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Working Paper #16-06

September 2016

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Evidence from the French Broadcast TV Industry**

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THE IMPACT OF ADVERTISING LENGTH CAPS ON TV: EVIDENCE FROM THE FRENCH BROADCAST TV INDUSTRY*

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This version: September, 2016

Abstract

The quantities of advertising on TV are regulated in France, as in many other developed countries. This paper aims at understanding the welfare implication of such regulation. It is the first paper which investigates this issue with a structural econometric model in two-sided market framework. I construct an unique database of per hour data on 12 main broadcast TV stations in France during one year (2014) to estimate structurally the demand and supply in the French broadcast television industry. I identify the shadow prices of regulation caps on advertising quantities, using the difference in estimated marginal costs between the binding and non-binding regulation constraints. A counterfactual experiment is carried out to quantify the exact impact of regulation. The results suggest that the TV channels advertise more without regulation but the overall impact of the current regulatory regime is small. The welfare analysis suggests that the current regulation framework is unnecessary, since it constrained the profit of TV channels without improving significantly the welfare of TV viewers.

JEL Classification: C35, D22, D62, H44, L13, L22, L51, L82, L88

Keywords: Advertising, regulation, media, TV, two-sided market, structural estimation, shadow prices, welfare

*I thank the Conseil supérieur de l'audiovisuel (CSA) for providing me data used in this study. In particular, I thank Nicolas Bouy (CSA) for his expert explanations and insights on the French TV industry. I am grateful to Marc Ivaldi for his support and encouragement. I also wish to thank Alessandro Iaria, Pierre Fleckinger, Margaret K. Kyle, Laurent Linnemer, Julien Monardo, Morten Sæthre for their comments and suggestions. The paper has benefited from discussions with seminar participants at CERN-Mines ParisTech and LEI-CREST. I gratefully acknowledge the financial supports from the NET Institute (www.netinst.org). Also, I thank Fondation Mines ParisTech and GENES for financing my PhD. Errors and opinions are mine.

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1 Introduction

The restrictions on the number of advertising minutes on TV are widespread in developed countries, with the conspicuous exception of the US. According to the European Audiovisual Media Services Directive, the broadcasters cannot exceed 12 minutes per hour of advertising. The French legal framework is more restrictive. In 2014, the private TV channels dispose of 9 minutes per hour of advertising and the public channels dispose of 6 minutes per hour on average within 24 hours (0:00 - 23:59). For each clock hour, the private channels are limited to 12 minutes maximum of advertising, and the public channels are limited on 8 minutes maximum.

The main purpose of these restrictions is to protect TV viewers from excessive advertising exposure, to limit the public audiovisual services dependency to advertising, and to sustain the diversity and the quality of TV programs broadcast by the TV channels. However, the broadcast television industry differs from other industries due to its two-sided market nature. (See Tirole and Rochet, 2006 and Armstrong, 2006.) There is no presumption that market forces should deliver excessive advertising. As discussed in detail in Anderson and Gabszewicz (2006), the broadcast TV channels deliver prospective customers to advertisers by attracting the viewership with entertainment content that carries advertising. The broadcasters know that the number of TV viewers influences the willingness to pay of advertisers for their advertising spots, while the quantity of ads affect the demand of TV viewers. In other words, the TV broadcasters recognize and internalize the network externalities between two sides of the market as they know that in such a market the viable business strategy requires bringing “both sides on board”.

On the other hand, the advertising revenues constitute important income sources for the broadcast TV channels. In order to offer high quality programs to the TV viewers, the TV broadcasters need resources to invest. A heavily restrictive cap on the advertising quantities may lead to a lack of resources for the broadcasters, and can limit the quality of broadcast contents. The regulation caps protect the direct welfare of consumers by restricting their exposure to ads, but may have indirect adverse-effect given the business model of the broadcast TV channels. It may involve less variety and perhaps lower quality of broadcast contents. Since ads are crowded out by caps, it is especially important to determine the welfare costs and benefits from the regulation. It is the aim of this paper.

Being an important issue, the impact of such regulation has not been extensively studied by the academic researchers, and lacks in particular empirical analysis. Anderson (2007) uses a two-sided market model to investi-

gate theoretically the effect of advertising caps on social welfare. The model shows that the level of advertising in equilibrium may be excessive (or insufficient) with respect to the social optimum if the TV viewers are highly (or weakly) ad-averse. A regulation cap is socially beneficial in the first case and harmful in the second case. Two empirical works are close in spirit to mine. Filistrucchi et al. (2012) analyzes the impact of advertising ban on the public TV channels from 8 p.m to 6 a.m in France. Their preliminary result suggest that the gross advertising revenues of public TV broadcasters decline after the introduction of the ban, but much of the loss between 8:00 p.m. and 6:00 a.m. is recovered by increased ad revenues of public broadcasters between 6:00 a.m. and 8:00 p.m. Furthermore, they find that advertising that was previously served on public TV channels did not switch to the private TV channels, contradicting claims made at the time the policy was introduced. Crawford et al. (2012) studies the (inverse) demand for advertising in the UK, and finds that increasing the public TV channels' advertising minutes to the level permitted for private TV channels would increase both the revenue of the public TV broadcasters and of the industry.

Both of the two empirical papers above use reduced form regressions and focus on the advertising side of the market. My paper complements the findings of the previous works. Most importantly, by using a two-sided market framework, I estimate separately the demand of TV viewers and of advertisers, and consider their feedback loops in the supply function of TV channels. This approach allows me to interpret the behavior of TV channels according to the sensitivity of TV viewers to advertising, and the flexibility of advertising prices with respect to the viewership of TV channels. Furthermore, using rich data on the broadcasting side, I am able to conclude on the impact of regulation on the welfare of TV viewers.

Precisely, I collect per hour data on 12 broadcast TV channels in France during one calendar year (2014). Details include the number of TV viewers watching each of the 12 TV channels, total number of TV viewers watching TV (*free and pay*) during each clock hour, the type of broadcasting contents (classified into 21 categories) on different TV channel, the quantities (in minute) and prices (in KEUR per minute) of advertising, as well as some variables affecting the broadcasting costs of certain programs to each TV channel.

The paper makes several contributions. Firstly, it is the first one which analyses the welfare implication of regulation on advertising quantities. Secondly, it structurally estimates the demand and supply of the TV channels in a two-sided market framework, and takes into account the interaction between TV viewers and advertisers. It simulates the counterfactual level of advertising prices, quantities and audience without regulation at a Nash

Equilibrium, which is new to the literature. Thirdly, it uses an original method to identify the shadow prices of regulation constraints, which can be applied to many regulated industries where the regulation constraints are observable. My identification strategy is similar to the techniques proposed by Dubois and Lasio (2015) where the authors identify the unobserved regulation constraints in pharmaceutical industry using the cost differences between regulated and unregulated markets. This identification strategy has not been widely applied in the literature of empirical industrial organization.

The reliability of the analysis proposed here hinges on the precise identification of the demand shapes and of substitution patterns across differentiated TV channels, which consists on the first step of the method. The use of aggregate data on audience makes the ability to accommodate the TV viewers' demand heterogeneity especially crucial, since the individual preferences for advertising and different broadcasting contents are confounded in the aggregate data. The empirical literature of industrial organization has addressed this need using random coefficient logit models (Berry, 1994; Berry, Levinsohn and Pakes (BLP), 1995; Nevo, 2000 and 2001), which have proved able to provide rich and plausible substitution patterns in diverse applications, from cars (BLP, 1995), to food (ready-to-eat cereals in Nevo, 2000 and 2001), to pharmaceuticals (Dubois and Lasio, 2015), and to broadcasting industry (Wilbur, 2008 and Jeziorski, 2014). I follow these previous works to modelize the demand of TV viewers, so that the heterogeneity in individuals being controlled. I estimate the model using recent methodological advances, and carefully checked the property of the obtained minimum. (See Train, 2003 and Knittel and Metaxoglou, 2014). Different to the discrete choice of TV viewers, the advertisers often advertise simultaneously on different TV channels. I follow Rysman (2004) to modelize the demand of advertisers as continuous choices and estimate the (inverse) demand of advertisers. All the estimates obtained are in line with expectation.

Once identified the demand of TV viewers and of advertisers, I modelize the TV stations as platforms which internalize the network externalities between TV viewers and advertisers, and supply advertising spaces under regulation constraints. Using the difference in estimated marginal costs between binding and non-binding regulation caps, I identify the "shadow prices" of the regulation constraints thanks to assumptions on the competition game played by the TV stations and the variation across observations for which the regulation caps are binding and those that are not. I then proceed to a counterfactual experiment to simulate the equilibrium level of advertising prices and quantities, and audiences of different TV channels without regulation. The results allow me to conclude on how the current regulatory regime affects the strategic behavior of TV channels and the welfare effect of such regulation.

The estimation results suggest that advertising is a nuisance cost that the TV channels charge to the TV viewers, though the preference of TV viewers is estimated to be fairly heterogeneous across individuals. Despite strong differentiation, captured by small cross-advertising elasticities of audience, the combination of substitution effects and regulation affect the ability of TV stations to set their preferred advertising level when the demand is strong. The advertising prices are very flexible with respect to audience, but are less elastic with respect to the advertising supply. As a consequence, the regulation caps on advertising quantities did not push up significantly the advertising prices. The TV stations' profits are constrained when the demands for advertising are important. According to the counterfactual simulation, on average, a TV station would broadcast one more advertising spot (30 seconds) every two hours without regulation. Yet, the deregulation on advertising quantities would not affect significantly the advertising prices and audience shares of TV channels. The welfare analysis suggests that the current regulatory regime is unnecessary, since it constrained the profit of TV channels without improving *significantly* the welfare of TV viewers.

The reminder of this paper is organized as follows. In section 2, I present the general background of the industry, the regulation framework and the data. In section 3, I introduce the econometric model. In section 4, I discuss the identification strategy. The estimated results are presented in section 5. Discussions about the policy implication of the counterfactual experiments are in section 6. Finally, I conclude in section 7.

2 Context

2.1 The free-broadcast TV industry

The free-broadcast TV channels are two-sided platforms, connecting TV viewers to advertisers by broadcasting TV contents. The viewers value the entertainment they get from watching TV programs, and are willing to pay for it. Contrary to the pay TV channels, which charge “double fees” (subscription fee and advertising) to the TV viewers, the TV channels broadcast free to air charge only the nuisance of advertising to their viewers. The TV viewers and the advertisers interact through feedback loops: The larger the audience size of a TV channel, the higher the advertisers' willingness to pay for its advertising spaces. The TV viewers may be ad-adverse, in which case the more extensive the advertising quantity of a TV channel, the lower its viewership.

On the advertising market, the advertisers demand audience and the TV

channels supply them. The TV channels sell the advertising spaces via the intermediary of the advertising sales houses (ASHs). In France, many broadcast TV stations share common ownership (i.e. belong to the same media group). Each media group owns or cooperates with an ASH, through which its channels exchange with the advertisers.

As a specific feature of the industry, the decisions are made between TV stations and advertisers before broadcasting time. That is to say, the deals established on the advertising market are based on the *expected audience*. In practice, the TV channels communicate their capacity of advertising spaces together with their expected revenues to the ASHs three months in advance. The advertisers get in touch with different ASHs to choose the advertising spaces corresponding to their expected audience and willingness to pay.

The broadcasting schedules (TV programs and advertising) are fixed and published one month prior to the broadcasting time. The deals between TV stations and advertisers conclude at the same time. The prices of advertising spots depend on the viewership, audience composition (demographics), and the lengths of advertising messages. According to the audience performance of TV channels, the advertising campaigns may be adjusted in real time to reach the desired effects.

At the end of the year, according to private contracts between different TV channels and advertisers, discounts are often applied to the initial prices of advertising. The discounts are confidential information which I cannot access. Still, I know from the experts' explanations that the discount rates are very channel specific: channels with big audience size discount much less than those with small audience size.

2.2 The French regulatory framework

In France, the quantities of advertising on TV are regulated. The French law imposes double caps to broadcast TV channels on the basis of clock hours and daily average levels. In 2014, the private TV channels dispose of 9 minutes per hour of advertising and the public channels dispose of 6 minutes per hour on average within 24 hours (0:00 - 23:59). For each clock hour, the private channels are limited to 12 minutes maximum of advertising, and the public channels are limited on 8 minutes maximum. Furthermore, commercial advertising is completely banned on the public channels from 8 p.m to 6 a.m. Ads of service nature remain authorized during the commercial bans (8 p.m to 6 a.m on the public TV channels).

Besides of the advertising revenues, the public TV channels receive a

sum of public allocation from the French government every year. This sum of public funding is collected from the TV viewers and some other public sponsors through tax.

The TV channels invest part of their revenues on program acquisitions. Apart from the programs purchased from the US studios (American series and movies), the broadcast TV stations in France are subject to different obligations regarding the participation in French and European audiovisual productions. The co-production or pre-purchase of audiovisual works give the TV stations the broadcasting rights of the works concerned.

2.3 Data and descriptive statistics

This study uses hourly data on 12 broadcast TV channels in France during one calendar year (2014). In France, there are in total 22 TV channels broadcast free-to-air. The 12 channels that I considered in this study are the most representative in terms of audience performance, with a cumulated audience share that equaled to 67.6% in 2014. These 12 channels are listed in Table 3.

For this study, I matched up data from four different sources so that the demand and supply on both sides of the market can be analyzed at equilibrium.

The first set of data consists of information on audience of different TV channels, and is provided by Médiamétrie, a French company specializing in audience measurement on different media. The audiences of different TV channels are measured based on a panel of households equipped with one or more TV sets in their main residence. This panel consists of nearly 4300 households, which corresponds to around 10500 individuals aged 4 years and more. The panel is constructed to represent both the socio-demographic characteristics of households in metropolitan France and the characteristics of the different television offers. In each household 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.¹ This survey allows to know the number of TV viewers on each broadcast TV channel and the total population watching TV (*free and pay*) instantaneously.

¹Source Médiamétrie: <http://www.mediametrie.fr>.

To complete the first set of data on the broadcasting market, I collect, with the help of the Conseil supérieur de l’audiovisuel (CSA)² detailed information on programs broadcast on different TV channels during the period of observation.³ These programs are then classified into 21 categories (*e.g. News, Documentary, Films, Series, Sports.*) following the industry practice. (See Table 2 for a list of all the program categories.) These 21 categories summarize all the types of programs of broadcast TV channels in France. A reconstruction of this dataset allows me to know the exact types and lengths of programs that each channel has broadcast during each hour of observation.

The data on the advertising market are provided by Kantar Media. Kantar Media is a company providing intelligence (data and analysis) on media consumption, performance, and value. To support this study, Kantar Media has provided, via contract with the CSA, hourly measurements on gross advertising revenues (revenues before rebates, in thousands of euros) and advertising quantities (in minutes) of the 12 broadcast TV channels. For the convenience of the analysis, I divide the gross advertising revenues by the corresponding lengths of advertising, to obtain the average spot prices of advertising for each channel-period pair of observation. The advertising prices calculated in such a way are prices before discounts and correspond to the equilibrium prices established on the market on the basis of the audience performance and the quantities of advertising offered on each TV channel.

In addition to the first three sets of data, I collect also data on the average investment of different TV channels on acquisition of broadcasting rights of the following types of programs: long films, theatrical feature films, documentaries, concerts, animated programs, and TV magazine. These variables represent the average broadcasting costs of the corresponding programs to each TV channel. These data are publicly available on published reports of the Centre national du cinéma et de l’image animée (CNC)⁴.

Combining the four sets of data together, in the final dataset, one observation (channel-period pair) is uniquely identified by the name of the TV channel, the corresponding media group and the period of observation (hour/day/month/year).

Summary statistics of the main variables are reported in Table 1. Details on the audience shares, advertising prices and quantities of different TV channels are reported separately in Figure 1- 3.

²The French regulator on television and radio.

³I acknowledge the effort of the CSA on uniting these data.

⁴An agency of the French Ministry of Culture, and is responsible for the production and promotion of cinematic and audiovisual arts in France

The audience shares of different TV channels vary from one hour to another, but are stable at monthly average level. The same is observed for the channels' advertising prices and quantities. The TV stations set advertising quantities strategically, based on their predictions on the audience performance, and the regulation constraints. The unit of prices are not reported for confidentiality reasons. In general, the advertising spaces in the evening (after 7 p.m) are more expensive than those during the days. Due to regulation and various physical constraints, the TV channels set similar level of advertising quantities, but are differentiated in advertising prices. (See Table 4 for comparison on the standard deviations of advertising prices and quantities.) The advertising prices are agreements between the TV channels and the advertisers upon the principle of cost recovering and profit maximization.

I observe from data that it has happened to all the TV channels to bind the per hour level of advertising constraints (8 minutes for the public TV channels, 12 minutes for the private TV channels), though the frequency varies with channels. Most of the binding observations are in the evening when the demand for advertising is strong. The distributions of advertising quantities by channel and by hour are reported in Figure 4.

3 Econometric model

3.1 Demand for TV viewers

The model specifies the utility of watching channel $j \in 1, \dots, J$ for TV viewer i in period t as:

$$U_{ijt} = \sum_l \beta_i^l x_{jt}^l + \alpha_i A_{jt} + \xi_{jt} + \epsilon_{ijt}, \quad (1)$$

where x_{jt}^l are L observed characteristics of TV channels. Precisely, x_{jt}^l are specified as a linear combination of dummies of 21 broadcasting contents, and dummies for channels, hours of the day, day of the week, and month of the year. The 21 content types include all the types of programs that a free-broadcasting TV channel can broadcast in France. A_{jt} represents the quantities of advertising. ξ_{jt} captures the unobserved qualities of channel j at period t . ϵ_{ijt} is a mean zero stochastic term. The model is completed by the inclusion of an outside good, which corresponds to not watching any of the J TV channels at time t , with a normalized indirect utility $u_{i0t} = \epsilon_{i0t}$.

Each individual chooses to watch one channel in the choice set $0, 1, \dots, J$ at period t according to the maximum utility (1). The preference parameters are specific to each user i :

$$(\beta_i^l, \alpha_i) = (\beta^l + \sigma_{\beta^l} v_i^l, \alpha + \sigma_{\alpha} v_i^A) \quad (2)$$

where $(v_i^1, \dots, v_i^l, \dots, v_i^L, v_i^A)$ summarizes all the unobserved individual characteristics and $(\sigma_{\beta^l}, \sigma_\alpha)$ characterizes how consumer tastes vary according to these unobserved characteristics. The indirect utility can be redefined as the sum of a mean utility $\delta_{jt}(X_{jt}, A_{jt}, \xi_{jt}; \theta_1) = \sum_l \beta^l x_{jt}^l + \alpha A_{jt} + \xi_{jt}$, a deviation from the mean utility $\mu_{ijt}(X_{jt}, A_{jt}, V_i; \theta_2) = \sum_l \sigma_{\beta^l} v_i^l x_{jt}^l + \sigma_\alpha v_i^A A_{jt}$, and an idiosyncratic error ϵ_{ijt} :

$$U_{ijt} = \delta_{jt} + \mu_{ijt} + \epsilon_{ijt}. \quad (3)$$

Under the assumption that ϵ_{ijt} is independently and identically distributed according to Gumbel (extreme value type I) distribution, the choice probability of alternative j by individual i is

$$s_{ijt}(\mathbf{X}_t, \mathbf{A}_t, \xi_t) = \frac{\exp(\delta_{jt} + \mu_{ijt})}{1 + \sum_k \exp(\delta_{kt} + \mu_{ikt})}, \quad (4)$$

and the outside good choice probability is

$$s_{i0t}(\mathbf{X}_t, \mathbf{A}_t, \xi_t) = \frac{1}{1 + \sum_k \exp(\delta_{kt} + \mu_{ikt})}. \quad (5)$$

Assuming that $V_i = (v_i^1, \dots, v_i^l, \dots, v_i^L, v_i^A)$ is distributed with p.d.f. φ , the audience share of channel j , s_{jt} , is given by

$$s_{jt}(\mathbf{X}_t, \mathbf{A}_t, \xi_t) = \int s_{ijt}(\mathbf{X}_t, \mathbf{A}_t, \xi_t) \varphi(V_i) dV_i. \quad (6)$$

Then, the own- and cross-advertising elasticities of the audience share s_{jt} are:

$$\frac{\partial s_{jt}}{\partial A_{kt}} \frac{A_{kt}}{s_{jt}} = \begin{cases} \frac{A_{jt}}{s_{jt}} \int \alpha_{it} s_{ijt} (1 - s_{ijt}) \varphi(V_i) dV_i, & \text{if } j = k \\ -\frac{A_{kt}}{s_{jt}} \int \alpha_{it} s_{ijt} s_{ikt} \varphi(V_i) dV_i, & \text{otherwise.} \end{cases}$$

3.2 Demand of advertisers

Following Rysman (2004), the inverse demand of advertisers to be estimated is:

$$\ln p_{jt} = \theta \ln A_{jt} + \gamma \ln y_{jt} + X_{jt}^A \beta^A + \xi_{jt}^A. \quad (7)$$

where p_{jt} is the prices of advertising spots (before discounts). A_{jt} measures the quantities of advertising offered by channel j during hour t , y_{jt} is the average number of TV viewers watching channel j during hour t . X_{jt}^A and ξ_{jt}^A represent separately the observable and unobserved characteristics of channel j , at time t , influencing the demand of advertisers. θ captures the joint effect of “congestion” and “decreasing return to scale” of advertising, γ

measures the “network effect of consumption”. As specified in the theoretical model, the estimated value of θ is expected to be negative and that of γ is expected to be positive. (See Rysman, 2004 and Ivaldi and Zhang, 2015 for details.)

This model fits the reality of the TV advertising market very well. As previously mentioned, p_{jt} is the prices of advertising spots without discounts. These prices are established on the market based on each channel’s capacity of advertising offers and audience. I don’t have information on the composition (demographics) of audience. However, since this latter varies in time, I specify X_{jt}^A as a linear combination of dummies for months, hours and days of the week to control this fact.

3.3 Supplies of TV channels

There are J free channels belonging to K different media groups active on the TV advertising market. Each media group owns or cooperates with a private advertising sales house, 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 $G_k, k = \{1, \dots, K\}$ from selling advertising spaces is given by

$$\Pi_{G_{kt}} = \sum_{jt \in G_{kt}} \Pi_{jt} = \sum_{jt \in G_{kt}} [(p_{jt} - c_{jt})A_{jt} - F_{jt}], \quad (8)$$

where c_{jt} and F_{jt} define the marginal costs and the fixed costs of channel j at time t .

The TV channels compete à la Cournot on the advertising market. (See Ivaldi and Zhang, 2015.) The regulation constraints for a private (public) TV channel are such that 9 (6) minutes per hour of advertising on average during a day and 12 (8) minutes maximum of advertising per any clock hour. Therefore, the the group G_k ’s constrained maximization program, given the other media groups’ advertising strategies, is

$$\begin{aligned} \text{Max} \quad & \{\Pi_{G_{kt}} | \mathbf{A}_{-jt}\} = \max_{A_{jkt}; jt \in G_{kt}} \sum_{jt \in G_{kt}} [(p_{jt}(A_{jt}, y_{jt}(\mathbf{A}_t)) - c_{jt})A_{jt} | \mathbf{A}_{t-jt}], \\ \text{s.t.} \quad & A_{jt} \leq \bar{A}_{jt}, \\ & \sum_t^{24} A_{jt} \leq \tilde{A}_{jt}, \end{aligned}$$

where $\bar{A}_{jt}$ equals to 12 (8) and $\tilde{A}_{jt}$ equals to 216 (144) for a private (public) TV channel.⁵ The first constraint states that the total quantity of advertising of private (public) TV channel j during clock hour t can not exceed 12 (8) minutes. The second constraint states that the total quantity of advertising of a public (private) TV channel j during a day (24 hours) cannot exceed 216 (144) minutes.

Define Lagrange multipliers λ_{jt} associated with the constraint $A_{jt} \leq \bar{A}_{jt}$, and μ_{jt} associated with the constraint $\sum_t^{24} A_{jt} \leq \tilde{A}_{jt}$. Assuming that the technical conditions for the existence of a pure-strategy Cournot-Nash equilibrium in quantities are satisfied and that the equilibrium quantities are positive, the constrained profit-maximizing quantities of advertising should satisfy the following Kuhn-Tucker conditions:

$$\begin{aligned} \frac{\partial \Pi_{G_{kt}}}{\partial A_{jt}} - \lambda_{jt} - \mu_j &= 0, \\ \min[\lambda_{jt}, \bar{A}_{jt} - A_{jt}] &= 0, \\ \min[\mu_{jt}, \tilde{A}_{jt} - \sum_t^{24} A_{jt}] &= 0, \\ \forall jt \in G_{kt} \end{aligned}$$

The complementary slackness conditions (in the second and third row) state that, for any channel j at time period t , the constraint is either binding (“active”), or nonbinding in which case $\lambda_{jt} = 0$ or $\mu_{jt} = 0$.

During the period of observation, the second regulation constraint on the total quantity of advertising during a day is never binding (“active”) for any TV channel. In another word, $\mu_{jt} = 0, \forall jt$. Therefore, the first order condition (in the first row) can be simplified as:

$$(p_{jt} - c_{jt}) + A_{jt} \frac{\partial p_{jt}}{\partial A_{jt}} + A_{jt} \frac{\partial p_{jt}}{\partial y_{jt}} \frac{\partial y_{jt}}{\partial A_{jt}} + \sum_{i \neq j, it \in G_{kt}} A_{it} \frac{\partial p_{it}}{\partial y_{it}} \frac{\partial y_{it}}{\partial A_{jt}} = \lambda_{jt}, \forall jt \in G_{kt}. \quad (9)$$

where λ_{jt} measures the **shadow prices** of regulation caps on advertising quantities for channel j at period t .

⁵I don't include the punishment on over-advertising into the game, because the penalties are not necessarily monetary. The punishment of CSA are graduated according to severity of the infraction. Over-advertising for once often conclude by a warning without penalties. In severe cases, the penalties can take different forms: bans on advertising during one month, reduction in legal level of advertising during one year, bans in broadcasting certain types of contents, etc. No penalty is applied in 2014 according to the CSA. Source: <http://www.csa.fr/Le-CSA/Presentation-du-Conseil/Des-missions-diversifiees/Les-sanctions>.

4 Identification and estimation

4.1 Demand of TV viewers

Identification of random coefficient logit models on aggregate data (Equation 6) is based on moment conditions between the structural demand error ξ_{jt} and some instrumental variables (BLP, 1995 and Nevo, 2000), which are needed to account for the endogeneity due to the fact that the quantities of advertising are correlated with unobserved demand factors ξ_{jt} (Berry, 1994 and BLP, 1995).

The quantities of advertising A_{jt} are endogenous in this model. The residual ξ_{jt} can be either unobserved tastes for ads and/or qualities of networks over time, or unobserved quality of broadcasting programs, unobserved additional services offered by the TV channels. These characteristics are unobservable to the econometricians but are likely to be observable to the TV channels. In general, if a channel knows in advance that a program can attract big audience at time t , it includes more ads at that moment as well. Without controlling for this fact, the estimate of α can be biased upward.

I use two sets of instruments to control for this endogeneity problem. A first set of instruments consists on the total quantities of advertising of the same channel during the other 23 hours of a day. (In my sample, I observe the quantity of advertising of TV channels per hour.) The French regulator imposes a maximum length of commercial times per day and per hour for each TV channel. The channels' strategic decisions on different broadcasting hours must be correlated. But there is no reason for the decision of TV viewers on watching a channel at time t to be dependent on the channel's advertising level during the other hours of the day, controlling for the broadcasting contents of the TV channels. This instrument reflects also the idea demonstrated in Hausman and Leonard (2002) and Nevo (2000a,b).

The second set of instruments follows the standard approach for demand-side instrumental variables, i.e. variables that shift costs but are uncorrelated with the demand shock ξ_{jt} . In the absence of direct data on the broadcasting costs, the instruments used for the analysis consist in proxies of cost shifters. I have information on the average investment per hour of each TV channel to obtain the broadcasting rights of the following contents: films, fiction, documentaries, entertainment, live performance, magazine shows.⁶ These are not the exact broadcasting costs since they are only the average values. Nevertheless, they indeed provide an idea on the difference in input prices

⁶The CNC publishes the average cost per hour of above broadcasting contents for different TV channels. Details can be found on the CNC's web-page through following link: [bluehttp://www.cnc.fr/web/fr/publications/-/ressources/4893373](http://www.cnc.fr/web/fr/publications/-/ressources/4893373).

of different types of broadcasting contents. To instrument the quantities of advertising of one TV channel at period t , I use above “cost shifters” of the same channel during the same day of the previous week. The proxies of cost shifters constructed in such way are related to A_{jt} since the channels tend to recover their input prices (by selling advertising spaces) over a large period of time. However, there is no reason for these cost shifters to be correlated with ξ_{jt} , because they represent only the expenditures of different channels during the past, but do not reflect the quality of any particular program. Compared to the average costs of contents at period t , the average costs of contents of the previous week have the advantage to be uncorrelated with the broadcasting contents of period t , X_{jt} . This avoids the potential bias on the estimate of α in case of endogenous contents choice.⁷ Typically, as a practice of self-regulation of the market, in France, the TV channels publish their detailed schedules of programs at least two weeks in advance. Strategic rescheduling within two weeks has not been observed.

4.2 Demand of advertisers

$\ln A_{jt}$ and $\ln y_{jt}$ are endogenous in Equation 7. The advertising agencies (with which the advertisers manage their advertising campaigns) and the TV channels may anticipate in advance that there would be a peak (or drop) in audience on channel j at time t , according to information sources that are unavailable to econometricians. In this case, the advertisers are willing to pay more (or less) for the corresponding advertising spaces, but channel j set more (or less) ads during time period t as well. If $\ln A_{jt}$ is positively (or negatively) correlated with ξ_{jt}^A , the estimate of θ will be biased upwards (or downwards), without controlling this fact. Likewise, the quality of programs (in terms of attractiveness of audience) are unobserved by the econometricians but are likely to be observable by the advertising sales house. That is, $\ln y_{jt}$ is correlated either positively or negatively with ξ_{jt}^A . Without controlling for this fact, the estimate of γ_3 will be either upward or downward biased.

I use the broadcasting lengths of different programs to correct the endogenous bias. The nature and broadcasting lengths of the TV programs affect the prices of advertising spots p_{jt} only through the quantity of advertising A_{jt} and audience y_{jt} of the TV channels.

⁷Akerberg et al(2011) and Crawford et al. (2012) have pointed out that, sometimes, the product characteristics X_{jt} could also be endogenous in this type of model. By using instruments uncarefully chosen on the quantities of advertising A_{jt} , not only the estimates of β , but also that of α can be biased. Akerberg et al(2011) show that one can get consistent estimate of α , without instrumenting the endogenous program choices, if the instrumental variables Z_{jt} used on A_{jt} are uncorrelated with x'_{jt} . A consistent estimates on α is enough to answer the policy questions that I investigate in this paper.

4.3 Supply of TV channels

The expression of marginal costs of TV channels c_{jt} can be derived from the first order condition of their profit maximization function (Equation 9):

$$c_{jt} = \Omega_{jt} - \lambda_{jt}, \quad (10)$$

where $\Omega_{jt} = p_{jt} + A_{jt} \frac{\partial p_{jt}}{\partial A_{jt}} + A_{jt} \frac{\partial p_{jt}}{\partial y_{jt}} \frac{\partial y_{jt}}{\partial A_{jt}} + \sum_{i \neq j, it \in G_{kt}} A_{it} \frac{\partial p_{it}}{\partial y_{it}} \frac{\partial y_{it}}{\partial A_{jt}}$, and

λ_{jt} is the shadow prices of regulation caps on advertising quantities, which is unobserved, and need to be identified.

If I could observe the marginal costs c_{jt} , the identification of λ_{jt} could be easily achieved. By Equation 10, the marginal cost of any channel j during time period t is a known function of λ_{jt} , depending on the demand, advertising quantities, and market shares of different TV channels. For any marginal cost vector c_0 , it is always possible to find a λ_{jt} such that $c_{jt}(\lambda_{jt}) = c_0$, using $\lambda_{jt} = \Omega_{jt} - c_0$.

Though, in the absence of direct information on the marginal costs, it is still possible to identify λ_{jt} , if there exist some time periods during which the regulation caps on certain broadcasting TV channels are not binding, and if some information on the cost shifters of different TV channels during different time periods are available.

I observe in my data that the regulation constraints are binding for some jt , but not for the others. According to the Kuhn-Tucker condition, any binding regulation constraint $\bar{A}_{jt} - A_{jt} > 0$ implies that its associated Lagrange multiplier λ_{jt} equals 0. Define S_{ub} the set of jt pairs for which the regulation caps are not binding, i.e. $\forall jt \in S_{ub}, A_{jt} < \bar{A}_{jt}$, and S_b the set of jt pairs for which the regulation caps are binding, i.e. $\forall jt' \in S_b, A_{jt'} = \bar{A}_{jt'}$. Then, for any $jt \in S_{ub} \cap G_{kt}$,

$$c_{jt} = \Omega_{jt}, \quad (11)$$

and for any $jt' \in S_b \cap G_{kt}$,

$$c_{jt'} = \Omega_{jt'} - \lambda_{jt'}. \quad (12)$$

The cost difference between any $jt' \in S_b$ and any $jt \in S_{ub}$ can be modeled to depend linearly on the observable difference $\mathbf{z}_{jt} - \mathbf{z}_{jt'}$ of the vector of observed

cost shifters $\mathbf{Z}$ and on unobserved channel-specific and time-specific additive shocks ω_{jt} :

$$c_{jt} - c_{jt'} = (\mathbf{z}_{jt} - \mathbf{z}_{jt'})' \rho + \omega_{jt} \quad (13)$$

with

$$E(\omega_{jt} | \mathbf{z}_{jt} - \mathbf{z}_{jt'}) = 0. \quad (14)$$

Then, each $\lambda_{jt'}$ is identified using the moment condition across all unconstrained $jt \in S_{ub}$ ⁸

$$E(\omega_{jt}(\rho, \lambda_{jt'})) = 0. \quad (15)$$

That is,

$$\Omega_{jt} - \Omega_{jt'} = -\lambda_{jt'} + (\mathbf{z}_{jt} - \mathbf{z}_{jt'})' \rho + \omega_{jt}. \quad (16)$$

5 Results

5.1 Demand of TV viewers and advertising elasticity of audience

Estimates on demand of TV viewers are reported in Table 5. The estimation is based on simulated method of moments, using 440 normalized Halton draws (Train, 2003), tight tolerance levels for the nested fixed point algorithm and up to 10000 starting values (Knittel and Metaxoglou, 2014).

Heterogeneity is controlled for with a normally distributed random coefficient on the advertising quantities and on all the program categories.

The estimation results are reported in Table 5. As a benchmark, I also present the results from a simple logit model, ignoring all individual heterogeneity. The demand parameters for both the logit (IV) and RC logit show that TV viewers dislike advertising on average. Yet, this preference is estimated to be fairly heterogeneous across individuals by the RC logit model. The taste heterogeneity for both advertising and different TV programs are strong and it causes the estimated mean parameters by simple logit model to be biased either upward or downward. According to the RC logit estimation, many program categories have insignificant mean-effects on the individuals' choices in TV channels, while the individuals' preferences for these program categories present big heterogeneities.

I also compare the results of OLS estimation to IV estimation of the simple logit model, to check whether the instruments used in the estimation are helpful in fixing the endogeneity bias. I find that the endogeneity of

⁸See Dubois and Lasio (2015) for details on the regularity conditions required for such type of identification.

advertising quantity biased the OLS estimations. Without controlling the endogeneity bias, the quantity of advertising reflects the quality of TV channel, and is estimated to have a positive effect on audience of the channel. The disutility effect of advertising can be isolated from the quality of TV channel only if the endogeneity bias is properly controlled.

The estimates by RC logit model are used to compute own- and cross-advertising elasticities of demand of audience. These estimates produce an average own-advertising elasticity of audience across all channels and periods of -0.313 , with some dispersion: the 25th percentile is -0.367 and the 75th 0.100 . In Table 6 - 8, I report the detailed estimates of elasticities by channel, hour and month. Table 6 is to be read as the percentage increase in audience that the channel in row benefits from if the channel in column raises its advertising quantity by 1%. The results suggest that the TV viewers are more sensitive to advertising on some channels than on others. On average, the own-advertising elasticities of audience are stable overtime, but there are 4 hours during a day where the viewers are in particular sensitive to the advertising: 9 – 10 a.m. 1 – 2 p.m. and 8 – 10 p.m. The substitution patterns suggest that the channels are highly differentiated. As expected, the highest cross-elasticities for all channels are towards channels with the highest audience shares (i.e. Channel 1-4). The cross-advertising elasticities are stable overtime.

5.2 Demand of advertisers and advertising price flexibility

Estimates on demand of advertisers are reported in Table 9. As for the demand of TV viewers, I compare the results of OLS estimation to the results of IV estimation. I find that the OLS estimates of $\hat{\theta}$ are biased upward and the OLS estimates of $\hat{\gamma}$ are biased downward. Without controlling the endogeneity bias, the quantity of advertising reflects the quality of TV channel, and is estimated to have a positive effect on the willingness to pay of advertisers. The bias of OLS estimates of $\hat{\gamma}$ suggests that $\ln(y_{jt})$ are negatively correlated with ξ_{jt}^A .

The signs of IV estimates are as expected in the theoretical model: $\hat{\gamma}$ is positive which confirms the existence of “network effect of consumption”. The negative sign of $\hat{\theta}$ reflects the combined effect of “congestion” and “decreasing return to scale” of advertising. (See Raysmen, 2004 and Ivaldi and Zhang, 2015 for details.)

As pointed out in Crawford *et al.* (2012), by estimating the inverse demand of advertisers instead of a direct demand equation, I estimate the

flexibility of advertising prices, rather than the elasticity.⁹ Though the elasticity of demand is theoretically given by the inverse of the price flexibility, the same is not true for the estimates.¹⁰ The ad-price flexibilities with respect to the viewership and the advertising quantities can be computed respectively according to the following formulas: $\partial \ln p_{jt} / \partial \ln y_{jt} = \gamma$; $\partial \ln p_{jt} / \partial \ln A_{jt} = \theta$. (See Equation 7.) It is estimated that 1% increase in viewership of a TV channel increases 1.077% of its average ad-prices, while 1% increase in ad-quantities of a TV channel decreases its average ad-prices by 0.208%.

5.3 Shadow prices of regulation caps on advertising and price-cost margins of broadcasting

The identification of shadow prices of advertising caps is proceeded by using Equation 16. The following variables are used to construct the vector of cost shifters: the number of employees in different media groups, the amount of public funding allocated to the public TV channels, the approximate broadcasting costs of several programs, including films, fiction, documentaries, entertainment, live performance, magazine shows.

There are in total 2249 shadow prices λ_{jt} associated to a binding advertising cap to identify. All of them are estimated to be significantly different from zero, but their estimated values are small.

Using the estimated λ_{jt} to recover the marginal costs of broadcasting c_{jt} , I can finally estimate the price-cost margins that realize different TV channels during different periods of observations. The average price-cost margin of binding observations is estimated to be 36.41%, while that of the non-binding observations is estimated to be 56.57%. This is not surprising because the regulation constraints are mainly binding when the demand for advertising are strong. Detailed estimates of price-cost margin are reported in Table 10 - 11.

⁹“*Price flexibility* is the percentage change in the price of a commodity associated with a one percent increase in the quantity demand of that commodity or a related variable, all else remaining constant.” (See Houck, 1965.)

¹⁰Huang (2007) shows that the estimated own-price elasticity will be less elastic than that implied by the inverse of the estimated by the inverse of the estimated own-price flexibility because the projection of a variable Y on a variable X (as in *OLS*) is not the inverse of a projection of X on Y .

6 Counterfactual equilibrium: Advertising strategy and welfare

In this section, I simulate the counterfactual equilibrium for the case where the regulation caps on advertising quantity are removed in 2014. At equilibrium, each TV channel plays strategically, taking into account the strategic reactions of the other TV channels. It is expected that the advertising quantities of all the TV channels change after the removal of the regulation caps. Even the advertising quantities of TV channels non-binding the regulation caps may change as strategic replays to actions of their competitors for each given time period. The simulation is proceeded by using the method illustrated in section 3.3, combined with estimates of demand, marginal costs and the first order conditions. Given the small estimated values of the “shadow prices” of the regulation constraints λ_{jt} , it is useful to compare the equilibrium outcomes under regulation and under “free-advertising policy” to conclude on the necessity of the regulation.

The counterfactual experiment suggests that, on average, the TV channels advertise more under “free-advertising policy” than under regulation constraints. Yet, the change in advertising quantities of TV channels after the removal of regulation caps are small. The removal of the advertising caps drive up the *average* advertising quantity of public TV channels from 4.240 minutes per hour to 4.282 minutes per hour, and the *average* advertising quantity of private TV channels from 8.493 minutes per hour to 8.693 minutes per hour. On average, a TV channel would broadcast one more advertising spot (30 seconds) every two hours if the regulation caps had been removed in 2014.

The TV channels would advertise more during the day without regulation. However, it seems not optimal for the private (public) TV channels to advertise more than 12 (8) minutes per hour in the evening, whatever there is regulation on advertising quantities. Besides, during some particular hours (1-2 p.m, 5-6 p.m, 7-8 p.m and 9-12 p.m), the TV channels would broadcast more ads under regulation constraints than under “free-advertising policy”.

The feedback loop between TV viewers and advertisers means that an increase in advertising quantities of a TV channel decreases the prices of advertising spots of the channel *directly* by the standard price response to the quantity supplied; and *indirectly*, by affecting negatively the viewership of the TV channels. Formally, the price response to an increase in advertising quantity of a TV channel is given by $\frac{\partial p_{jt}}{\partial A_{jt}} + \frac{\partial p_{jt}}{\partial y_{jt}} \frac{\partial y_{jt}}{\partial A_{jt}}$. Given the strong “network externalities” between TV viewers and advertisers, it is optimal for the TV channels to not broadcast too much ads, but gain from the high

willingness to pay of the advertisers.

Overall, the deregulation on the advertising quantities drives up the average price-cost margins of public TV channels from 39.35% to 41.20%, and the average price-cost margins of private TV channels from 61.19% to 63.46%.

Surplus of TV viewer and revenues of TV channels

The surplus of TV viewers can be computed according to the formula below (McFadden, 1991 and Small and Rosen, 1979):

$$CS = \int -\frac{1}{\alpha_i} \ln[1 + \sum_j \exp(\delta_{jt} + \mu_{jt})] \varphi(V_i) dV_i, \quad (17)$$

where δ_{jt} and μ_{jt} are defined as in section 3.1.

The simulation suggests that the deregulation decreases the surplus of TV viewers by 0.28%. However, the regulation restricts the revenues of TV channels. It is estimated that on average, one TV channel loses 7.11 million euros during a year due to the regulation constraints on advertising quantities. I compared the estimated loss in revenue (due to regulation) to the published total revenue of broadcasting contents of some TV channels in 2014.¹¹ The results suggest that the *eventual* losses represent more than 0.7% of the total broadcasting costs for the TF1 Group, more than 3.7% for the M6 Group, and about 0.2% for the France Télévision.

7 Conclusion

This paper investigates the impact of advertising length caps on TV. The regulation aims at protecting the welfare of TV viewers, limiting their excessive exposure to advertising, and sustaining the diversity of broadcasting contents. However, the broadcast television market differs to many other markets due to its two-sided market nature. The broadcast TV channels are platforms mediated between TV viewers and advertisers. The advertisers value viewership of TV channels, while the TV viewers are estimated to be ad-averse. Moreover, the French broadcast TV market are competitive. There are in total twenty-two channels broadcasting free-to-air. The flexibility of advertising prices is estimated to be equal to 20.8% in this paper. As a consequence, the regulation on advertising quantities go beyond the

¹¹Only three big TV groups (*TF1 Group*, *M6 Group* and *France Télévision*) publish their total expenditures on broadcasting contents, so I don't have this data for all the TV channels. Still, the comparison for these three groups is informative.

expectation of the regulatory authority.

The paper explores the impact of regulation on advertising quantity by carrying out a structural analysis in two-sided market framework. By simulating the counterfactual equilibrium under “free-advertising policy”, the analysis allows to infer how the current French regulatory framework affects the strategic behavior of TV channels, through the interaction between TV viewers and advertisers.

The role of regulation is accounted for in the model by considering the regulation constraints in the TV channels’ profit maximization problem. The difference in estimated marginal costs between binding and non-binding observations allow to identify the “shadow prices” of regulation constraints.

Finally, comparing the observed equilibrium (under regulation) and simulated equilibrium (without regulation), the model predict that the TV channels advertise more without regulation but the impact of regulation caps on TV broadcasters’ strategic decision are small. The welfare analysis suggest that the current regulation framework is not necessary, since it constrained the profit of TV channels without improving *significantly* the welfare of TV viewers.

8 Tables and Figures

Table 1: Summary statistics

Panel 1: hourly-channel					
Variable	Mean	Std. Dev.	Min.	Max.	N
Audience (in millions)	0.547	0.934	0	13.944	74468
Ad prices (per minute)	12.040	25.369	0.004	411.201	74468
Commercial breaks (in minutes)	7.446	3.598	0.100	23.933	74468
Broadcast cost_LF* (in MEUR)	2.481	22.675	0	665.185	74468
Broadcast cost_TFF* (in MEUR)	67.224	163.451	0	1825	74468
Broadcast cost_Docu* (in MEUR)	4.259	20.942	0	352	74468
Broadcast cost_Anim* (in MEUR)	6.421	24.538	0	366.600	74468
Broadcast cost_Conc* (in MEUR)	0.280	3.685	0	213.400	74468
Broadcast cost_Mag* (in MEUR)	5.571	22.259	0	410.600	74468
Panel 2: per hour					
Variable	Mean	Std. Dev.	Min.	Max.	# hours
TV population (in millions)	10.144	6.975	0.515	30.344	8270
Panel 3: annually-media group					
Variable	Mean	Std. Dev.	Min.	Max.	
Employees	4850.824	3936.415	725	10673	
Public funding (in MEUR)	617.194	1073.979	0	2486	

*LF: long film; TFF: theatrical figure film; Docu: documentary;
Anim: animation; Conc: concert; Mag: magazine.*

Table 2: List of program categories

Index	Program categories
01	News_journal
02	News_magazine
03	News_public service
04	News_others
05	Documentary
06	Magazine
07	Long movies
08	Short movies
09	Theatrical figure films
10	Animated programs
11	Series
12	Game shows
13	Music videos
14	Other entertainments
15	Concerts
16	Spots
17	TV shopping
18	Public service announcement
19	Trailers
20	Channel specific programs 1
21	Channel specific programs 2

Table 3: List of TV channels

Channels	Nature	Media Group membership
TF1	commercial	TF1 Group
F2	public	FTV Group
F3	public	FTV Group
M6	commercial	M6 Group
F5	public	FTV Group
D8	commercial	Canal plus Group
RNJ12	commercial	RNJ Group
NT1	commercial	TF1 Group
F4	public	FTV Group
TMC	commercial	TF1 Group
Gulli	commercial	Lagardère Group
D17	commercial	Canal plus Group

Table 4: The variations of ad-prices and -quantities

	Ad-prices		Ad-quantities	
	Mean	Std.Dev.	Mean	Std.Dev.
Jan.	11.966	14.569	6.305	2.137
Feb.	11.702	13.356	6.820	2.297
Mar.	12.142	14.961	6.769	2.259
Apr.	12.081	14.212	7.416	2.108
May	11.977	13.720	7.224	2.090
Jun.	12.418	15.312	7.691	2.292
Jul.	9.194	10.780	7.305	2.352
Aug.	8.666	9.758	6.551	1.904
Sep.	13.258	17.471	8.097	2.519
Oct.	13.240	16.475	8.584	2.241
Nov.	13.790	17.688	8.702	2.268
Dec.	13.726	18.207	7.616	2.174
Annual	12.040	15.041	7.446	2.342

Number_spots in thousands.

Table 5: Demand of TV viewers

	Logit OLS	Logit IV	RC logit Mean	St. Dev.
Quantity of advertising(α)	1.218** (0.502)	-1.679*** (0.201)	-2.666*** (1.081)	1.343*** (0.556)
News_journal(β_1)	0.128 (0.101)	0.167*** (0.011)	-0.053 (0.542)	2.483 (2.201)
News_magazine(β_2)	0.038 (0.057)	0.025** (0.012)	-2.372* (1.349)	3.926*** (1.228)
News_public services(β_3)	-0.037 (0.061)	-0.030*** (0.009)	-0.184*** (0.055)	-0.087 (1.141)
News_others(β_4)	0.967*** (0.178)	1.077*** (0.028)	0.812*** (0.342)	0.578 (1.089)
Documentary(β_5)	-0.122* (0.059)	-0.154*** (0.0112)	-0.020 (0.287)	0.470 (0.996)
Magazine(β_6)	0.072 (0.045)	0.071*** (0.006)	-2.010 (1.535)	3.936** (1.957)
Long movies(β_7)	0.037 (0.063)	0.015 (0.011)	-3.008 (1.995)	4.488*** (1.908)
Short movies(β_8)	-0.217 (0.175)	-0.318** (0.124)	-2.750*** (0.222)	2.991*** (0.240)
Theatrical feature films(β_9)	0.001 (0.057)	0.008 (0.006)	0.187 (0.321)	0.721 (1.090)
Series(β_{11})	0.0745 (0.055)	0.033 (0.021)	-1.072 (0.564)	1.979*** (0.643)
Music video programs(β_{12})	-0.153* (0.084)	-0.143*** (0.009)	-0.290 (0.242)	1,336*** (0,202)
Sport(β_{16})	0.241 (0.146)	0.240*** (0.015)	-2.571*** (1.020)	4.871*** (0.897)
TV_shopping(β_{17})	-0.822*** (0.192)	-0.934*** (0.023)	-1.734*** (0.426)	1.181** (0.577)
Objective function value			0.297	
No. of Observations	74468	74468	74468	
Channel FE	Yes	Yes	Yes	
Hour FE	Yes	Yes	Yes	
Month FE	Yes	Yes	Yes	
Day of the week FE	Yes	Yes	Yes	

Notes: Standard error in parentheses. Significance levels: *** : 0.01, ** :0.05, * : 0.1. The column “St. Dev.” reports the normally distributed random coefficient capturing heterogeneity in the taste for the variable it refers to. Estimates of certain broadcasting programs are not reported, but are available upon request. The estimates of broadcasting programs may be biased due to endogenous broadcasting choice of TV channels.

Table 6: Advertising elasticities of audience by channels (* **CH** denotes channel)

	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH 10	CH 11	CH 12
CH 1	-0.253	0.026	0.013	0.024	0.002	0.008	0.005	0.005	0.002	0.009	0.003	0.004
CH 2	0.076	-0.149	0.017	0.029	0.004	0.009	0.008	0.006	0.001	0.009	0.004	0.004
CH 3	0.052	0.033	-1.152	0.021	0.006	0.019	0.007	0.006	0.003	0.007	0.005	0.003
CH 4	0.079	0.039	0.015	-1.326	0.006	0.013	0.006	0.006	0.002	0.012	0.004	0.004
CH 5	0.056	0.040	0.030	0.034	-1.144	0.028	0.025	0.026	0.004	0.013	0.008	0.007
CH 6	0.063	0.029	0.018	0.033	0.006	-0.396	0.010	0.015	0.004	0.014	0.005	0.006
CH 7	0.074	0.037	0.024	0.028	0.011	0.019	-0.447	0.017	0.005	0.015	0.008	0.006
CH 8	0.063	0.041	0.016	0.030	0.010	0.030	0.018	-0.417	0.003	0.022	0.006	0.009
CH 9	0.091	0.035	0.023	0.037	0.008	0.029	0.021	0.014	-1.199	0.021	0.016	0.003
CH 10	0.062	0.020	0.011	0.026	0.004	0.016	0.007	0.010	0.002	-0.350	0.005	0.006
CH 11	0.078	0.029	0.017	0.031	0.007	0.017	0.015	0.013	0.011	0.016	-0.243	0.007
CH 12	0.078	0.025	0.015	0.031	0.005	0.018	0.010	0.016	0.003	0.009	0.003	-0.469

Table 7: Advertising elasticities of audience by hour (*H denotes hour)

	H 1	H 2	H 3	H 4	H 5	H 6	H 7	H 8	H 9	H 10	H 11	H 12
Own-ad elasticities	-0.264	-0.294	-0.252	-0.260	-0.263		-0.134	-0.176	-0.312	-0.459	-0.260	-0.296
Cross-ad elasticities	0.024	0.023	0.020	0.021	0.022		0.020	0.015	0.020	0.026	0.013	0.018
	H 13	H 14	H 15	H 16	H 17	H 18	H 19	H 20	H 21	H 22	H 23	H 24
Own-ad elasticities	-0.453	-0.366	-0.318	-0.263	-0.241	-0.291	-0.301	-0.436	-0.441	-0.274	-0.243	-0.279
Cross-ad elasticities	0.031	0.018	0.018	0.016	0.013	0.016	0.015	0.025	0.028	0.016	0.015	0.018

Table 8: Advertising elasticities of audience by month (*M denotes month)

	M 1	M 2	M 3	M 4	M 5	M 6	M 7	M 8	M 9	M 10	M 11	M 12
Own-ad elasticities	-0.265	-0.283	-0.265	-0.298	-0.298	-0.343	-0.318	-0.277	-0.354	-0.359	-0.367	-0.313
Cross-ad elasticities	0.019	0.018	0.018	0.019	0.021	0.020	0.018	0.022	0.021	0.021	0.018	

Table 9: Demand of advertisers by Raysman approach

	OLS	IV
Log(Quantity of advertising)(θ)	0.0777* (0.00396)	-0.208*** (0.0183)
Log(Audience)(γ)	0.638*** (0.00364)	1.077*** (0.0123)
No. of Observations	75376	75376
F-Statistic	8332.35***	2792.92***
<i>t</i> statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$		
Kleibergen-Paap rk LM statistic (<i>p-value</i>)		0.0000
Cragg-Donald Wald F statistic		40.184

Note: The dependent variable is log spot price of advertising (see Equation 7). The robustness correction is applied to the estimation so that the standard errors are robust to the presence of arbitrary heteroskedasticity. The channel-fixed effects, dummies for months, hours of the day and the days of the week are included in the regressions. Their estimates are not reported but are available upon request. All of these coefficients are significant.

Table 10: Price-cost margins per hour (*H denotes hour)

	H 1	H 2	H 3	H 4	H 5	H 6	H 7	H 8	H 9	H 10	H 11	H 12
Price-cost margins	51.0%	55.7%	52.0%	54.8%	49.2%		37.2%	40.5%	56.5%	72.9%	50.1%	53.6%
	H 13	H 14	H 15	H 16	H 17	H 18	H 19	H 20	H 21	H 22	H 23	H 24
Price-cost margins	73.8%	62.6%	57.6%	51.9%	43.8%	54.4%	53.1%	70.2%	65.0%	51.2%	46.9%	51.6%

Table 11: Price-cost margins per channels (*CH denotes channel)

	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH 10	CH 11	CH 12
Price-cost margins	49.7%	36.2%	36.2%	52.6%	41.2%	64.8%	69.0%	71.2%	45.0%	65.3%	46.7%	71.1%

Figure 1: Audience shares

Figure 2: Ad quantities

Figure 3: Ad prices

Figure 4: Distribution of advertising quantities by TV channel *and* by hour

Figure 5: Counterfactual equilibrium level of ad quantities by TV channel

Figure 6: Counterfactual equilibrium level of ad prices by TV channel

Figure 7: Counterfactual equilibrium level of audience shares by TV channel

Figure 8: Counterfactual equilibrium level of ad quantities by hour

Figure 9: Counterfactual equilibrium level of ad prices by hour

Figure 10: Counterfactual equilibrium level of audience shares by hour

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