect significantly the estimated coefficients, given our large sample size. (See Table 14 - Table 15.)

Finally, from Equation 8, the TV viewers' demand equation to be estimated is given by:

$$ln(s_{jt}) - ln(s_{0t}) = \alpha A_{jt} + \sigma ln(\bar{s}_{jt/g}) + X_{jt}\beta + \xi_{jt}, \tag{19}$$

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

4.2 Demand of advertisers

From Equation 13, we specify the inverse demand of advertisers to be estimated as:

$$ln(p_{jt}) = \theta ln(A_{jt}) + \gamma_3 ln(y_{jt}) + X^A_{jt}\beta^A + \xi^A_{jt}. \tag{20}$$

In other words, $ln(\gamma_1) + ln(\pi_{jt}) = X^A_{jt}\beta^A + \xi^A_{jt}$, where X^A_{jt} and ξ^A_{jt} represent separately the observable and unobservable characteristics of channel j, at time t, influencing the demand of advertisers. Precisely, we specify X^A_{jt} as a linear combination of dummies for channels, for months and for years. $\theta = \gamma_2 + \gamma_1 - 1$ captures the joint effect of "congestion" and "decreasing return to scale" of advertising, γ_3 measures the "network effect of consumption" as specified in the model above, we expect the estimated value of θ to be negative and the estimated value of γ_3 to be positive.

5 Estimation

We estimate the demand of TV viewers (Equation 19) and the demand of advertisers (Equation 20) separately using the two-stage least squares (2SLS) estimator. Below we explain our choice of instrumental variables for each equation because both equations encounter problems of endogeneity.

5.1 Demand equations

Identification

Equation 19 introduces two identification problems: i) The first is related to σ. Conceptually, the switch of audience between channels within the same category identifies the σ. Such a variation can be a result of either changes in channels' characteristics or changes in the number of channels over the market. However, there is a potential endogeneity problem with the first type of identification if many people watch one particular channel at time t for some unobservable reasons. Formally, in Equation 19, when ξ_{jt} is high, s_{jt} will be high, but $\bar{s}_{jt/g}$ will be high as well, not only due to the switch of audience from its own category, but also from other categories. As a consequence, the estimate of σ will be biased upwards unless $\bar{s}_{jt/g}$ is properly instrumented too. ii) The second issue comes from the fact that the market shares of TV channels and the quantities of advertising are determined simultaneously. If for some exogenous reason many people watch the TV, it is also expected to have a positive impact on the equilibrium amount of advertising because the TV advertising become more efficient. Without controlling this fact, the estimate of α will be biased downward.

We use the following instrumental variables to account for above endogeneity issues: "the number of films screened during 20h30-22h30", "the total amount of French audiovisual programs screened (in hours)", "the total amount of advertising investments on the cinema market" and "the total quantity of advertising (in number of advertising spots) on the radio market". The first two variables are at channels' level and are available on a yearly base. They reflect the status of different channels in the industry. The broadcasting contents of TV channels are partially regulated in France as well. The incumbent channels have different broadcasting obligations to the newly launched ones. We expect the variation of these two variables to be correlated with the channels' audience share within the same category $\bar{s}_{jt/g}$ but not affect the left hand side of the Equation 19 once holding the $\bar{s}_{jt/g}$ constant. The two remaining variables measures the outside market competition on advertising and is available on a monthly base. They are certainly correlated with the quantities of advertising of TV channels, while there is no reason that the demand of TV viewers being affected by these factors. In order to gain a clear sight on the explanatory relationship between the instrumental and the instrumented variables, we report the first stage estimation proceed by Stata in Table 16. (See Appendix 4.)

Equation 20 for the inverse demand of advertisers entail two identification problems as well. As at equilibrium, the quantity of advertising depends on price, we expect $ln(A_{jt})$ and $ln(y_{jt})$ to be correlated with ξ^A_{jt}. For instance, if advertisers' willingness to pay is high for some unobservable reasons, we expect the quantity of advertising to be high via the TV channels' first order condition, and as a consequence, the TV viewers' demand to be low.

The following instrumental variables are used to control the endogeneity bias of Equation 20: "the number of films screened during 20h30-22h30", "the total amount of French audiovisual programs screened (in hours)" "the total quantity of advertising on the radio market" and "average watching time per day per individual". The first three variables are correlated with $ln(A_{jt})$ and are also used as instrumental variables in the Equation 19. The "average watching time per day per individual" constitutes an important instrumental variable for $ln(y_{jt})$. Since we do not observe this latter at channels' level, we cross it with two dummies indicating the channels' category (incumbent, new) so that the effect of this variable depends on the different categories of TV channels. None of the above variables should affect the willingness to pay of advertisers once holding the variables $ln(A_{jt})$ and lny_{jt} constant. As for the Equation 19, we report the first stage estimation of Equation 20 in Table 17 to show the exact explanatory relationship between the instrumental and the instrumented variables. (See Appendix 4.)

Estimation results

The estimation results of Equation 19 and of Equation 20 are reported separately in Table 3 and Table 4. Each time, we compare the estimation results of the IV estimator to that of the two-step feasible GMM.

Table 3: Demand of TV viewers

	IV	Two-step GMM
Quantity of advertising(α)	-0.549**	-0.551**
	(-2.18)	(-2.19)
Within-nest share(σ)	0.386**	0.367**
	(2.09)	(2.00)
No. of Observations	690	690
F-Statistic	49.51***	59.44***
R-Squared	0.5523	0.5446
t statistics in parentheses		
* p<0.1, ** p<0.05, *** p<0.01		
Kleibergen-Paap rk LM statistic (*p-value*)	0.0000	0.0000
Cragg-Donald Wald F statistic	11.615	11.615
Hansen J statistic (*p-value*)	0.0583	0.0583

Note: The dependent variable is log market share of channel j minus log market share of the outside goods. (See Equation 8 and Equation 19.) In the first regression, we use IV estimator, in the second one, we use two-step feasible GMM, the robustness correction is applied to both estimations so that the standard errors are robust to the presence of arbitrary heteroskedasticity. 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 significant.

Table 4: Demand of advertisers

	IV	Two-step GMM
Log(Quantity of advertising)(θ)	-0.385**	-0.373**
	(-2.46)	(-2.43)
Log(Audience)(γ_3)	0.604***	0.606***
	(4.05)	(4.08)
No. of Observations	689	689
F-Statistic	16.65***	19.66***
R-Squared	0.4308	0.4301
t statistics in parentheses		
* p<0.1, ** p<0.05, *** p<0.01		
Kleibergen-Paap rk LM statistic (*p-value*)	0.0000	0.0000
Cragg-Donald Wald F statistic	8.638	8.638
Hansen J statistic (*p-value*)	0.1070	0.1070

Note: The dependent variable is log spot price of advertising (see Equation 20). In the first regression, we use IV estimator, in the second one, we use two-step feasible GMM, the robustness correction is applied to both of the two estimation so that the standard errors are robust to the presence of arbitrary heteroskedasticity. 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 while the yearly dummies are not.

For the demand of TV viewers, 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 there exists competition between the 5 incumbent channels and the newly launched ones, yet the significance level of $\hat{\sigma}$ suggests that there is a segmentation between categories. Tests of the instrument validity are also reported in Table 3. The Kleibergen-Paap rk LM statistic rejects the null of under-identification at 1% significance level; The Stock-Yogo weak instrument test suggest the instruments are strong; while the Hansen J statistic does not reject the null hypothesis that the instruments are valid, at 5% significance level.

For the demand of advertisers, the coefficient of the logarithm of the quantity of advertising $\hat{\theta}$ is significant at the 5% significance level while the coefficient of the logarithm of the audience level $\hat{\gamma}_3$ is significant at the 1% significance level. The results of estimation are consistent with the prediction of our theoretical model: $\hat{\gamma}_3$ is positive which confirms the existence of "network effect of consumption". The negative sign of $\hat{\theta}$ reflect the combined effect of "congestion" and "decreasing return to scale" of advertising. Tests of the instrument validity are reported in Table 4 as well. The Kleibergen-Paap rk LM statistic rejects the null of under-identification at 1% significance level; The Stock-Yogo weak instrument test suggest the instruments are strong; while the Hansen J statistic does not reject the null hypothesis that the instruments are valid, even at 10% significance level.

The estimates with the results of IV estimator are close to those obtained with the two-step feasible GMM estimator. Since some of our instrumental variables are not specific to a specific endogenous variable, we prefer to use the results of the two-step feasible GMM as benchmark estimates in the following analysis.

6 Empirical analysis

6.1 Elasticities of demand

The different elasticities of demand are reported in Table 5 - Table 7. (See Appendix 5 for the formulas.) On average, an one percent increase in spot price of advertising leads to a 2.7% decrease in demand of advertisers, while an one percent increase in audience increases the demand of advertisers for 1.6%; The TV viewers dislike advertising in general, an one percent increase in advertising quantity reduces on average the audience of own channel by 0.5%.

At the channels' level, the elasticity of demand of advertisers with respect to audience and to the advertising spots prices do not vary a lot with channels. This confirm our intuition that the advertisers care only about audience and do not have special preference for different TV channels. In contrast, at the viewers' side, we find three ranks of own-advertising-elasticities of audience. The TV viewers are less sensible to the advertising of public channels than to the private ones, because the public channels broadcast much less advertisements than the private channels (the marginal dis-utility of advertising is expected to be augmenting). Compares to the other private channels, we find the TV viewers particularly sensitive to the advertising on news channels, indicating that the news channels loss more easily audience due to advertising. There are two potential explanations for this finding. Firstly, people are less tolerant to ads when watching news than the other types of TV programs. Then, the programming schedules of news channels are special: Commercial breaks come frequently (more precisely, every 15 mins during the prime times) which increases the chance that the viewers switch during the breaks.

To measure how an increase in advertising quantity of one TV channel impact the audience of other channels, we compute the TV viewers' cross elasticities of demand with respect to the advertising quantities of different TV channels. The values of these elasticities also reflect the substituability of programs between different TV channels. Given our nested logit modeling on the TV viewers' demand, their cross-advertising elasticities between channels i and j varies according to whether these two channels belong to the same category. (See Appendix 5.) We compute the average value of these elasticities channel per channel. The estimated results indicate that an increase in advertising quantity of one TV channel have a positive effect on the audience of the other TV channels and the magnitude of this effect is not negligible. On average, an one percent increase in advertising quantity of one TV channel gives rise to an increase in audience of another channel for 0.03%. However, the value of this elasticity is quite different from one channel to another. Overall, it seems more likely to observe a raise in the audience of other channels when an incumbent channel increases its advertising quantity. (See Table 18 in Appendix 5.)

Given the estimated values, the demand of advertisers is elastic with respect to pricing and audience. We conclude firstly that the competition between TV channels is fierce on the advertising market. Then, the sign of estimated (own & cross) advertising-elasticity of audience tells that the TV viewers dislike advertising in general. While the estimated values of these elasticites suggest that the TV viewers are sensitive to advertising, but the quantity of ads is not the only factor which affects the audience of TV channels. The TV viewers care more about the quality of TV programs. All the results are intuitive.

Table 5: Average elasticities of demand

	Coef.
Price-elasticity of advertising demand	-2.682 (1.103)
Audience-elasticity of advertising demand	1.625 (0.521)
Own-advertising-elasticity of audience	-0.530 (0.333)
Cross-advertising-elasticity of audience	0.030 (0.020)

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

Table 6: 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 parenthesis.

Table 7: Cross-advertising-elasticity of audience

	2008	2009	2010	2011	2012	2013
incumbent channels	0.053	0.051	0.057	0.053	0.050	0.078
	(0.032)	(0.031)	(0.035)	(0.033)	(0.031)	(0.049)
news channels	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 parenthesis.

6.2 Marginal cost

We derive the marginal costs of TV channels by considering the profit maximization problem of their media groups. The 21 TV channels in our data-set belongs separately to 10 different media groups and 9 groups out of the 10 use one advertising agency for all channels within the groups. The exceptional case is the TF1 Group. The channels TMC and NT1 have managed their advertising offers through an independent advertising agency to that of the TF1 Group during the entire period of observation. (See introduction for details.) We specify the 4 channels of TF1 group as belonging to 2 independent entities, each makes their profit maximization problem independently. The profit maximization problems of all the other groups are as described in section 3.3. By inserting the estimated demand parameters together with the observed quantities, pricing and market shares into the first order condition associated to the profit maximization function of different media groups, namely Equation 16 and Equation 18, we obtain the estimated marginal costs of TV channels under Cournot and Bertrand competition assumption.

6.3 Market conduct

As already mentioned in section 2.1 that during each period of observation, the advertising quantities of different channels are similar, while their pricing are different. (See Table 12 in Appendix 1 for details on the standard errors of advertising prices and quantities.) Given that the TV viewers dislike advertising, and the advertisers are sensitive to audience, without forgetting that the advertising on TVs is physically limited due to the time constraints, we conjecture the channels compete on quantity setting on the advertising market. Literature on market conduct under capacity constraints highlighted this point. To mention only a few, Kreps and Scheinkman (1983) study a two-stage oligopoly game where there is firstly a quantity precommitment, then a price competition and find that the unique equilibrium outcome is the Cournot outcome. Osborne and Pitchik (1986) studies the similar issue. By considering the price competition in a capacity-constrained duopoly, the authors show that if capacities are chosen simultaneously, before prices, the set of equilibrium capacities coincides with the set of Cournot quantities.

To test this hypothesis, we implement a Davidson and MacKinnon test based on the estimated marginal costs of the TV channels. (See Greene, 2013.) Letting $\hat{c}_{co}$ denote the vector of estimated marginal costs under Cournot assumption and $\hat{c}_{be}$ denote the vector of estimated marginal costs under Bertrand assumption. We test the following hypothesis: H_0: *Cournot competition* versus H_1: *Bertrand competition*, by regressing separately $\hat{c}_{co}$ and $\hat{c}_{be}$ on a vector Z of variables reflecting the variable costs of the TV channels, namely:

$$H_0 : \hat{c}_{co} = Z\mu + \epsilon_1; \tag{21}$$

$$H_1 : \hat{c}_{be} = Z\lambda + \epsilon_2. \tag{22}$$

The TV channels' variable costs include mainly the cost of stuffs and of the broadcasting contents. The following variables are used to construct the vector Z: the total number of employees of each media group, the amount of public funding allocated to public TV channels, the financial participation (in M€) of TV channels on the movie production, the channel-fixed effect and the monthly-fixed effect.

Table 8: First step of the Davidson and MacKinnon test

	(H_0) $\hat{c}_{co}$	(H_1) $\hat{c}_{be}$
Employees	0.00168*	0.00356
	(1.90)	(0.49)
Public funding	-1.231***	0.795
	(-7.22)	(0.31)
Financial participation on movie production	32.27**	475.6
	(2.34)	(0.98)
Constant	2541.4***	-2845.9
	(13.20)	(-0.31)
No. of Observations	870	869
No.of Group	15	15
F-Statistic	871.6***	7.582***
R-Squared	0.134	0.0148

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Note: The channel-fixed effect and monthly dummies are included in the regressions. The estimates are not reported but are available upon request. The coefficients of monthly dummies are not significant.

The results of estimation are reported in Table 8. We observe that the vector Z explain well the estimated marginal costs under Cournot assumption $\hat{c}_{co}$ but not the estimated marginal cost under Bertrand assumption $\hat{c}_{be}$. We next consider regression below to check whether the null hypothesis that the market is under Cournot competition should be rejected, that is to say:

$$\hat{c}_{co} = Z\rho + \varphi(Z\hat{\lambda} - Z\hat{\mu}) + u. \tag{23}$$

The estimated coefficient $\hat{\varphi}$ is not significantly different from zero, which signifies that the features of Equation 21 can be explained by the features of Equation 22 but the reverse is not true. (See Table 9.) Not surprisingly, we conclude that the channels compete à la Cournot on the TV advertising market.

Notice that this result is not trivial. For instance, in US where the TV channels' capacity on advertising offers is much less restricted than in France. Firstly, there is no regulation on the advertising quantities.[15] Then, given its large population (316 millions versus 66.03 millions in France, in 2013), the switch of audience due to advertising can be much less a concern for the advertising revenue of a US TV channel. For instance, in order to transmit an advertising message to 1 million people, a US national TV channel needs to capture the attention of 0.2% of its total population, while a France national TV channel needs to achieve 2%. For these reasons, we conjecture it might be that the channels compete à la Bertrand in the US free TV industry. This leaves an interesting question for the future research.

7 Competitive analysis

7.1 Lerner Index

Given that the TV channels compete on quantity setting, we can derive the expression of Lerner Index (L_{jt}) according to Equation 16. For each given period t, the Lerner Index of channel j belonging to media group G_k can be written as:

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

where E_{a_j,p_j} stands for the price-elasticity of demand of advertisers, E_{p_j,y_j} ($\forall j$) represents the audience-elasticity of demand of advertisers, E_{y_j,A_j} is the own-advertising-elasticity of demand of TV viewers, and E_{y_i,A_j} is the cross-advertising-elasticity of demand of TV viewers. We drop the time index again here for simplicity.

The profit margins of TV channels thereby derived comprise their margins on both sides: the direct margins obtained from the advertisers $-\frac{1}{E_{a_j,p_j}}$, and the indirect margins obtained on their market power over audience, denoted by p^v_j, and defined as $p^v_j = -\frac{1}{E_{p_j,y_j}} E_{y_j,A_j} - \frac{1}{A_j p_j} \sum_{i \neq j, j \in G_k} A_i p_i \frac{1}{E_{a_i,y_i}} E_{y_i,A_j}$.

Inserting the estimated demand parameters together with the observed quantities, pricing and market shares into Equation 24, we derive the value of Lerner Indexes of different

[15] Except for children's program.

Table 9: Second step of the Davidson and MacKinnon test

	$\hat{c}_{co}$
c_diff (φ)	-0.00309
	(-1.42)
Employees	0.00168*
	(1.91)
public funding	-1.227***
	(-7.18)
Financial participation on movie production	33.62**
	(2.31)
Constant	2526.0***
	(13.29)
No. of Observations	869
No.of Group	15
F-Statistic	824.3***
R-Squared	0.132

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Note: **c_diff** denotes $Z\hat{\lambda} - Z\hat{\mu}$. The channel-fixed effect and monthly dummies are included in the regressions. The estimates are not reported but are available upon request. The coefficients of monthly dummies are not significant.

TV channels. The estimated results suggest that the profit margins of channels are high in general, consistent with the high fixed cost nature of the industry. This latter includes the operating cost, the cost of purchasing or leasing a transmitter as well as other overheads. For the national TV channels (all the channels in our sample set) which broadcast across a large geographic area, these expenditures are very large. Precisely, the estimated profit margin of TV channels can be ranked into three levels: Around $40\% - 50\%$ for the public channels, above 80% for the private news channels, and between $60\% - 80\%$ for the other private channels.

The different profit margins of TV channels reflect mainly their market powers on the viewers' side: the value of p_j^v is estimated to be around $3\% - 13\%$ for the public channels, 43% for the private news channels, and $23\% - 43\%$ for the other private ones. Following Rochet and Tirole (2006), the expression of Lerner Index of TV channels can be rewritten as:

$$\frac{p_j - (c_j + p_j^v)}{p_j} = -\frac{1}{E_{a_j,p_j}}, \tag{25}$$

where p_j^v represents the negative tariff that the TV channels charge to the TV viewers (payed by the advertisers). Its value depends on the audience-elasticity of demand of advertisers, the own and cross advertising-elasticity of demand of TV viewers: The more responsive are TV viewers to advertising (the higher is the value of $-E_{y_j,A_j}$ or $E_{y_i,A_j}, i, j \in G_k$), the more valuable the attention of the marginal viewer to the advertisers; the higher the willingness to pay of advertisers for the own audience of a TV channel (the higher is the value of $\frac{1}{E_{a_j,y_j}}$), the more the TV channel can raise its spot price to the advertisers; the higher the willingness to pay of advertisers for audience of the other TV channels (the higher is the value of $\frac{1}{E_{a_i,y_i}}$), the less it can raise its spot price to the advertisers.

The "opportunity cost" of a loss of transaction on the advertising market due to an increase in the spot price of advertising, namely $c_j + p_j^v$ is very high for the TV channels, since it concerns not only the channels' marginal costs of production, but also the value of the audience to be payed by the marginal advertiser. As a consequence, regardless of the profit margins of the TV channels in this industry, the channels' ability to raise profitably the market prices of advertising is still limited. (An average TV channel's ability to raise profitably the market prices of advertising is evaluated by the right hand side of the Equation 25, i.e. $-\frac{1}{E_{a_j,p_j}} = 37\%$.) The competition among TV channels is fierce on the French TV advertising market.

It is noteworthy to mention that, regardless the TF1 channel's important position on the advertising market (with about $40\% - 50\%$ of market shares), its estimated Lerner Index is not higher than these of the other private channels. That is to say, given the two-sided business model of the free TV channels, a stronger position on one side of the market does not necessarily result in a higher market power of the channel in question, due to the presence of feedback loop between viewers and advertisers. This finding can be indicative to the anti-trust authorities: A simple measurement on the firms' market position is not enough to conclude on the competitive level of the two-sided markets. Moreover, the estimated Lerner Indexes of TF1, TMC and NT1 have not changed over the period 2010-2013. Especially, in comparison to their evolution from 2008 to 2010, we can conclude that the operation of acquisition of TMC and NT1 by the TF1 Group under the implemented behavioral remedies as explained on the introduction has not significantly affected the market power of these three channels.[16]

7.2 Consumer surplus

Given the two-sided feature of the free TV industry, there are two types of consumers for the TV channels: viewers and advertisers. However, standing on the regulators' point of view, the surplus of advertisers corresponds to profit of firms, only the surplus of TV viewers (i.e. the surplus of French households from free TV consumption) constitutes the aim of protection.

By our nested-logit specification, the surplus of TV viewers can be computed according to the formula (Williams, 1977 and Small and Rosen, 1981):

$$CS\_{viewers} = -\frac{1}{\alpha} ln[1 + \sum_{g} [\sum_{j \in C_g} exp(\frac{\delta_{jt}}{(1-\sigma)})]^{(1-\sigma)}]. \tag{26}$$

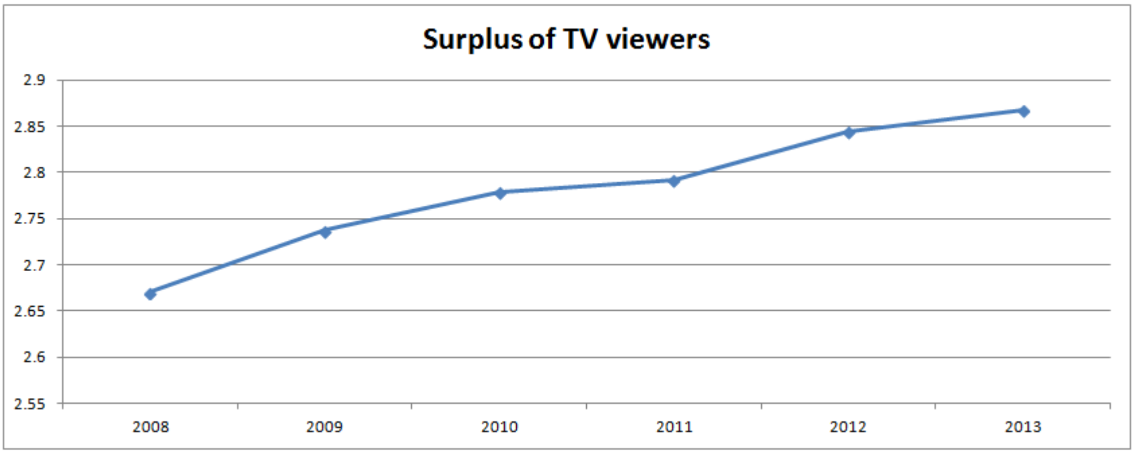

Figure 3: Evolution of the viewers' surplus during 2008-2013.

(*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 study, what matters is the trend of evolution of the line.*)

Figure 3 exhibits the evolution of viewers' surplus during the period of observation, 2008-2013. Regardless of the recent concentration in the industry following the acquisition of TMC and NT1 by the TF1 Group, the French households' consumption surplus from the free TV broadcasting has increased continuously. The behavioral remedies requested by the competition authority apparently prevented the risk of competitive harm to the consumers that these acquisition could have involved.

[16] More detailed Lerner Indexes of TV channels are not reported, but are available upon request to the authors.

8 Counterfactual experiment: simulating the the merger effect of two advertising agencies

The behavioral remedies requested by the Adc, took effect on 26 January 2010 for a period of five years. Staring from 26 January 2015, the merger between the advertising agency of TF1 and that of TMC and NT1 becomes possible. If the merger indeed takes place, how would it affect the market at equilibrium: What would be the advertising spot prices and quantities of different TV channels? What about the demand of TV viewers? In this section, we use the estimated demand and supply sides parameters to simulate the equilibrium outcomes in case where the two advertising agencies merged at the moment of acquisition.

Equation 16 can be written in matrix notation as:

$$(1-\theta)\mathbf{p}(\mathbf{A}) - \mathbf{c} + r(\mathbf{O}(\mathbf{A}) \cdot \mathbf{Q}(\mathbf{A})) = 0 \tag{27}$$

where $\mathbf{A} = (A_1, ..., A_J)'$; $\mathbf{c} = (c_1, ..., c_J)'$; $\mathbf{p}(\mathbf{A})$ is vector of prices as function of $\mathbf{A}$, derived from Equation 20; $\mathbf{Q} = (Q_1, ..., Q_J)'$ with $Q_j = p_j(\mathbf{A})A_j$; $\mathbf{O}(\mathbf{A})$ is a matrix depending on $s_j(\mathbf{A})$, $\bar{s}_{j/g}(\mathbf{A})$, and the ownership of TV channels.

We assume here that the merger of two advertising agencies would not arise additional efficiency gains on variable costs than the operation of acquisition. That is, we assume $c_j^{nm} = c_j^m, \forall j$, where nm stands for "non-merged" and m stands for "merged". We simulate separately the equilibrium outcomes before and after merger for each year of observations. The evolution of the sum of advertising quantities $SA\_nm = \sum_j^J A_j^{nm}$, $SA\_m = \sum_j^J A_j^m$, as well as the average spot price of advertising $Ap\_nm = \dfrac{1}{J}\sum_j^J p_j^{nm}$, $AP\_m = \dfrac{1}{J}\sum_j^J p_j^m$ are presented in Figure 4.

We notice firstly that the merger of the two advertising agencies does not affect importantly the market equilibrium outcomes. Then, comparing the red bar and the blue bar in Figure 4, we find the merger increases the total capacity of TV advertising market but decreases slightly the average spot prices. This result comes from the two-sided nature of the industry. The TV channels broadcasting free-to-air and draw revenues only from advertising. The TV viewers are ad-adverse while the advertisers are sensitive to audience. The advertising is as an indirect tariff that the channels charge to TV viewers and is the carrier of network effects between the two sides of the market. Given this feature, the quantities of advertising are difficult to adjust, and the channels compete on capacity of advertising offers in the long run. The merger reduces the number of competitors on the advertising market, therefore allows the TV channels to increase uniformly their quantities of advertising offers. The demand and supply adjust at equilibrium, the average spot price decreases. In December 2012, six new DTTV channels have been launched, expanding the market size of free TVs. As a consequence, the total amount of advertising offers increase, driving down the average spot price in 2013.

9 Conclusion

This paper investigates the advertising competition in the French free-to-air TV broadcasting industry. Especially, following the approval of the acquisition of channels TMC and

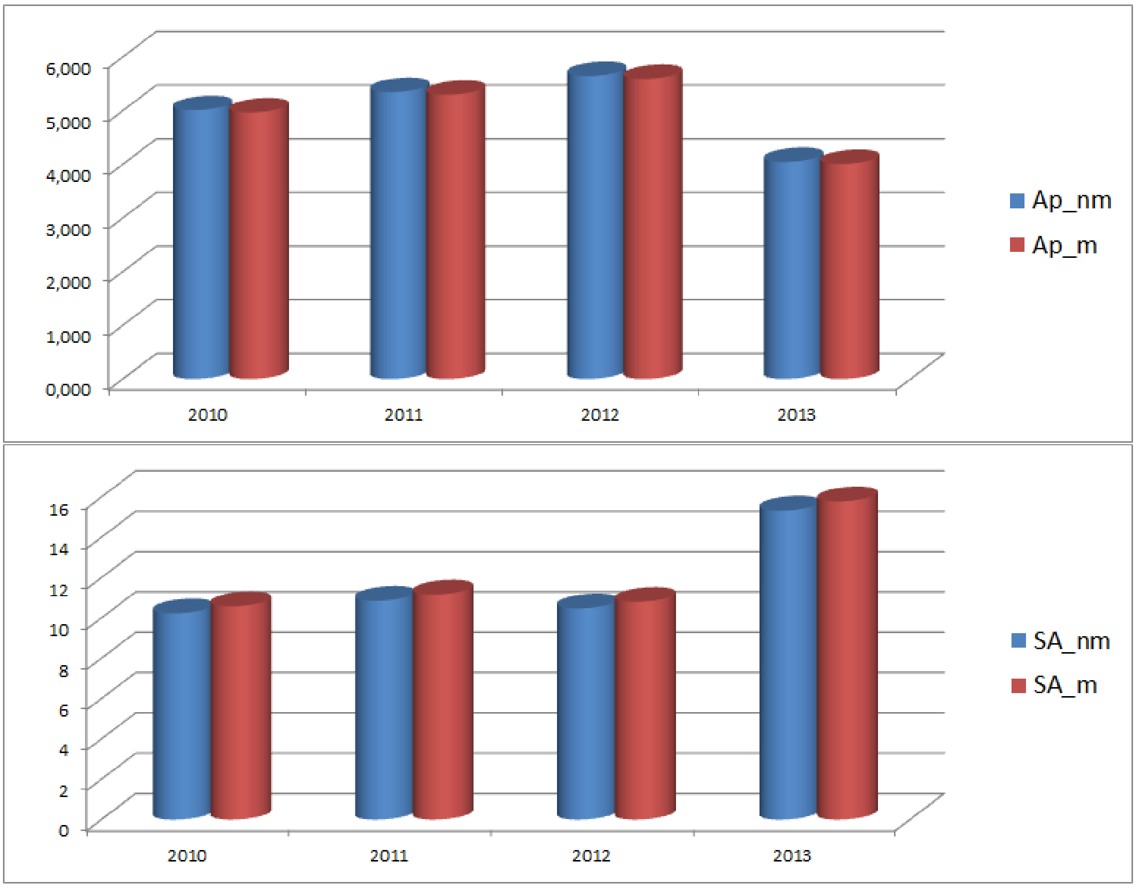

Figure 4: Comparison of equilibrium outcomes before and after merger of advertising agencies.

(*Note: SA_nm and SA_m represent the sum of simulated advertising quantities without and with merger of the advertising agencies, measured in thousands of spots; Ap_bm and Ap_am represent the average of simulated spot prices of advertising without and with the merger. The units of prices are scaled down for confidentiality reason.*)

NT1 by the TF1 Group under behavioral remedies, we evaluated the impact of this acquisition on the consumer surplus. Given the two-sidedness nature of the free TV channels, we specified a structural model of oligopoly competition, we estimated separately the demand of TV viewers and of advertisers using French market data. Our findings suggest firstly that the indirect network externalities between TV viewers and advertisers are significant and affect importantly 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 the TF1 channel to enjoy a higher market power than its competitors due to the feedback loop between viewers and advertisers.

We implemented a simple procedure to test the market conduct of the TV channels and have identified the nature of competition in the French free TV industry is of Cournot type. Strong network effects between TV viewers and advertisers, as well as the relatively small market size restricting the channels' capacity on advertising offers explained the Cournot nature of competition in the French free TV broadcasting industry.

According to the estimated Lerner Indexes of TV channels and the evolution of viewers' surplus during the period of observation (2008-2013), we conclude that the recent acquisition of TMC and NT1 by the TF1 Group has not significantly affected the competitiveness of the French free TV industry and that the policy of behavioral remedies seems to have been efficient in this case.

Finally, we conduct a counterfactual experiments to simulate the market equilibrium outcomes in case where the advertising agency of TF1 and that of TMC and NT1 merged at the moment of acquisition. Our results suggest that the merger increases the total capacity of TV advertising market but decreases slightly the average spot prices. However, the impacts are almost negligible. It seems that the market equilibrium outcomes would not be importantly affected by the merger of the two advertising agencies.

10 Appendix

Appendix 1: Descriptive statistics

Table 10: 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-Têlé	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

** Since 2010; ** Since October 2012.*

Table 11: Annual average audience shares of TV channels

		2008	2009	2010	2011	2012	2013
Incumbent Channels	Channel 1	17.5%	16.7%	16.1%	14.9%	14.9%	14.0%
	Channel 2	13.3%	11.8%	10.7%	9.7%	9.7%	9.5%
	Channel 3	3.0%	3.1%	3.2%	3.3%	3.5%	3.3%
	Channel 4	11.0%	10.8%	10.4%	10.8%	11.2%	10.6%
	Channel 5	27.2%	26.1%	24.5%	23.7%	22.7%	22.8%
Channels	Channel 6	0.4%	0.7%	0.9%	1.4%	1.8%	1.9%
launched in 2005	Channel 7	0.5%	0.7%	1.0%	1.2%	1.2%	1.3%
	Channel 8	0.7%	1.4%	2.0%	2.3%	2.3%	3.2%
	Channel 9	0.9%	1.1%	1.6%	2.0%	2.1%	1.8%
	Channel 10	1.5%	1.8%	2.2%	2.1%	1.9%	1.7%
	Channel 11	1.0%	1.5%	1.9%	2.3%	2.4%	2.2%
	Channel 12	1.0%	1.4%	1.6%	1.9%	2.1%	2.1%
	Channel 13	2.1%	2.6%	3.3%	3.5%	3.6%	3.4%
	Channel 14	1.8%	2.5%	3.0%	3.4%	3.2%	2.9%
	Channel 15	0.3%	0.5%	0.7%	0.8%	0.8%	0.8%
Channels	Channel 16						0.5%
launched in 2012	Channel 17						0.2%
	Channel 18						0.6%
	Channel 19						0.3%
	Channel 20						0.5%
	Channel 21						0.2%

Table 12: The 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

Spot_price in thousands €; Number_spots in thousands.

Table 13: Ratio of the observed advertising quantities over the cellings authoried

		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%

Appendix 2: Algebra transformations of nested logit model

$$\bar{s}_{jt/g}(\delta,\sigma) = [exp(\delta_{jt}/(1-\sigma))]/D_{gt}, \tag{28}$$

where:

$$D_{gt} = \sum_{j\in G_g} exp[\delta_{jt}/(1-\sigma)]. \tag{29}$$

$$\bar{s}_{gt}(\delta,\sigma) = \frac{D_{gt}^{(1-\sigma)}}{[\sum_g D_{gt}^{(1-\sigma)}]}. \tag{30}$$

Finally the unconditional probability that an individual choose to watch channel j at time t is given by:

$$s_{jt}(\delta,\sigma) = \bar{s}_{jt/g}(\delta,\sigma)\bar{s}_g(\delta,\sigma) = \frac{exp(\delta_{jt}/(1-\sigma))}{D_{gt}^{\sigma}[\sum_g D_{gt}^{(1-\sigma)}]}. \tag{31}$$

Normalizing the mean utility level for the outside good to 0, ie., $\delta_0 = 0$, then $D_0 = 1$ and

$$s_{0t}(\delta,\sigma) = 1/[\sum_g D_{gt}^{(1-\sigma)}]. \tag{32}$$

Taking log of the market shares,

$$ln(s_{jt}) - ln(s_{0t}) = \delta_{jt}/(1-\sigma) - \sigma ln(D_{gt}). \tag{33}$$

Taking log of Expression 29,

$$ln(\bar{s}_{gt}) = (1-\sigma)ln(D_{gt}) - ln(\sum_g D_{gt}^{(1-\sigma)}) = (1-\sigma)ln(D_{gt}) + ln(s_{0t}). \tag{34}$$

Then,

$$ln(D_{gt}) = [ln(\bar{s}_{gt}) - ln(s_{0t})]/(1-\sigma) = [ln(s_{jt}) - ln(\bar{s}_{jt/g}) - ln(s_{0t})]/(1-\sigma). \tag{35}$$

Plugging Expression 34 into Expression 32, we derive the TV viewers' demand equation to be estimated as:

$$ln(s_{jt}) = \bar{V}_{jt} + \alpha A_{jt} + \sigma ln(\bar{s}_{jt/g}) + ln(s_{0t}) + \xi_0 + \xi_{jt}. \tag{36}$$

Appendix 3: Robustness check on the approximation of "the total French population who watch the TV"

Table 14: Demand of TV viewers

	$0.25M_t$	$0.5M_t$	$0.75M_t$	M_t
Quantity if advertising(α)	-0.667**	-0.653**	-0.626**	-0.551**
	(-2.44)	(-2.40)	(-2.31)	(-2.19)
Within-nest share(σ)	0.359*	0.355*	0.347*	0.367**
	(1.93)	(1.91)	(1.89)	(2.00)
No. of Observations	690	690	690	690
No.of Group	15	15	15	15
F-Statistic	41.04	42.76	46.12	59.44
R-Squared	0.4206	0.4329	0.4557	0.5446
Kleibergen-Paap rk LM statistic (*p-value*)	0.0000	0.0000	0.0000	0.0000
Cragg-Donald Wald F statistic	11.059	11.059	11.059	11.615
Hansen J statistic (*p-value*)	0.1953	0.1694	0.1270	0.0583

t statistics in parentheses
* $p<0.1$, ** $p<0.05$, *** $p<0.01$

Note: M_t denotes "the total French population having access to the TV service".
All the results are estimated by two two-step feasible GMM.

Table 15: Demand of advertisers

	$0.25M_t$	$0.5M_t$	$0.75M_t$	M_t
Log(Quantity of advertising)(θ)	-0.373**	-0.373**	-0.373**	-0.373**
	(-2.43)	(-2.43)	(-2.43)	(-2.43)
Log(Audience)(γ_3)	0.606***	0.606***	0.606***	0.606***
	(4.08)	(4.08)	(4.08))	(4.08)
No. of Observations	689	689	689	689
No.of Group	15	15	15	15
F-Statistic	19.66	19.66	19.66	19.66
R-Squared	0.4301	0.4301	0.4301	0.4301
t statistics in parentheses				
* p<0.1, ** p<0.05, *** p<0.01				
Kleibergen-Paap rk LM statistic (*p-value*)	0.0000	0.0000	0.0000	0.0000
Cragg-Donald Wald F statistic	8.638	8.638	8.638	8.638
Hansen J statistic (*p-value*)	0.1070	0.1070	0.1070	0.1070

Note: M_t denotes "the total French population having access to the TV service".
All the results are estimated by two two-step feasible GMM.

Appendix 4: First stage estimation of the demand equations

Table 16: First stage estimation of Equation 19

	A_{jt}	$ln(\bar{s}_{jt/g})$
Films_evening	-0.002***	-0.003***
	(-6.01)	(-6.03)
French audiovisual	0.005***	-0.009***
	(3.17)	(-5.47)
Advertising investment_cinema	1.52e-09*	-3.72e-10
	(1.73)	(-0.41)
Advertising quantity_radio	3.06e-06***	3.18e-07
	(3.73)	(0.34)
No. of Observations	689	689
F-Statistic	16.44***	19.38***

t statistics in parentheses
* p<0.1, ** p<0.05, *** p<0.01

Table 17: First stage estimation of Equation 20

	$ln(A_{jt})$	$ln(y_{jt})$
Films_evening	-.003***	0.0002
	(-4.13)	(0.30)
French audiovisual	0.009***	-0.010***
	(3.42)	(-3.74)
Advertising quantity_radio	3.06e-06***	2.91e-07
	(3.01)	(0.19)
Average watching time*incumbent channels dummy	-0.004**	-0.006 ***
	(-2.32)	(-2.90)
Average watching time*new channels dummy	0.002	0.001
	(0.85)	(0.30)
No. of Observations	689	689
F-Statistic	22.52***	18.32***

t statistics in parentheses
* p<0.1, ** p<0.05, *** p<0.01

Appendix 5: Elasticities of demand

Appendix 5.1: Formulas

According to Equation 2, 5 and 7,

- Own-Advertising elasticity of demand of TV viewers:

$$\varepsilon_{y_{jt}}^{A_{jt}} = \frac{\partial y_{jt}}{\partial A_{jt}} \frac{A_{jt}}{y_{jt}} = \frac{\alpha}{(1-\sigma)} A_{jt}[1-(1-\sigma)s_{jt} - \sigma \bar{s}_{jt/g}]. \tag{37}$$

- Cross-Advertising elasticity of demand of TV viewers:

  – if channel j and channel i belongs to the same category (incumbent and new):

$$\varepsilon_{y_{jt}}^{A_{it}} = \frac{\partial y_{jt}}{\partial A_{it}} \frac{A_{it}}{y_{jt}} = -\alpha A_{it}(s_{it} + \frac{\sigma}{(1-\sigma)} \bar{s}_{it/g}); \tag{38}$$

  – if channel j and channel i belongs to two different categories (incumbent and new):

$$\varepsilon_{y_{jt}}^{A_{it}} = \frac{\partial y_{jt}}{\partial A_{it}} \frac{A_{it}}{y_{jt}} = -\alpha A_{it} s_{it}. \tag{39}$$

By Equation 20,

$$A_{jt} = exp(-\frac{\omega + X_{jt}^A \beta^A + \xi_{jt}^A}{\theta}) p_{jt}^{(1/\theta)} y_{jt}^{(-\gamma_3/\theta)}. \tag{40}$$

- Own-price elasticity of demand of advertisers:

$$\varepsilon_{A_{jt}}^{p_{jt}} = \frac{\partial A_{jt}}{\partial p_{jt}} \frac{p_{jt}}{A_{jt}} = exp(-\frac{\omega + X_{jt}^A \beta^A + \xi_{jt}^A}{\theta}) \frac{p_{jt}^{(1/\theta)} y_{jt}^{(-\gamma_3/\theta)}}{\theta A_{jt}}. \tag{41}$$

- Own-audience elasticity of demand of advertisers:

$$\varepsilon_{A_{jt}}^{y_{jt}} = \frac{\partial A_{jt}}{\partial y_{jt}} \frac{y_{jt}}{A_{jt}} = -exp(-\frac{\omega + X_{jt}^A \beta^A + \xi_{jt}^A}{\theta}) \frac{\gamma_3 p_{jt}^{(1/\theta)} y_{jt}^{(-\gamma_3/\theta)}}{\theta A_{jt}}. \tag{42}$$

Appendix 5.2: Cross-advertising-elasticities of audience

Table 18: Cross-advertising-elasticity of audience

		2008	2009	2010	2011	2012	2013
Incumbent Channels	**Channel 1**	0.049 (0.027)	0.041 (0.022)	0.049 (0.027)	0.046 (0.025)	0.038 (0.021)	0.034 (0.018)
	Channel 2	0.030 (0.017)	0.020 (0.011)	0.023 (0.013)	0.022 (0.012)	0.020 (0.011)	0.020 (0.011)
	Channel 3	0.003 (0.002)	0.004 (0.002)	0.005 (0.003)	0.006 (0.003)	0.006 (0.003)	0.005 (0.003)
	Channel 4	0.052 (0.028)	0.052 (0.029)	0.058 (0.032)	0.054 (0.030)	0.055 (0.031)	0.060 (0.032)
	Channel 5	0.141 (0.077)	0.150 (0.082)	0.155 (0.086)	0.142 (0.079)	0.141 (0.079)	0.140 (0.074)
Channels launched in 2005	**Channel 6**	0.007 (0.007)	0.011 (0.010)	0.016 (0.013)	0.024 (0.020)	0.025 (0.020)	0.030 (0.024)
	Channel 7	0.007 (0.006)	0.008 (0.007)	0.009 (0.008)	0.009 (0.007)	0.008 (0.006)	0.011 (0.009)
	Channel 8	0.009 (0.008)	0.015 (0.013)	0.020 (0.017)	0.029 (0.024)	0.027 (0.022)	0.034 (0.028)
	Channel 9	0.003 (0.003)	0.005 (0.004)	0.008 (0.007)	0.009 (0.007)	0.008 (0.006)	0.008 (0.007)
	Channel 10	0.011 (0.010)	0.011 (0.010)	0.012 (0.010)	0.0128 (0.010)	0.012 (0.010)	0.013 (0.013)
	Channel 11	0.011 (0.010)	0.015 (0.013)	0.019 (0.016)	0.034 (0.028)	0.032 (0.026)	0.030 (0.025)
	Channel 12	0.015 (0.013)	0.020 (0.018)	0.0208 (0.017)	0.024 (0.020)	0.028 (0.023)	0.031 (0.025)
	Channel 13	0.035 (0.032)	0.037 (0.32)	0.047 (0.039)	0.044 (0.036)	0.048 (0.039)	0.051 (0.042)
	Channel 14	0.017 (0.015)	0.027 (0.023)	0.032 (0.027)	0.036 (0.030)	0.036 (0.030)	0.043 (0.035)
	Channel 15	0.006 (0.006)	0.008 (0.007)	0.010 (0.009)	0.012 (0.010)	0.012 (0.010)	0.013 (0.010)
Channels launched in 2012	**Channel 16**	. .	. .	. .	. .	. .	0.004 (0.003)
	Channel 17	. .	. .	. .	. .	. .	0.001 (0.001)
	Channel 18	. .	. .	. .	. .	. .	0.007 (0.006)
	Channel 19	. .	. .	. .	. .	. .	0.002 (0.001)
	Channel 20	. .	. .	. .	. .	. .	0.005 (0.004)
	Channel 21	. .	. .	. .	. .	. .	0.004 (0.003)

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

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