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Platform Mergers: Lessons from a Case in the Digital TV Market

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JEL Classification: K21, L10, L40, L82, M37

Keywords: two-sided market, platform merger, advertising, TV market, competition policy

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Marc Ivaldi[†] Jiekai Zhang[‡]

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1 Introduction

Competition authorities have been particularly concerned in recent years by the behavior of dominant firms in two-sided markets, which provide services on one side but generate revenues on the other, in a way that could harm the interest of consumers.[1] In the internet industry, users search the web free of charge, but trigger advertisements which generate revenues for the firms that supply the search engines. Similarly, in the digital TV market, when viewers watch a program for free, they receive a flow of advertisements that generate revenues for the TV channels. Dominant firms in these markets often provide better services than their rivals without charging an extra monetary price to their users. In this way, the dominant firms retain more users, which, in turn, increases their attractiveness in the advertising market. While consumers enjoy a free service from these firms, they may be overwhelmed by the amount of advertising. This can be even more problematic when the dominant media companies get bigger by acquiring smaller competitors. On the one hand, the dominant firms can offer better services by expanding their customer base, which allows them to show more advertisements (as a non-monetary price) to their users. On the other hand, the acquisition can increase the market power of the merging firms in the TV advertising market, which allows them to charge higher prices to the advertisers.

This paper studies this situation by providing a structural analysis of the acquisition of two new entrants in the French digital TV market, namely, channels NT1 and TMC, by a big media holding company, the TF1 Group. We observe a unique situation in which the French competition authority approved the merger of the broadcasting services of the two purchased channels with those of the acquiring company but blocked the merger of their advertising sales houses (ASHs herein).[2] In practice, the competition authority imposed a behavioral remedy which requires that the ASH of NT1 and TMC remain separate from that of the main channel of the TF1 Group, namely, channel TF1.[3] In this decision, the authority wished to improve the broadcasting quality of the two purchased channels without generating detrimental effects for the advertising market.[4] Its expectation was to enhance competition for viewers among TV broadcasters without reducing competition in the TV advertising market.

While the competition authority's examinations of both the broadcasting and advertising sides of the market were straightforward, its decision nevertheless treated the channels' advertising services separately from their broadcasting services. We show here that ignoring the interaction between the two sides of the market can result in unexpected outcomes.

Using a comprehensive dataset on the French digital TV market, covering two years of the pre-acquisition period and three years of the post-acquisition period, we first provide reduced-form evidence that the French TV market is a two-sided market. In other words, we show that cross-side network externalities between viewers and advertisers do exist. Based on the assumption that TV channels are two-sided platforms, we then build a structural model which describes the demand functions of TV viewers and advertisers as well as the objective of the ASHs.

TV viewers' preferences between different channels are approximated by a nested logit model. Thanks to data about the genres of broadcasting content, we take care to solve the endogeneity issues related to this type of model. Our estimates of demand elasticities with respect to the amount of advertising indicate a 10 percent increase in advertising time causes a mean audience loss of about 10.55 percent for a private TV station, suggesting that the negative externalities that

[1]See for instance the European Commission decision of March 2019 to fine Google 1.49 billion euros for abusive practices in online advertising.

[2]An ASH handles and sells the advertising time available on the TV stations that it works for.

[3]Note that NT1 and TMC were co-owned by AB Group before being acquired by TF1 Group. The sales of their advertising slots were already managed by one common ASH before TF1 Group acquired it.

[4]More details about the merger decision are provided in Section 5 of the paper.

advertisers generate for TV viewers are not negligible.

Our novel approach to model the demand of advertisers considers their multi-homing behavior and allows us to estimate, using aggregated advertising data, whether a channel is a substitute or complement to another channel for advertisers.[5] In more detail, we model the advertisers' objective as one that minimizes the total advertising costs which generate the desired audience, and estimate the advertisers' cost function approximated by a translog model. We find that the advertisers consider the two purchased channels (NT1 and TMC) as substitutes, but both as complements of channel TF1. This demand pattern of advertisers implies that merging the ASHs of the three channels would not result in a significant increase in the price of advertising.

Based on the estimates of the model parameters, we evaluate the consequences of the acquisition. Using post-acquisition data, we first show that merging the broadcasting services of TV channels has consequences for their equilibrium amounts and prices of advertising. While the joint management of broadcasting services improves the broadcasting quality of the merging channels, it also increases the value (and therefore the prices) of their advertising slots. At equilibrium, the negative externalities that advertisers generate for viewers incentivize the ASHs to increase the amount of advertising following an increase in TV channels' broadcasting quality. Welfare analysis further suggests that the total surplus of TV viewers has decreased post-acquisition, meaning that the positive effects of the increase in broadcasting quality on the viewers' surplus are not sufficiently large to outweigh the associated detrimental effects of the increase in the amount of advertising. Overall, the approved merger harms consumers (both viewers and advertisers) but benefits the TV stations.

To gain an insight into the potential consequences of merging the ASHs of the three channels, compared to the observed situation under the remedy of keeping them separated, we simulate the equilibrium amount of advertising and its price for the case in which the advertising time of NT1, TMC and TF1 is chosen and sold by one common ASH. The results show that merging the ASHs of the three channels would only slightly increase their total advertising, due to the small substitution effect of advertising on the viewers' side, and would have almost no impact on the price of advertising, since the slots of the two merged ASHs are complements for advertisers. Moreover, welfare analysis confirms that the implemented behavioral remedy is ineffective once the merger on the broadcasting side has been approved.

This paper first contributes to the relatively limited empirical literature on two-sided markets. Beginning with the seminal articles of Rochet and Tirole (2003) and Armstrong (2006), theoretical papers have addressed TV advertising competition by considering the amount of advertising as a nuisance to TV viewers (e.g., Anderson and Coate, 2005; Cunningham and Alexander, 2004; Nilssen and Sørgard, 2000). In practice, very few empirical papers have estimated viewers' demand elasticities with respect to the amount of advertising. Wilbur (2008) finds TV viewers dislike advertising. A similar attitude of viewers towards advertising has also been found in the radio and newspaper industries. (See Jeziorski, 2014a; Ivaldi and Muller, 2018.) However, empirical studies have also found audiences appreciating advertising in yellow pages and magazines. (See Rysman, 2004; Kaiser and Wright, 2006; Ivaldi and Muller, 2018.) Here, identifying the sign of the network externalities that the advertisers generate for viewers is crucial, as it impacts the strategic behavior of the ASHs in the advertising market. If viewers dislike advertising and switch channels during the advertisements, the ASHs would restrict the amount of advertising on TV to avoid losing viewers, but would increase the amount of advertising on a TV channel following an increase in its broadcasting quality. In our estimates, we find a statistically significant disutility of advertising to TV viewers.

[5] We thank the Editor for pointing out the critical role of the substitutability and complementarity among TV channels in the analysis of equilibrium outcomes of our model.

This paper also contributes to the extensive literature on mergers. Post-merger analysis has been adopted to evaluate the effectiveness of competition policy in numerous industries, such as airlines (Borenstein, 1990; Kim and Singal, 1993), banking (Facacelli and Panetta, 2003), petroleum (Hastings, 2004; Gilbert and Hastings, 2005; Hosken, Silvia, and Taylor, 2011), and appliances (Ashenfelter, Hosken, and Weinberg, 2013). Ashenfelter and Hosken (2010) assess mergers in five different branded-goods industries. Björnerstedt and Verboven (2015) evaluate the performance of merger simulations in the Swedish analgesics market. In line with the previous literature, we evaluate the ex-post consequences of an approved acquisition under behavioral remedy in the digital TV market. Our structural analysis is related to another branch of the merger literature that quantifies the welfare effects of mergers. Examples of such articles include Baker and Bresnahan (1985), Hausman *et al.* (1994), Werden and Froeb (1994), and Nevo (2000), among others.

More recent literature has addressed the issue that the merger may change the firms' product positioning (Gandi *et al.*, 2008) and/or impact the quality of product offered at equilibrium (Chen and Gayle, 2019). Gandi *et al.* (2008) show that the product repositioning has consequences for the pricing decisions of firms. Mazzeo *et al.* (2018) find that the product-offering adjustment results in additional effects on profitability and consumer welfare that are not realized by price responses alone. Li *et al.* (2020) highlight that ignoring the potential changes in product offering may bias the merger evaluation.

Sweeting (2010) has initially studied this topic in detail in the context of two-sided media markets. Fan (2013) develops a model which endogenizes the choice of characteristics and shows that ignoring adjustments of product characteristics causes substantial differences in the estimated effects of mergers. Jeziorski (2014a) decomposes the changes in consumer surplus into product repositioning effects and advertising quantity readjustment effects, and shows that the product repositioning effect of a merger improves consumer surplus but the resulting advertising readjustment reduces it. In the same vein, combining ex-ante and ex-post data, we show that the post-merger changes in product quality impact market pricing and welfare. Our data are not sufficiently disaggregated to allow us to study the repositioning of products after the merger. However, we demonstrate the key role of the quality of broadcasting services, alongside that of two-sided network externalities, in determining the magnitude of the impact of the merger.

In an article related to this strand of literature, Gentzkow, Shapiro and Sinkinson (2014) study the competitive forces which shaped ideological diversity in the US press. Their results highlight that optimal competition policy must account for the two-sidedness of the news market. Similarly, we take advantage of our relatively detailed advertising data to provide evidence that when TV channels increase their broadcasting quality, they also raise the amount of advertising for viewers and the prices of advertising for advertisers, in response to the cross-side network externalities between viewers and advertisers. In other words, the two-sidedness of the digital TV market cannot be ignored.[6]

The remainder of this paper is structured as follows. In Section 2, we present the French digital TV market. In Section 3, we model the demand of TV viewers and of advertisers. The demand estimates are presented in Section 4. We carry out the merger evaluation in Section 5 and conclude in Section 6.

[6] In the context of this paper, the amount of advertising can be viewed as a price that TV stations charge their viewers.

2 The French digital TV market

2.1 Data

The Conseil supérieur de l'audiovisuel (the French audiovisual regulator, CSA herein), has made available to us the monthly audience and advertising data of 12 major broadcast TV stations in France from March 2008 to December 2013. The sample is representative of the French TV market: The total audience share of the 12 stations exceeds 95 percent of the free-broadcast TV market and 79 percent of the whole TV market including pay TV; the total advertising revenue share of the 12 stations exceeds 90 percent of the free-broadcast TV market and 81 percent of the whole TV market. The list of the 12 TV stations is provided in Table 1. All 12 TV stations are generalist, broadcasting a wide range of programs. The incumbent channels have been broadcasting since 1950, while the new channels entered the market in 2005. The three channels involved in the acquisition (as mentioned in the Introduction) are highlighted in bold.

Table 1: List of TV channels and their ownership since 2010

	Channels	Nature	Media Group membership
Incumbents	**TF1**	**private**	**TF1 Group**
	M6	private	M6 Group
	FR2	public	FTV Group
	FR3	public	FTV Group
	FR5	public	FTV Group
New entrants	**NT1**	**private**	**TF1 Group**
	TMC	**private**	**TF1 Group**
	W9	private	M6 Group
	FR4	public	FTV Group
	D17	private	Canal plus Group
	D8	private	Canal plus Group
	Gulli	private	Lagardère Group

The audience data come originally from Médiamétrie, which builds a measure of audience by recording the television usage every second by a panel of households equipped with one or more TV sets in their main residence.[7] From these raw data, we derive our monthly measure of audience as a weighted average of viewers per second in a month.[8]

The advertising data – more precisely, the gross advertising revenues and the number of advertising seconds – come from Kantar Media. Using this information, we estimate the monthly average advertising price per second by dividing each channel's gross advertising revenues by the

[7] This panel has been built to account for both the socio-demographic characteristics of households in metropolitan France and the structure of the television supply. It is made up of nearly 4,300 households, which corresponds to approximately 10,500 individuals aged 4 and over. In each home, Médiamétrie installs one or more audimeters (depending on how many pieces of equipment there are) 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. (See http://www.mediametrie.fr.)

[8] In practice, the number of viewers of channel j in month t, y_{jt} used in the model later, is defined as follows. Médiamétrie measures the number of viewers of channel j at each second s. Assuming there are 30 days in month t (so in all, 2,592,000 seconds in the month), the monthly average number of viewers of channel j, y_{jt}, is equal to $\frac{\sum_s^{2592000} y_{js}}{2592000}$, where y_{js} denotes the total number of viewers of channel j at second s. In other words, y_{jt} denotes the average number of viewers per second of channel j in month t.

number of seconds of advertising in the month. This is the price that the ASHs charge advertisers in our model.

Table 2 presents summary statistics of the main variables in our analysis. The total number of TV viewers per channel per second is on average equal to 3.84 thousand. A TV channel broadcasts on average 56 hours (i.e., roughly 0.2 million seconds) of advertising per month. The average advertising price is 5.96 euros per second. These three main variables are measured at the monthly level for each channel.

Table 2: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max
Number of TV viewers (in thousands)	3.84	4.14	2.86	16.03
Number of seconds of advertising (in millions)	0.20	0.09	0.03	0.44
Advertising price per second (in thousands)	5.96	8.01	0.42	35.95

Note: The total number of observations is 840, which amounts to 70 monthly observations per TV channel. Source: Médiamétrie & Kantar Media.

In addition to the above data provided by the CSA, Médiamétrie supplied us with complementary information on the broadcasting content of the 12 TV stations in our sample. In more detail, we observe the monthly broadcasting hours of six major genres of TV shows per channel per month during the period of study (i.e., 2008–2013). Summary statistics on the broadcasting of the six program genres are provided in Table 3. TV series/movies, culture/science, and entertainment are the most broadcast genres, which occupy more than 70 percent of the broadcasting time of each TV station. The broadcasting of news varies significantly from channel to channel: The new entrants such as Gulli and D17 do not show any news. Sports and cartoons occupy relatively small shares of the total broadcasting time of the 12 generalist TV stations in our sample; in particular, FR5 and TMC do not show sports, while D8 and W9 do not show cartoons.

Table 3: Monthly broadcasting hours of different genres

Genre	Unit	Level	Man	Stv.	Min.	Max
TV Series/Movies	hours	channel/month	283.85	157.30	16.78	696.00
Culture/Science	hours	channel/month	153.23	156.77	2.70	711.45
Entertainment	hours	channel/month	123.41	137.39	0	692.67
News	hours	channel/month	52.31	53.66	0	214.47
Sports	hours	channel/month	14.31	19.45	0	166.80
Cartoons	hours	channel/month	1.30	2.35	0	21.13

Source: Médiamétrie

2.2 Market structure

TV stations could be considered as two-sided market platforms connecting viewers to advertisers. They provide two services: TV shows to viewers on one side, and advertising slots to advertisers on the other. While viewers enjoy the news and entertainment content on TV, they receive the flow of advertising. When TV viewers see the advertisements, this generates an audience for the advertisers. TV viewers may, however, be sensitive to the amount of advertising, in which case the advertisers generate externalities for the TV viewers. Advertisers value TV advertising for its ability to inform and/or persuade viewers of the merits of products or services they have to commercialize. Therefore, a priori, the more popular a TV channel is among viewers, the more demanded it is by advertisers. Our empirical analysis below provides evidence on the sign and the magnitude of these externalities between the two sides of TV stations.

Advertisers buy the advertising slots of TV channels from the advertising sales houses (ASHs), whose role is to handle and sell the advertising time available on different TV stations. The ASHs charge advertisers a price per second of advertising that warrants a certain level of audience. The advertisers' objective is then to minimize their total advertising costs by combining the advertising slots on several TV channels in order to achieve a certain overall reach of audience. In other words, the advertisers practice multi-homing strategies.

TV programming is decided by the TV channels several months in advance. Based on the broadcasting content provided by the TV channel, each ASH determines its optimal supply of advertising slots. The amount of advertising of a broadcast TV station is, however, subject to two regulation caps enforced by the French law, at the hourly and daily average levels.[9] In Table A1 in Appendix A, we compare the effective amount of advertising to the maximum minutes of advertisements per month allowed for each TV station (calculated based on the daily average level of the regulation cap); we note that the observed advertising time of different TV channels is well below the regulatory ceilings.[10,11] The ASHs behave as Cournot-type firms, since they adjust the amount of advertising according to the quality of the TV program and the sensitivity of viewers to the amount of advertising. At equilibrium, each ASH's objective is to determine the optimal amount of advertising on each channel under its management to maximize the sum of its profits from all of these channels.[12]

Unlike pay TV channels, which charge subscription fees to their viewers, free-broadcast TV stations only require their viewers to bear the advertising. While the pay TV stations play an important role in the U.S. TV market, they are much less common in France. Although there were between 184 and 207 pay TV channels available in the French TV market during the observation period, neither their total audience share nor their total advertising revenue share exceeds 10 percent.[13] In addition, most of the pay TV channels specialize in one theme and target a specific audience (children, young women, etc.), while the 12 major free-broadcast TV stations included in our study are generalist TV channels which aim to serve a wide audience. We group all the pay TV channels into an outside option of our model because the statistics on the audience share of an individual pay TV channel are not available, due to their negligible share of the market.

[9] The average time per hour per day devoted to advertising must not exceed six minutes for public TV channels, nine minutes for the incumbent private channels, and 12 minutes during the first seven years of broadcasting for the new channels launched in 2005. Moreover, the advertising time cannot exceed 12 minutes within any given clock hour for private TV broadcasters and eight minutes for public TV broadcasters.

[10] As we use monthly data in this paper, we computed the maximum minutes of advertisements per month allowed for each TV station from its daily average level of regulation cap imposed by the regulator: The maximum minutes of advertisements allowed for channel j in month t is equal to the maximum minutes of advertisements per day allowed for channel j in month t multiplied by the number of days in month t.

[11] Regulatory constraints at the hourly level can be binding during prime time, though our monthly aggregate data does not allow us to explore this. Crawford *et al.* (2017) and Zhang (2019) have studied this issue in detail.

[12] As long as TV channels comply with legal regulations regarding the maximum amount of advertising per hour and per day, the ASHs have full flexibility to adjust the length of advertising breaks and the number of advert slots within each hour and within each day.

[13] See for instance the publication of CSA: `https://www.csa.fr/Informer/Collections-du-CSA/Panorama-Toutes-les-etudes-liees-a-l-ecosysteme-audiovisuel/Les-chiffres-cles/Les-chiffres-cles-de-l-audiovisuel-francais-Edition-du-2nd-semestre-2013`

2.3 Relation between advertising and TV viewership

If the broadcast TV market is a two-sided market, there are two elements that could support this view: The relation between the amount of advertising and the number of viewers; and the relation between the number of viewers and the advertising spending. For an industrial organization to be considered as a two-sided market, we must identify the externalities between the consumers on the two sides, which are here the viewers and the advertisers.

As the cross-side externalities among these consumers could play a crucial role in the evaluation of the merger decision that we investigate in this paper, we perform a descriptive analysis to gain insight into the existence and the sign of those externalities, and to show that there is sufficient variation in our data to identify the structural parameters that we estimate below.

Relation between amount of advertising and viewership

To understand whether the amount of advertising has a significant effect on the viewership of TV channels, and the direction of such an effect, we regress the *number of viewers* on the *number of seconds of advertising*, controlling for the broadcasting hours of different program genres and the channel-, month-, and year-fixed effects. The OLS results presented in the second column of Table 4 indicate that a higher viewership is associated with a higher amount of advertising, which is counterintuitive.

The number of advertising seconds is likely to be endogenous, however, because the error term contains unobserved characteristics of channel-time-genre specific program quality, which are correlated with the amount of advertising. We therefore re-estimate the same equation using BLP IVs, namely, the sum of broadcasting hours of news and entertainment programs of the competing channels during the same months. In contrast to the OLS results, we now find a negative correlation between the amount of advertising and the viewership of a TV station, as shown in the third column of Table 4.

Table 4: Relation between amount of advertising and viewership

	Number of viewers (y_{jt})	
	OLS	IV
Amount of advertising	0.138***	−0.269*
	(0.027)	(0.140)
Program characteristics	Yes	Yes
Channel FE	Yes	Yes
Month FE	Yes	Yes
Year FE	Yes	Yes
No. observations	840	840
Cragg–Donald Wald F statistic		10.36
Hansen J statistic (p-value)		0.298

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

Relation between viewership and advertising spending

Another important element which characterizes the broadcast TV market as a two-sided market platform is the occurrence of network externalities that viewers generate for advertisers. Intuitively, advertisers' willingness to pay should be higher for the advertising seconds of a channel which attracts more viewers. Accordingly, we should expect higher advertising spending on the advert seconds with more viewers.

To illustrate this, we present a binned scatterplot of the relation between the *number of viewers per second* and its corresponding advertising spending, i.e., the *per second advert price* defined in Section 2.1, controlling for channel-, month- and year-fixed effects.[14] The result is presented in Figure 1. Note that a higher viewership is associated with higher advertising spending, meaning that the TV viewers generate positive network externalities for the advertisers. Moreover, it suggests that there are network-effect advantages to having a broader audience in the sense that an advertising second is more valuable (expensive) when it is seen by more viewers.

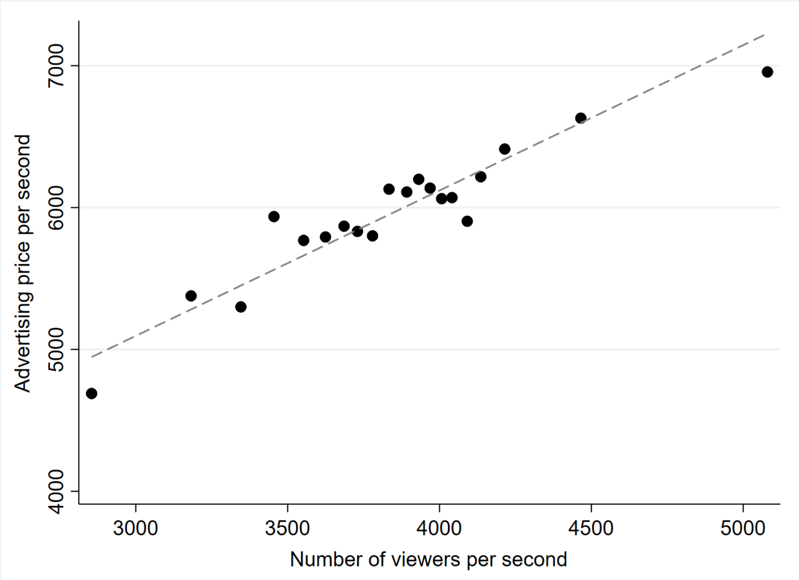

Figure 1: Relation between TV viewership and advertising price

3 Demand model

We now present our structural model for the demand of TV viewers and advertisers. We explain here the motivation behind the choice of our specification. Then, in the next section, we discuss the estimation results for these models.

3.1 Viewers' demand

We specify the viewers' demand using a nested-logit model, which classifies the choices of the TV viewers into g groups (or nests) and an additional group for the outside goods. As it is well known, one of the main properties of this model is that choices within the same group are closer substitutes than choices from different groups (see Berry, 1994). The categorization of groups is motivated by the following considerations.

Our sample includes 12 major broadcast TV stations: five incumbent channels and seven new entrants. We categorize the incumbent channels and the new entrants into two different groups to take into account their different brand awareness, type of content, and quality. The seven new entrants do not enjoy the same market position as the five incumbent channels: The audience shares of the new channels are remarkably lower than those of the incumbents. (See Table A2 in Appendix A for detailed statistics.)

[14]We thank an anonymous referee for suggesting this representation of the data.

Three elements explain this difference. First, the incumbent channels and new entrants do not have the same brand awareness, simply because they entered the market at different times. The incumbent channels have been broadcasting since 1950, while the seven new channels entered the market in 2005. The new entrants also required a new reception technology, which was only adopted gradually by the French households between 2005 and 2013.

Second, the broadcasting content on the incumbent channels has a different focus and quality from that on the new channels. Although all of the 12 TV stations in our sample show a wide range of genres of programs, the incumbent channels devote relatively more time to news and culture/science, while the new channels show more TV series/movies.[15] The incumbent channels offer better quality of sports events and entertainment programs than the new entrants: Only the incumbent channels can afford the cost of broadcasting popular sports events such as the Champions League, the Olympic Games, and expensive live shows such as *The Voice*.

Third, a French law requires the free-broadcast TV stations to show at least 40 percent of French audiovisual programs per day. The incumbent channels must fulfill this obligation in the evening, from 18:00 to 23:00, while the new entrants have the whole day to carry out the same obligation.

Instead of choosing one of the channels in our sample, viewers can select the outside option (corresponding to group 0) which consists of either watching one of the remaining free or pay TV channels (for which we have no individual data due to their very small audience) or engaging in activities other than watching TV.

The nested logit model allows for the incumbent TV channels to be considered as closer substitutes for each other than for the new channels. It also allows for the probability that a representative viewer chooses an incumbent channel to be higher than the probability of choosing a new channel, which is consistent with their respective audience shares and with the higher reputation and quality of incumbent channels compared to the new channels.

Formally, in each period t, the indirect utility of consumer i from watching channel j, belonging to the group g (incumbent, entrant or outside good), is given by:

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

where δ_{jt} denotes the mean utility level of TV viewers from watching channel j or choosing the outside good at time t and ζ^i_{jgt} denotes the departure of consumer i's preference from the common utility level.[16] We define:

$$\delta_{jt} = q_{jt} + \alpha A_{jt}, \tag{2}$$

where q_{jt} denotes the perceived quality of channel j in period t and A_{jt} denotes the amount of advertising. We model the quality by $q_{jt} = X_{jt}\beta + \xi_{jt}$, where ξ_{jt} is a random term capturing the unobserved quality of channel j in period t and X_{jt} is a matrix of variables including observed content characteristics, channel-fixed effects, as well as month- and year-fixed effects. The observed content characteristics are broadcasting hours of TV series/movies, entertainment, news, culture/science, sports and cartoons, capturing the observable channel-time specific broadcasting quality. Channel dummies capture the brand awareness of each individual TV station; year dummies capture the potential changes in policy, fluctuations of the economic climate and the generalization of the digital TV technology; month dummies capture the seasonality of TV viewing.

[15] See Figure A.1 in Appendix A for the distribution of different genres of program on incumbent and new entrant channels.

[16] Recall that we observe the monthly average number of viewers per channel per second, computed from the per second measurement by Médiamétrie. (See footnote 8.) We assume that a viewer chooses one channel to watch in a given second, but we only observe the average number of viewers per second for each channel in a given month.

We also specify the error term ζ^i_{jgt} in Equation (1), which reflects individual deviations from the mean valuation, as a weighted sum of two unobserved variables ε^i_{gt} and ε^i_{jt} given by:

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

The term ε^i_{gt} affects the individual i's preferences common to all channels belonging to group g, and the term $(1-\sigma)\varepsilon^i_{jt}$ affects the individual i's preferences specific to channel j. The two terms ε^i_{gt} and ε^i_{jt} are distributed in such a way that the individual preferences have an extreme value distribution and are allowed to be correlated across channels j. (See MacFadden *et al.*, 1978 and Williams, 1977.)

The parameters of interest to be estimated are α and σ. The parameter α denotes the mean preference of TV viewers for advertising: A positive (negative) value of α suggests that viewers value (disvalue, respectively) advertisements. We let the data decide the sign of α at the estimation stage. Moreover, a statistically significant α would confirm the two-sided nature of the TV market and is hence a crucial element of our structural estimation.

The parameter $\sigma \in [0,1)$ defines the substitutability of TV channels belonging to the same group. As σ approaches one, the TV viewers substitute significantly between channels within the same group g; as σ decreases, the correlation of preferences for channels within the same group decreases. Typically, $\sigma = 0$ signifies that the TV viewers are equally likely to switch between channels of different categories as between channels in the same group.

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

$$ln(\mathfrak{s}_{jt}) = X_{jt}\beta + \alpha A_{jt} + \sigma ln(\mathfrak{s}_{jt/g}) + ln(\mathfrak{s}_{0t}) + \xi_{jt}, \tag{4}$$

where $\mathfrak{s}_{jt}$ (respectively, $\mathfrak{s}_{0t}$) is the probability that an individual chooses to watch channel j (respectively, to take the outside option) at time t. The probability $\mathfrak{s}_{jt}$ is decomposed as the product of two probabilities: the probability $\mathfrak{s}_{jt/g}$ of watching channel j given that channel j belongs to group g and the probability $\mathfrak{s}_{gt}$ that an individual chooses to watch channels of group g. The difference in brand awareness between incumbents and new entrants implies that the probability of choosing an incumbent channel is greater than the probability of choosing a new entrant. As we pass over the representative TV viewers, the choice probabilities $\mathfrak{s}_{jt}$, $\mathfrak{s}_{jt/g}$, $\mathfrak{s}_{0t}$ coincide at the aggregate level with the market share of channel j s_{jt}, the market share of channel j within its group $s_{jt/g}$ and the market shares of the outside goods s_{0t}, respectively.

If T_t is the market size at time t, and if y_{jt} is the number of TV viewers watching channel j, the audience share of channel j and its audience share within its group are given by: $s_{jt} = y_{jt}/T_t$ and $s_{jt|g} = s_{jt}\Big/\sum_{j\in C_g} s_{jt}$, respectively, where C_g is the set of TV channels in group g. The audience share of the outside good is obtained as $s_{0t} = 1 - \sum_j s_{jt}$.[17]

From Equation (4), we write the number of viewers as $y_{jt} = s_{jt}T_t \equiv y_{jt}(\mathbf{A}_t)$, where $\mathbf{A}_t = \{A_{1t}, \ldots, A_{jt}, \ldots, A_{Jt}\}$ is the vector of amounts of advertising for each channel. Then, the TV viewers' demand function to be estimated is given by:

$$\ln s_{jt} - \ln s_{0t} = \alpha A_{jt} + \sigma \ln s_{jt/g} + X_{jt}\beta + \xi_{jt}. \tag{5}$$

Identification

Since the error term ξ_{jt} might include the unobserved programming quality of channel j that might be correlated with the conditional market share $s_{jt/g}$ and the amount of advertising A_{jt}, Equation (5) entails two identification problems.

[17] In the empirical part, the market size T_t is considered to be the total population of France.

Conceptually, observing the viewers' switching between channels within the same group (i.e., incumbent, entrant, or outside channels) over time should allow identifying σ, as it involves changes in the conditional probabilities of choosing the same group. These variations can be either the result of changes in the channels' programming quality or the result of changes in the number of channels operating in the market. There is, however, a potential endogeneity problem if viewers switch from a channel because of some unobserved changes in the programming quality of the TV channel. In Equation (5), when ξ_{jt} is high, the market share s_{jt} is high, but the conditional market share, $s_{jt/g}$, is also high, not only because of viewers' switching from channels of the same group but also because of some viewers that have switched from channels of other categories. For instance, when an incumbent TV channel j increases the quality of its broadcasting content during period t, it attracts additional viewers both from other incumbent channels and from the new channels. We do not observe this change in the quality of channel j, which is captured by ξ_{jt}; however, we observe an increase in its market share s_{jt} and its conditional market share $s_{jt/g}$. As a consequence, the estimate of σ could be biased upwards unless $s_{jt/g}$ is properly instrumented for.

Some information regarding the quality/attractiveness of content included in the error term ξ_{jt} might be revealed to, or observed by, the ASHs after the content has been produced and received by the TV channels. If the ASHs make use of this information to determine the optimal amount of advertising A_{jt}, this variable becomes endogenous in our model. Without controlling for the potential endogeneity problem with A_{jt}, the estimate of α would be biased either upward or downward.

We use the following BLP-style instrumental variables to address above endogeneity issues: monthly broadcasting hours of news and entertainment of all competing channels, as well as monthly broadcasting hours of news and entertainment of all competing channels in a group (incumbent or entrant). Note that the channels which share a common ownership with the instrumented channel are not considered as competing channels in our IV construction.

The validity of this set of instruments relies on an assumption commonly used in the literature of logit-type demand estimation: Channels do not observe the error term ξ_{jt} until after they have selected the content X_{jt}; therefore, content selection does not depend on the unobserved characteristics included in ξ_{jt}.[18] This timing is realistic and based on facts. In general, TV channels obtain the broadcasting rights of a show via a contract with its producer, which requires a commitment to broadcast even when the program is still at the production stage. Experts in the industry have confirmed to us that broadcasting content is decided at least three months prior to the broadcasting time.

3.2 Advertisers' demand

The literature on two-sided media markets has modelled advertisers' demand by their inverse demand curve relating the price of advertising to the amount of advertising and size of the audience. (See, among others, Rysman, 2004; Argentesi and Filistrucchi, 2007; Wilbur, 2008; Fan, 2013; Berry, Eizenberg, and Waldfogel, 2016.) While this approach can provide the elasticity of advertisers' inverse demand, it does not explicitly model the substitutability or complementarity between the advertising slots of different TV channels. Since cross-substitution of channels by advertisers can incentivize the ASHs to increase advertising prices via a merger, ignoring the substitutability and/or complementarity between the advertising slots of the TV channels could bias the results of the merger analysis that we carry out below. We propose a demand model which takes into

[18] Similar timing assumption is made in, for example, Jeziorski (2014a and 2014b).

account the advertisers' multi-homing behavior and allows us to estimate, from the aggregated advertising data, the cross-elasticities between the advertising slots of different TV channels.

To reach a wide range of TV viewers, advertisers place the same advertisements on different TV channels. The advertisers book an amount of advertising A_{jt} from channel j and expect it could reach out to a minimum number of viewers y_{jt}. This activity comes at a cost. Let p_{jt} denote the price per second of advertising that the ASHs charge to advertisers. A representative advertiser's problem consists of choosing the vector of amounts of advertising $\mathbf{A_t} = (A_{1t}, ..., A_{Jt})$ that minimizes the total costs C_t of achieving the desired overall reach of audience, $Y_t = \sum_j^J y_{jt}$.[19,20] The associated cost function of the advertiser is defined as:

$$C_t = C(\mathbf{p_t}, Y_t) = \left\{ \min_{A_{1t},...,A_{Jt}} \sum_j p_{jt} \times A_{jt} | \mathcal{F}(A_{1t}, ..., A_{Jt}) \geq Y_t \right\}, \tag{6}$$

where $\mathbf{p_t} = (p_{1t}, ..., p_{Jt})$ and $\mathcal{F}(A_{1t}, ..., A_{Jt})$ is the production function of the representative advertiser.[21]

We assume that this cost function can be approximated by a translog flexible form as:[22]

$$\begin{aligned} \ln C_t = \gamma_0 + \gamma_y \ln Y_t + \frac{1}{2}\gamma_{yy}(\ln Y_t)^2 + \sum_j^J \gamma_j \ln p_{jt} + \frac{1}{2}\sum_i^J \sum_j^J \gamma_{ij}(\ln p_{it})(\ln p_{jt}) \\ + \sum_j^J \theta_j (\ln Y_t)(\ln p_{jt}) + \sum_j^J \xi_{jt}^A \ln p_{jt}, \end{aligned} \tag{7}$$

where ξ_{jt}^A denotes the error term. Taking the derivative of Equation (7) with respect to $\ln p_{jt}$ and applying Shephard's lemma yields the cost share equations for each TV channel j:[23]

$$S_{jt}^A = \gamma_j + \sum_i^J \gamma_{ij}(\ln p_{it}) + \theta_j(\ln Y_t) + \xi_{jt}^A \tag{8}$$

[19] We implicitly assume that the desired number of viewers is the observed number of viewers. This assumption is based on the fact that a contract between an advertiser and an ASH often specifies the cost of an advertising campaign to be a function of the effective amount of advertising seconds which, in turn, determines the overall reach in audience. In any case, it should be satisfied at equilibrium. Note that the property of linear homogeneity in input prices implies that changing the production scale does not impact the degree of substitution between the different input factors. So this assumption has no consequences for the estimates of demand elasticities.

[20] Note that we do not consider any outside alternative, i.e., any other media advertising channels, to TV advertising. This assumption is based on the fact that the advertisers often proceed in a multistage budgeting. They first define an overall budget for an advertising campaign to promote a specific product, then share this budget among the different types of media (TV, print media, social networks, etc.). It does not mean that there is no reallocation of budgets among the different media. However, if there is a reallocation, it is unlikely due to the behavior of a dominant media platform in a specific segment of the advertising market, but is more likely linked to the changes in the advertisers' strategy to promote the product. This assumption is also coherent with the market definition that we consider in the analysis of the merger in Section 5. See footnote 33 for more details.

[21] Researchers in this literature sometimes use price per viewer as a measure of advertising price. We have chosen to use the price per second here because it is what the professionals in the TV advertising market use to talk about the cost of an advertising campaign. Indeed, the contracts between advertisers and the ASHs specify the number of minutes booked for an advertisement on a channel j and its price, which depends a lot on the broadcasting time and network of the advertisement. In practice, there is no specific price per viewer, because audiences differ during a day and on different networks.

[22] The translog cost function is flexible in the sense that it does not impose restrictions on the substitutability or complementarity between the input factors (A_{it} and A_{jt}, $\forall i \neq j$). (See Berndt, 1991; Christensen *et al.*, 1973.)

[23] That is to say: $S_{jt}^A = \frac{\partial \ln C_t}{\partial \ln p_{jt}} = \frac{p_{jt} \partial C_t}{C_t \partial p_{jt}} = \frac{p_{jt} A_{jt}}{C_t}$.

To satisfy the adding-up, homogeneity and symmetry conditions of the duality theory, the parameters of the translog cost function must satisfy the following constraints:[24]

$$\sum_{j}^{J} \gamma_j = 1 \quad \text{and} \quad \sum_{j}^{J} \gamma_{ij} = \sum_{i}^{J} \gamma_{ij} = \sum_{j}^{J} \theta_j = 0 \quad \text{and} \quad \gamma_{ij} = \gamma_{ji} \tag{9}$$

Solving the system of Equations (8) yields the vector of advertising prices $p_{jt} \equiv p_{jt}(\mathbf{A}_t, Y_t)$. Given this expression, we can view the Translog cost model as a way to retrieve the relation between the price per second, the amount of advertising, and the number of viewers, which is defined in the contracts between advertisers and ASHs.

The own- and cross-price elasticities of the advertiser's demand ($E^A_{jj,t}$, $E^A_{ji,t}$) can be derived from the Allen partial elasticities of substitution (see Berndt and Wood, 1975):

$$E^A_{jj,t} = \frac{\partial A_{j,t} p_{j,t}}{\partial p_{j,t} A_{j,t}} = \gamma_{jj}/S^A_{j,t} + S^A_{j,t} - 1 \tag{10}$$

$$E^A_{ji,t} = \frac{\partial A_{j,t} p_{i,t}}{\partial p_{i,t} A_{j,t}} = \gamma_{ij}/S^A_{j,t} + S^A_{i,t} \tag{11}$$

Identification

We estimate the system of advertising cost share equations, specified by Equations (8), under the constraints in Equations (9), using Zellner's iterated seemingly unrelated regression method. To avoid the singularity of the covariance matrix of the advertising cost share system, one share equation must be omitted in the estimation. We select randomly one channel, channel j, to omit, but recover its parameters, γ_j, γ_{ij} and θ_j, using the restrictions given by Equations (9).

The error term ξ^A_{jt} might include unobserved factors revealing the broadcasting quality of channel j in month t, which does not only impact the amount of advertising A_{jt} but also the advertising prices $p_{1t}, ..., p_{Jt}$. If this is the case, there would be a problem of endogeneity. We then need instruments for $\ln p_{1t}, ..., \ln p_{Jt}$ to estimate the system of advertising cost share equations using the three-stage least squares method. We have compared two sets of instruments for $p_{1t}, ..., p_{Jt}$: the broadcasting hours of news and entertainment programs of the competing channels (also used as instruments for A_{jt} in the viewers' demand model) and the twice-lagged logarithm of the price of advertising (i.e., $\ln p_{1t-2}, ..., \ln p_{Jt-2}$).[25,26] For each set of instruments, we tested the difference between the estimates with and without instrumenting for $\ln p_{jt}$ using the Hausman test. The testing results do not reject the null assumption that the difference between the estimates under the two specifications (with and without IVs) is not systematic. In other words, we obtain very similar estimates with and without instrumenting for $\ln p_{jt}$; thus $\ln p_{jt}$ can be treated as exogenous in Equations (8).

[24] Since each cost share is the proportion of the total advertising cost spent on that input, the cost shares of the different TV stations must sum to one. This condition implies that the intercepts of the cost share equations must sum to one, while both the row and column coefficients must sum to zero. In addition, imposing the symmetry $\gamma_{ij} = \gamma_{ji}$ guarantees the integrability of the demand function of the advertisers. (See Hurwicz and Uzawa, 1971.)

[25] The assumption on the timing of the decision process supporting the exogeneity of the BLP IVs is similar to the one we use for the identification of viewers' demand in Section 3.1: The broadcasting content is selected before the unobserved demand shock to advertisers ξ^A_{jt} is realized. We note that, in this model, the error term ξ^A_{jt} is realized simultaneously with the determination of the advertising prices $p_{1t}, ..., p_{Jt}$. It means that the past advertising prices are chosen before ξ^A_{jt}. Any lagged prices should then be exogeneous in principle. Here, we reported the results using the second lags of advertising prices, but in practice, we obtain similar results with either first, second or third lags of advertising prices.

[26] The first stage estimations with each set of IVs are provided in Table A7 and Table A8 in Appendix A.

4 Estimation results

4.1 Viewers' demand

The estimation results for Equation (5) are presented in Table 5. Both the coefficient associated with the amount of advertising, $\hat{\alpha}$, and the one associated with the within-nest shares, $\hat{\sigma}$, are significant at the one percent level. Since $\hat{\alpha} < 0$, an increase in the amount of advertising induces a decrease in the number of viewers of the TV channel. This result suggests that, on average, TV viewers are adversely sensitive to the amount of advertising. The estimated $\hat{\sigma}$ is significantly smaller than 1, indicating that there is competition between the incumbents and the new channels, although its value suggests that there is significant segmentation between the two groups of TV channels (incumbents and entrants).

Note that news and cartoons have a statistically significant mean positive effect on the size of the audience, but entertainment has a statistically significant mean negative effect on this size. This latter fact, which looks counterintuitive, can be explained as follows: The entertainment genre includes many unpopular programs that the TV channels use to fill the broadcasting slots during working hours and sleeping time; several high-quality shows belonging to this category are exclusively broadcast by the incumbent channels; their impact on audience size is captured by the nest parameter and the channel fixed effect. We could not identify any statistically significant effect of either TV series/movies or culture/science on the audience size, because the total broadcasting hours of both genres do not vary from one month to another, although their availability (in terms of broadcasting hours) is very channel-specific. In other words, the effects of TV series/movies and culture/science programs on the audience size of a TV channel are absorbed by the channel fixed effect in the monthly data. We have identified a positive effect of sports on the audience size, although the parameter is not significant at usual levels. This is because there is an important heterogeneity between the different sport events: This genre includes the broadcasting of the Champions League, the Roland Garros tennis tournament, and the Olympic Games, but also many small sports events that are scheduled daily between 00:00 and 06:00. We note here that monthly data are not the best way to study the effects of genre on audience size. TV channels have a strategy of scheduling different genres at different times of day, but the availability of many genres (in terms of broadcasting hours) does not vary significantly from one month to another. However, the broadcasting hours of different program genres are here covariates that we control for in the viewers' demand model to better identify the disutility of advertising (measured by $\hat{\alpha}$) and the segmentation between the incumbent channels and the new entrants (measured by $\hat{\sigma}$).[27]

To validate our choice of instruments, we conducted statistical tests for weak instruments and overidentification of the IV estimations of Equation (5). The results are presented in the bottom of Table 5. The Stock–Yogo weak instrument test suggests the instruments are strong, while the Hansen J statistic does not reject the null hypothesis that the instruments are valid at the 10 percent level.

The first stage regressions are presented in Table A3 in Appendix A. The total number of hours of news and entertainment broadcast by all the competing channels can explain the amount of advertising on the instrumented channel. News has a mean positive effect on the size of the audience, while entertainment programs have a mean negative effect on the size of the audience. (See Table 5.) Accordingly, the amount of advertising of competing channels is higher during news programs, but lower during entertainment programs. The amount of advertising of the instrumented channel is higher when it anticipates more advertising by its rivals, due to their

[27] Zhang (2019) provides more detailed comments and more precise estimation of the different genre effects on the audience size of a TV channel using hourly data.

Table 5: Estimates of viewers' demand

	$\ln s_{jt} - \ln s_{0t}$	
	coeff.	(s.e.)
Amount of advertising (α)	-0.111***	(0.031)
Within-nest share (σ)	0.636***	(0.192)
TV Series/Movies	0.003	(0.003)
Culture/Science	0.001	(0.004)
News	0.068***	(0.009)
Entertainment	-0.255***	(0.078)
Sports	0.011	(0.009)
Cartoons	0.461**	(0.111)
Channel FE	Yes	
Month FE	Yes	
Year FE	Yes	
No. observations	840	
Cragg–Donald Wald F statistic	14.665	
Hansen J statistic (p-value)	0.440	

Note: Standard errors cluster-robust at channel level are in parentheses: ***p <0.01, **p <0.05, *p <0.1

scheduling of more news and/or less entertainment programs. The sum of the broadcasting hours of news and entertainment programs of the competing channels in a group (incumbent, entrant) significantly explain the logarithm of the conditional market share, $\ln(s_{jt/g})$. The conditional market share of a channel decreases with the amount of news broadcast by its close competitors (i.e., competing channels in the same group), but increases with the amount of entertainment broadcast by its close competitors. We have also tested whether the estimates in Table 5 are robust to the choice of instruments, by including additional instrumental variables in the estimation. Such an experiment does not change significantly the values of the estimates but decreases the associated Cragg–Donald Wald F statistics. (See Table A5 in Appendix A for details.)

To determine whether the instruments used in the estimation are helpful in fixing the endogeneity bias, we compare the results from the IV estimation with those from OLS in Table A4 in Appendix A. We observe that the parameter estimates associated with the amount of advertising and the within-nest share in the viewers' demand function strongly differ under the two types of estimation. Without controlling for the endogeneity bias, the quantity of advertising reflects the quality of TV channel and is estimated to have a positive effect on the audience of the channel. The effect of the disutility of advertising can be isolated from the effect of the quality of the TV channel only if the endogeneity bias is properly controlled for. Moreover, with the nested-logit model specification, the value of $\hat{\sigma}$ should be between 0 and 1. This constraint is not satisfied with OLS.

The own- and cross-elasticities of the viewers' demand with respect to the amount of advertising ($E^V_{jj,t}$, $E^V_{ji,t}$) follow the classical formula in the nested-logit model. (See, for instance, Verboven, 1996.) Their estimates, averaged by channel over the sample periods, are presented in Table 6. They suggest that a 10 percent increase in advertising time causes a mean audience loss of about 10.55 percent (resp. 1.87 percent) for a private (resp. public) TV station. The substantial difference between the estimated elasticities of viewing with respect to advertising for public and private TV stations must be related to the large difference in their advertising levels. Because of the ban on commercial advertising on public TV stations during the prime times, the monthly total amounts of advertising for the public TV stations are much smaller than for the private ones, although none of them hit the maximum minutes of advertising per month allowed legally.[28] All the estimates of own-demand elasticities are significant at the 10 percent significance level. The estimated cross-demand elasticities are very small, suggesting that viewers substitute between channels to a very limited degree. Nevertheless, it is important to note that viewers do switch to other channels following an increase in the amount of advertising, although the estimated substitution effects are very small. This is true notably for channels TF1, NT1 and TMC, which suggests that these three channels do have an incentive to merge their ASHs in order to internalize the competition between them for the audience. However, given the weak substitution effects of advertising, we should not expect an important change in the amount of advertising following the merger of their ASHs.

[28] We find relatively small own-demand elasticities, compared to previous articles using US data. Wilbur (2008) finds that a 10 percent rise in advertising time causes a median 25 percent audience loss for highly rated TV networks, and larger percentage audience losses for low-rated networks. Using improved audience measurement, Wilbur, Goeree and Ridder (2009) find a median audience loss of about 15 percent in response to a 10 percent increase in advertising time. The difference between our estimates and the findings in Wilbur *et al.* (2009) could be explained by the much more intensive TV advertising in the US.

Table 6: Viewers' demand elasticities with respect to the amount of advertising

		E^V_{jj}	E^V_{ji}_SG	E^V_{ji}_DG
Incumbents	TF1	-0.120	0.0033	0.00085
		(0.074)	(0.0023)	(0.00024)
	FR2	-0.062	0.0011	0.00020
		(0.038)	(0.0008)	(0.00008)
	FR3	-0.054	0.0006	0.00017
		(0.033)	(0.0004)	(0.00005)
	M6	-0.108	0.0013	0.00033
		(0.066)	(0.0009)	(0.00009)
	FR5	-0.036	0.0001	0.00003
		(0.022)	(0.0001)	(0.00001)
New entrants	NT1	-0.117	0.0008	0.00006
		(0.072)	(0.0007)	(0.00002)
	TMC	-0.118	0.0015	0.00011
		(0.072)	(0.0013)	(0.00003)
	D8	-0.101	0.0008	0.00006
		(0.062)	(0.0007)	(0.00002)
	FR4	-0.041	0.0003	0.00002
		(0.025)	(0.0002)	(0.00001)
	Gulli	-0.061	0.0005	0.00003
		(0.038)	(0.0004)	(0.00001)
	D17	-0.080	0.0003	0.00002
		(0.050)	(0.0003)	(0.00001)
	W9	-0.097	0.0014	0.00008
		(0.060)	(0.0012)	(0.00002)

Note: E^V_{ji}_SG denotes the cross-elasticities between channels within the same group (incumbents and entrants); E^V_{ji}_DG denotes the cross-elasticities between channels of two different groups (incumbents and entrants). Standard errors computed by delta method are in parentheses.

4.2 Advertisers' demand

The estimates of γ_{ij} in the cost share Equations (8) are presented in Table A6 in the Appendix A.[29] All the estimates of γ_{jj}, $\forall j$ are positive and statistically significant.[30] Many of the γ_{ij}, $i \neq j$ are estimated to be close to zero.

Using these estimates, we compute the own- and cross-price elasticities of advertisers' demand for viewers ($E^A_{jj,t}$ and $E^A_{ji,t}$) according to Equations (10) and (11). The estimated elasticities, averaged over the whole period of observation, for all channels are presented in Table A9 in the Appendix A. The elasticities of channels TF1, NT1 and TMC are extracted from this table and presented in Table A9 below. Each cell of these two tables display the percentage change in demand that the row channel benefits from the column channel's change in its price by one percent.

Table 7: Elasticities of demand for channels TF1, NT1 and TMC

	TF1	NT1	TMC
TF1	**−0.296**	−0.035	−0.055
	(**0.047**)	(0.014)	(0.013)
NT1	−0.346	**−0.290**	0.312
	(0.124)	(**0.072**)	(0.070)
TMC	−0.485	0.174	**−0.094**
	(0.133)	(0.053)	(**0.032**)

Note: The estimates of elasticities are averaged over the entire period of observation. Own-price elasticities are in bold. Standard errors of these average estimates of elasticities computed by the delta method are in parentheses.

According to Table A9, the estimates of own-price elasticities are statistically significant for all channels. They show that the advertisers' demand for viewers is relatively price inelastic since all cross-price elasticities are smaller than one in absolute value. Concerning the cross-price elasticities, we observe that inter-channel substitutability coexists with complementarity. Out of the 132 average cross-price elasticities, 72 (i.e., 55 percent) indicate that channels are substitutes. The precision of the estimates tends to be slightly greater for substitutes than for complements: 53 percent of the positive average cross-price elasticities are statistically significant, while this percentage is 51 percent for the negative average cross-price elasticities. The magnitude of cross-price effects, whether they identify substitutes or complements, tends to be limited. The median value of the 67 positive average cross-price elasticities is 0.11 (with a range between 8×10^{-4} and 0.83). The median value of the 54 negative cross-price elasticities is -0.10 (with a range between -0.54 and -3×10^{-3}).

The cross-price elasticities presented in Table 7 suggest that the advertisers consider channels NT1 and TMC as substitutes, but both as complements of channel TF1. The result of complementarity can be explained as follows. First, NT1 and TMC had a programming (and therefore an audience) structure close to that of channel TF1 even before the acquisition. For instance, the programs attracting the best audience on these two small channels were fictional series and movies,

[29]Note that we have 78 independent parameters, and 69 data points for each of the 11 cost share equations in the estimation, which provides 681 degrees of freedom ($69 \times 11 - 78 = 681$). Computing the degree of freedom equation by equation is incorrect as it would not account for the constraints that we specified in Equation (9).

[30]Note that a positive sign of γ_{jj} does not imply positive demand elasticity. (See Equations (10) and (11) in Section 3.2.)

as on channel TF1. Second, when TF1 Group took over the broadcasting services of the two channels in 2010, it introduced more news programs on NT1 and TMC. We can observe that after the acquisition NT1 broadcast six times more news programs and TMC broadcast three times more news programs than before. This has de facto reinforced the similarity of these channels' programs and audiences. It means that the advertisers on channel TF1 can consider the advertising slots of NT1 or TMC as additions to those of channel TF1, especially when these advertisers target an audience coverage that exceeds the capacity of channel TF1. In these conditions, a change in the price per second of advertising on channel TF1 should affect the demand for advertising slots of NT1/TMC in the same way as it affects the demand for the advertising slots of channel TF1.[31]

Given this demand pattern of advertisers, we conjecture that a merger between the ASH of channel TF1 with the ASH of channels NT1 and TMC would not lead to a significant increase in their advertising prices. Indeed, if the merged ASH increased the price of advertising on channel TF1, the marginal advertisers would not switch to NT1 or TMC but to the other channels that are substitutes for channel TF1.

5 Merger evaluation

In January 2010, the Autorité de la concurrence (the French competition authority) cleared the acquisition of two free broadcast TV channels, NT1 and TMC, by the TF1 Group, subject to a behavioral remedy requiring that channels NT1 and TMC sell their advertising time separately from the main channel of TF1 Group, namely, channel TF1. In practice, the decision prohibits the merger between the ASH of channel TF1 and that of channels NT1 and TMC; only the broadcasting content of the three channels is allowed to be managed jointly following the acquisition.

The competition authority had concluded that the acquisition would have a positive impact on the broadcasting side, since channels NT1 and TMC could benefit from the large catalog of programs of TF1 Group, which is due to its partnership with numerous content providers: Having more channels offering high-quality content could enhance the competition between the different TV broadcasters for audience.[32]

The authority was, however, concerned about the potential anti-competitive effects of merging the ASHs of the three channels, due to the dominant position of TF1 Group in the TV advertising market. Before the acquisition, the ASH of channel TF1 held a 40 percent share in the TV advertising market, while the ASH of NT1 and TMC held a five percent share. The merger could simply reinforce the position of TF1 Group in the TV advertising market, which would translate into an increase in either the amount of advertising or its price.[33] To avoid any detrimental effect of the acquisition on the TV advertising market, the authority decided to impose a behavioral remedy, which prohabits the joint sales of advertising time of the three channels, for a period of

[31] More generally, the complementarity between the different advertising platforms could be explained by a phenomenon that is common knowledge in marketing literature: Repeated exposure to the same advertising message increases the efficiency of advertising (see Schmidt and Eisend, 2015). Advertisers might value the fact that a viewer sees the same advertising message when he/she switches from one channel to the other. This implies that TV networks with a similar audience structure are likely to be complementary for advertisers.

[32] While NT1 and TMC are growing very fast as new entrants to the market, their catalogs of broadcasting programs are not as rich as the catalogs of the incumbent channels like TF1.

[33] In its decision, the French competition authority states that the TV advertising market is a separate market from the other media advertising channels (radio, print media, and internet), because of their specific pricing, population coverage rate, and costs for the advertisers. Note that the ASH of channel TF1 is no longer dominant if we consider the whole advertising market including all types of media. TF1 Group made use of this argument when proposing the merger between the ASH of channel TF1 with that of NT1 and TMC. However, it was rejected by the French competition authority.

at least five years.[34]

Below, we first evaluate the aftermath of the approved acquisition; we then comment on the effectiveness of the implemented behavioral remedy. We start by providing some reduced-form evidence on the effect of the acquisition on the TV advertising market. We next explain why it is crucial to account for the interaction between the two sides of the market by exploiting the strategic decisions of the ASHs at equilibrium. In more detail, we estimate the post-acquisition changes in broadcasting quality of the three merging channels using our viewers' demand model; to highlight how the changes in quality of broadcasting impacts the equilibrium amounts and prices of advertising, we then counterfactually simulate the effects of the acquisition in the hypothetical case in which there are no post-acquisition changes in the broadcasting quality of the three merging channels. To break down the direct impact of the changes in broadcasting quality and the effect of two-sided network externalities, we also counterfactually simulate the effects of the acquisition in the absence of the two-sided network externalities between viewers and advertisers. To comment on the effectiveness of the implemented remedy, we simulate the advertising market equilibrium for the case in which the three merging channels sell their advertising time via a common ASH. Finally, we conclude with a welfare analysis to assess the overall impacts of the decision of the French competition authority.

5.1 Evidence of the effects of the merger

To get an initial insight into the impact of the acquisition on the amounts and prices of advertising by the merging channels, we estimate the following regression, in line with Ashenfelter and Hosken (2010) and Björnerstedt and Verboven (2015):

$$\ln A_{jt} = \mu_j^1 + \mu_t^2 + \rho_j PostAcquisition_t + \eta_{jt};$$

$$\ln P_{jt} = \tau_j^1 + \tau_t^2 + \lambda_j PostAcquisition_t + \omega_{jt},$$

where A_{jt} denotes the amount of advertising by channel j and P_{jt} its price during period (month-year) t; μ_j^1 and τ_j^1 denote the channel fixed effect; μ_t^2 and τ_t^2 denote the month-year time fixed effect; the variable $PostAcquisition_t$ is equal to 0 from March 2008 to January 2010, and is equal to 1 from January 2010 to December 2013, for all channels.

As noted by Björnerstedt and Verboven (2015), these regressions can be interpreted as difference-in-differences estimators, where the difference between the merging firms' ρ_j (or λ_j) and the competitors' ρ_j (λ_j) measures the effect of the acquisition on the amounts (prices, respectively) of advertising under the assumption that the acquisition does not have an impact on the competitors' amounts (prices) of advertising. In practice, however, the acquisition could raise the competitors' prices as well; then, the difference between the merging firms' ρ_j (λ_j) and the competitors' ρ_j (λ_j) could be viewed as a lower bound of the effect of the merger on the amount (price) of advertising of channel j.

We use our full sample (22 months' pre-acquisition data and 47 months' post-acquisition data) to estimate the channel-specific treatment effects ρ_j and λ_j. The estimation results are presented in Table 8.[35]

[34] The ASHs of the three channels have remained separate after the effective period of the behavioral remedy, possibly because TF1 Group did not want to encourage increased scrutiny by the competition authority.

[35] Since the acquisition was announced in January 2010, while the merger of broadcasting services of the three channels could have taken time, we also re-estimated ρ_j and λ_j, excluding the post-acquisition data immediately following the announcement of the acquisition (from February 2010 to December 2010), i.e., using 22 months' pre-acquisition data and 36 months' post-acquisition data, as a robustness check. The estimates using this reduced post-acquisition sample are presented in Table A10 in Appendix A. We obtain very similar results with the two samples.

Table 8: Effects of the merger

	Amount of advertising (percent change)		Advertising price (percent change)	
	coeff.	(s.e.)	coeff.	(s.e.)
$TF1 \times Acquisition$	29.06***	(0.099)	26.77***	(0.100)
$NT1 \times Acquisition$	49.71***	(0.115)	119.44***	(0.174)
$TMC \times Acquisition$	43.761***	(0.110)	110.60***	(0.167)
$Others \times Acquisition$	41.039***	(0.093)	56.18***	(0.107)
Channel FE	Yes		Yes	
Month-Year FE	Yes		Yes	

Note: The percentage effects on the amount of advertising and price are obtained from a transformation of the parameters ρ_j and λ_j using $\exp(\rho_j) - 1$ and $\exp(\lambda_j) - 1$. $Others \times Acquisition$ presents the estimated average effect of the acquisition on the non-merging channels. Standard errors are computed using the delta method. ***p <0.01, **p <0.05, *p <0.1

Our results suggest that the acquisition led to a significant increase in both the amounts and prices of advertising by the three merging channels. We also notice that the acquisition affected the two purchased channels more strongly than channel TF1. These results could eventually be explained by the increase in broadcasting quality of the merging channels after the acquisition. Intuitively, viewers' demand is less elastic to the amount of advertising cast during a show with a better content, which implies that the ASHs of the merging channels have an incentive to increase their amount of advertising after the acquisition as a strategic reaction to an increase in their broadcasting quality: Better programs attract more viewers, which in turn increases advertisers' willingness to pay for the advertising slots of these two channels. As we find a stronger effect of the acquisition on the two purchased channels than on channel TF1, we conjecture that the acquisition may have mainly increased the broadcasting quality of the two purchased channels. This is what we show in Section 5.3 below.

5.2 Market equilibrium

We now write down the profit maximization problem of ASHs, which we use to perform different counterfactual simulations. The profit of an ASH depends on the demands of viewers and advertisers and on the feedback loop between these two groups of consumers. Each ASH maximizes the joint profit from the advertising slots of all the channels under its management. Formally, the profit function of an ASH $\mathscr{H}$, in month t is given by:

$$\Pi_{kt} = \sum_{j \in \mathscr{H}} \Pi_{jt} = \sum_{j \in \mathscr{H}} (p_{jt} - c_{jt}) A_{jt}, \tag{12}$$

where c_{jt} is the marginal cost of commercializing one second of advertising on channel j in month t for the ASH $\mathscr{H}$.[36]

[36] A referee has pointed out that we study here a static short-run equilibrium in which content decisions are fixed; in other words, we do not consider the dynamic equilibrium in which TV stations strategically select the

At equilibrium, the amount of advertising is the variable which links both sides of the market: It has an impact on both the number of viewers and on the advertising prices of the TV channels. An ASH internalizes the network externalities between viewers and advertisers by choosing the amount of advertising which maximizes its profits. Using the notation introduced in Section 3.1 where we write down the number of viewers y_{jt} of channel j as a function of the amounts of advertising of different TV channels $\mathbf{A}_t$: $y_{jt} \equiv y_{jt}(\mathbf{A}_t)$, and the notation introduced in Section 3.2 where we write down the price of advertising p_{jt} of channel j as a function of the amounts of advertising of different channels $\mathbf{A}_t$ and of the total number of TV viewers $Y_t = \sum_j^J y_{jt}$: $p_{jt} \equiv p_{jt}\Big(\mathbf{A}_t, Y_t\big(y_{1t}(\mathbf{A}_t), ..., y_{Jt}(\mathbf{A}_t)\big)\Big)$, the objective of an ASH $\mathscr{H}$ at equilibrium can be written as:

$$\max_{\{A_{jt}\}_{j\in\mathscr{H}}} \sum_{j\in\mathscr{H}} \Big[p_{jt}\Big(\mathbf{A}_t, Y_t\big(y_{1t}(\mathbf{A}_t), ..., y_{Jt}(\mathbf{A}_t)\big)\Big) - c_{jt}\Big] A_{jt}.$$

Assuming that a pure strategy Nash equilibrium in the amount of advertising exists, and omitting the time index t for the sake of clarity, the first-order conditions (FOCs) associated with the above profit-maximization problem are:

$$(p_j - c_j) + \sum_{k\in\mathscr{H}} \left[A_k\left(\frac{\partial p_k}{\partial A_j} + \frac{\partial p_k}{\partial Y} \sum_{i,\forall i} \frac{\partial Y}{\partial y_i} \frac{\partial y_i}{\partial A_j}\right)\right] = 0, \forall j, \tag{13}$$

where $\frac{\partial p_k}{\partial A_j}$ measures the impact of the amount of advertising of channel j on the price of advertising seconds of channel k, $\frac{\partial p_k}{\partial Y}\frac{\partial Y}{\partial y_i}$ measures the impact of the number of viewers of channel i on the price of the advertising seconds of channel k, and $\frac{\partial y_i}{\partial A_j}$ is the impact of the amount of advertising of channel j on the number of viewers of channel i.

The above FOCs suggest that each ASH $\mathscr{H}$ trades off between three effects when determining the amount of advertising A_j of channel j at equilibrium: first, the impact of A_j on the price of advertising p_j of channel j and on the price of advertising of the other channels p_k managed by the same ASH $\mathscr{H}$, through the term $\frac{\partial p_k}{\partial A_j}, \forall j \in \mathscr{H}$; second, the impact of A_j on the number of viewers of different TV channels y_i through the term $\frac{\partial y_i}{\partial A_j}, \forall i$; lastly, the impact of the number of viewers of different TV channels $y_i, \forall i$ on the price of advertising of each channel p_k of the ASH $\mathscr{H}$, through the term $\frac{\partial p_k}{\partial Y}\frac{\partial Y}{\partial y_i}, \forall k \in \mathscr{H}$.

Using the estimated preference parameters on the viewing and advertising sides (α, σ, γ_j, γ_{ij}, θ_j), and the observed amounts and prices of advertising (A_{jt} and p_{jt}), we can solve Equations (13) for the marginal costs c_{jt}.

In what follows, we make use of Equations (13), the estimated preference parameters, and the estimated marginal costs: first, to show the impact of changes in broadcasting quality on the equilibrium amounts and prices of advertising; then, to comment on the role of two-sided network externalities; finally, to evaluate the effectiveness of the behavioral remedy imposed by the French competition authority.

5.3 Impact of changes in broadcasting quality

In this section, we first estimate the post-acquisition changes in the broadcasting quality of channels TF1, NT1 and TMC, using observed data. We next simulate the equilibrium amounts and prices

content. Endogenizing the content choice of TV stations is a stimulating avenue that we have left for future research. Nonetheless, we note that the following merger evaluation uses ex-post data which takes into account the post-merger changes in content quality.

of advertising in the absence of these changes, which allows us to assess if changes in broadcasting quality can either reinforce or offset the merger effects on the advertising side. Panels 1 and 2 of Table 9 summarize the different results discussed in this section.

We estimate the TV channels' broadcasting quality from our nested-logit model of viewers' demand. Formally, according to the TV viewer's utility function (Equation 1), the mean quality of channel j at time t can be measured by q_{jt} (Equation 2) and is denoted as $\bar{q}_{jt}$. The estimated percentage changes in $\bar{q}_{jt}$ post-acquisition are presented in the first row of Table 9 for each of the three merging channels.[37] As expected, we find a clear increase in the broadcasting quality of the two purchased channels (NT1 and TMC) after the acquisition. The estimated broadcasting quality of channel TF1 has increased as well but much less significantly than for the two purchased channels. Taken all together, the average quality of the three merging channels has increased by 14.57% post-acquisition.

In practice, thanks to the merger, both NT1 and TMC obtained the rights to broadcast some attractive programs that might otherwise have been only scheduled on channel TF1. For instance, in 2011, NT1 started to broadcast some popular foreign series, such as "True Blood" and "Falling Skies", and started to offer a new culture program, "Tous Différents", which is fully produced by TF1 Group and has a significant audience. TMC obtained the broadcasting rights to the marriage of Prince Albert II of Monaco in July 2011, and for the movie "Bodyguard" in February 2012, in tribute to the deceased singer Whitney Houston. In these two examples, TMC benefited from the broadcasting rights acquired by TF1 Group. These two broadcasts generated significant peaks in audience for TMC. Moreover, prior to the acquisition, channels NT1 and TMC had hardly any news programs. Since TF1 Group took over their broadcasting services, it has introduced six times more news programs on NT1 and three times more news programs on TMC, so that they now offer the most news programs among the seven new entrants to the market.

Accompanied with the increase in broadcasting quality of the merging channels, we also observe a significant increase in their amounts and prices of advertising. (See Panel 1 of Table 9.) We could explain these rather non-standard effects of acquisition by the joint impact of the changes in broadcasting quality of the merging channels and the two-sided network externalities between viewers and advertisers.

To highlight the quality effects, we here simulate the equilibrium amounts and prices of advertising post-acquisition (i.e., their average levels between 2011 and 2013) for the case in which the broadcasting qualities of the merging channels remain at their levels before the acquisition (i.e., in 2009).[38] We then compute the post-acquisition changes in the merging channels' amounts and prices of advertising based on the simulated equilibrium, as presented in Panel 2 of Table 9.

The counterfactual simulation is performed according to the algorithm detailed in Appendix B.1. The equilibrium choices of the amounts of advertising by the ASHs of the 12 TV stations are simulated simultaneously. Our simulation procedure considers the strategic reactions between the ASHs of different TV channels. For instance, the ASH of channel TF1 acknowledges that its

[37] The post-acquisition changes presented in Table 9 compare the average levels of $\bar{q}_{jt}$, A_{jt}, p_{jt} before the acquisition in 2009 to their respective average levels after the acquisition between 2011 and 2013. We exclude the year 2008 in the estimation of pre-acquisition levels of the three variables, because data on the first two months of 2008 are missing from the sample. However, we have checked that the average levels of $\bar{q}_{jt}$, A_{jt}, p_{jt} beween March 2008 and December 2008 are close to their average levels between March 2009 and December 2009, which means that the data in 2009 approximates well the pre-acquisition levels of these three variables. We estimate the average levels of $\bar{q}_{jt}$, A_{jt}, p_{jt} post-acquisition from three years of post-acquisition data, i.e., 2011-2013. We excluded the year 2010 because it was a transition period.

[38] Note that we keep the post-acquisition levels of the broadcasting qualities of the non-merging channels as they are; in the simulation, only the broadcasting qualities of the three merging channels are set at their levels before the acquisition (i.e., in 2009).

Table 9: Observed and simulated impacts of the acquisition

	TF1	NT1	TMC	TF1 Group average
Panel 1: Observed equilibrium				
Estimated broadcasting quality ($\bar{q}_{jt}$)	4.82%	19.76%	20.40%	14.57%
Amount of advertising (A_{jt})	4.86%	19.63%	20.28%	14.52%
Price of advertising (p_{jt})	2.09%	74.15%	40.16%	8.12%
Panel 2: Simulated equilibrium in the absence of changes in broadcasting quality				
Counterfactual broadcasting quality ($\bar{q}_{jt}$)	0%	0%	0%	0%
Amount of advertising (A_{jt})	0.09%	0.19%	0.22%	0.16%
Price of advertising (p_{jt})	0.03%	0.02%	0.04%	0.03%
Panel 3: Simulated equilibrium in the absence of two-sided externalities				
Counterfactual broadcasting quality ($\bar{q}_{jt}$)	4.82%	19.76%	20.40%	14.57%
Amount of advertising (A_{jt})	−16.73%	−14.49%	−15.76%	−15.66%
Price of advertising (p_{jt})	3.77%	114.05%	81.01%	14.44%
Panel 4: Simulated equilibrium in the absence of the behavioral remedy				
Counterfactual broadcasting quality ($\bar{q}_{jt}$)	4.82%	19.76%	20.40%	14.57%
Amount of advertising (A_{jt})	11.33%	20.07%	22.95%	17.83%
Price of advertising (p_{jt})	1.41%	70.03%	39.31%	7.29%

Note: The percentage changes compares the observed equilibirum pre-acquisition (i.e, in 2009) to the simulated equilibirum post-acquisition (i.e, averaged between 2011 and 2013) amount of advertising impacts not only the number of viewers of channel TF1 but also the number of viewers of the other channels, all of which have an impact on the price of advertising of channel TF1 at equilibrium.

Comparing the results presented in Panels 1 and 2 of Table 9 allows us to draw conclusions about the impact of merging the broadcasting side of the market on the advertising side. We note that the post-acquisition changes in the merging channels' amounts and prices of advertising are mainly due to the changes in their broadcasting quality, as their levels would remain almost unchanged post-acquisition in the absence of the changes in their broadcasting quality. We hence establish clear evidence that merging one side of the market has significant impacts on the other side in a two-sided market.

5.4 The role of two-sided network externalities

We now discuss the role of two-sided network externalities. To do so, we simulate the post-acquisition changes in the amounts and prices of advertising if viewers were not negatively impacted by the amount of advertising. Panel 3 of Table 9 presents the results.

The counterfactual simulation is performed according to the algorithm detailed in Appendix B.2. In the simulation, we keep the broadcasting quality of the different TV channels at the same level as in the observed equilibrium (both before and after the acquisition), so that the simulated results are directly comparable to the observed effects of the acquisition in Panel 1.

Comparing the simulated acquisition effects in Panel 3 to the observed acquisition effects in Panel 1, we can draw three conclusions. First, in the absence of the negative externalities that advertisers generate for viewers, the ASHs respond to the increase in advertisers' willingness to pay for the advertising slots of the merging channels (as a result of the increase in their broadcasting quality and therefore their number of viewers) by restricting the total amount of advertising slots on the merging channels and thereby increasing their prices. Second, the negative externalities that advertisers generate for viewers incentivize the ASHs to increase the amount of advertising following an increase in TV channels' broadcasting quality, as indicated by the difference between the amount of advertising (A_{jt}) in Panel 1 and Panel 3. Lastly, the joint effect of the two-sided network externalities and the changes in the broadcasting quality of the three merging channels is that both the amounts and prices of advertising of the three merging channels are increased, as presented in Panel 1.[39]

We could explain the above findings using the FOCs derived in Section 5.2, namely, Equations (13). The broadcasting quality q_j of channel j, $\forall j$, affects the amount of advertising A_j in two ways: first, via its impact on viewers' demand elasticity with respect to A_j, and second, through its impact on the flexibility of advertising prices with respect to A_j. Specifically, the derivatives $\frac{\partial y_i}{\partial A_j}$ in Equations (13) depend on q_j according to the nested logit model for viewers' demand in Section 3.1; the derivatives $\frac{\partial p_k}{\partial A_j}$ in Equations (13) depend on q_j, because the prices of advertising p_k, $\forall k$, are functions of the number of viewers of different TV channels according to the model for advertisers' demand in Section 3.2.

Intuitively, improving the broadcasting quality of a TV channel incentivizes its ASH to choose a higher amount of advertising, as it reduces the TV viewers' demand elasticity with respect to the

[39]Note that the advertising level in a given period should be higher when viewers do not care about the amount of advertising than when they do. The simulated total amount of advertising is 7.65 percent higher under the assumption that viewers do not care about the amount of advertising than in the observed equilibrium where viewers do care. The negative values in the first row of Panel 3 in Table 9 are changes in the amounts of advertising post-acquisition, capturing the effects of the change in broadcasting quality of the merging channels in the absence of the negative externalities that advertisers generate for viewers.

amount of advertising of this channel: The value of $d\frac{\partial y_j}{\partial A_j}/dq_j$ is always negative. However, there may be an offsetting incentive for the ASH to reduce the amount of advertising but increase its price instead, due to the increase in the flexibility of the price of advertising with respect to its amount: The value of $d\frac{\partial p_j}{\partial A_j}/dq_j$ can be either positive or negative in practice. The first incentive comes from the negative externalities that the advertisers generate for the viewers. The second incentive is the direct effect of changes in the broadcasting quality of a TV channel on its amount and price of advertising (in the absence of two-sided network externalities between viewers and advertisers). Our post-acquisition data suggest that the joint effect of the two-sided network externalities and the changes in broadcasting quality of the three merging channels results in an increase in both the amounts and prices of advertising of the three merging channels at equilibrium.

5.5 Effectiveness of the behavioral remedy

In this section, we comment on the effects of the behavioral remedy imposed as a counterpart to the approval of the acquisition of channels NT1 and TMC by the TF1 Group. Since our sample covers the post-acquisition period, we observe a partial merger outcome in which the broadcasting side of the market is consolidated, while the advertising side is not due to the behavioral remedy. One practical way to assess the effectiveness of this remedy is to simulate the post-acquisition market equilibrium for the case in which the ASHs of the three channels are merged post-acquisition. As we observe the ex-post quality adjustment of different TV channels, our counterfactual simulation (using post-acquisition data between 2011 and 2013) takes into account the merger effect on product quality.

The simulation algorithm is the one detailed in the Appendix B.1. Panel 4 of Table 9 presents the simulated impacts of the acquisition in the absence of the behavioral remedy. Here, we take the simulated equilibrium post-acquisition in which a common ASH manages the advertising slots of the three channels and precisely compare it to the observed equilibrium pre-acquisition in which the ASH of NT1 and TMC is separated from that of channel TF1.[40]

Comparing the results presented in Panel 4 to those in Panel 1 of Table 9, we can conclude that the implemented behavioral remedy, blocking the merger of the ASHs of the three channels, has very limited impacts at equilibrium. It has only slightly reduced the increase in the total amounts of advertising post-acquisition, and has almost no effect on the market equilibrium levels of advertising prices. In Panel 1 of Table A11 in Appendix A, we report the exact changes in the amounts and prices of advertising caused by the merger of ASHs. Here, we compare the simulated post-acquisition equilibrium in the absence of the remedy to the observed post-acquisition equilibrium under the remedy. We find that merging the ASHs of the three channels would increase their total amount of advertising by about 3 percent and decrease their average advertising price by less than 1 percent.

This result is not surprising, provided that the substitution effects of the amount of advertising on the viewers' side are small, and that the advertisers consider the advertising slots of NT1 and of TMC to be complementary to those of channel TF1. (See the demand elasticities presented in Section 4.1 and Section 4.2.) Nonetheless, it is important to understand the role of complementarity in the simulated impacts of a merger of ASHs. We therefore conduct an additional simulation to separate the substitution effects of the amounts of advertising on the viewers' side from the complementary and substitution effects of prices on the advertising side. This simulation is performed using the procedure detailed in Appendix B.2, under the assumption that a common ASH determines the profit-maximizing amounts of advertising for the three channels. Panel 2 of

[40] We have carefully checked that the simulated amounts of advertising are below the maximum levels imposed by the regulator.

Table A11 in Appendix A presents the results of this counterfactual exercise, which exhibits the effects of a hypothetical merger of complementary firms. We show that the prices for the complementary products (advertising slots) are lower under joint ownership rather than independent ownership, which is consistent with a well-known finding of Economides and Salop (1992). When viewers are negatively impacted by the amount of advertising, the merged ASH internalizes the substitution effects on the viewers' side, in addition to the complementary and substitution effects on the advertising side. This explains why we find a greater increase in the total amount of advertising (thereby a smaller decrease in the advertising prices) when the two complementary ASHs merged at equilibrium in the presence of the negative externalities that advertisers generate for viewers. (See Panels 1 and 2 of Table A11 in Appendix A.)[41]

5.6 Welfare effects of the merger decision

We now assess the welfare consequences of the merger decision. We first look at how the approved merger under the behavioral remedy impacts the surplus of TV viewers, the total advertising costs and the advertising profits of different TV Groups. Then we evaluate the welfare implications of the behavioral remedy.

The viewers' surplus can be evaluated from our nested-logit model, as in Small and Rosen (1981): $CS\_{viewers} = -\dfrac{1}{\alpha} ln[1 + \sum_g [\sum_{j \in g} \exp(\dfrac{q_{jt} + \alpha A_{jt}}{(1-\sigma)})]^{(1-\sigma)}]$. The advertisers' surplus can be measured by their total cost: $C_t = \sum_j p_{jt} \times A_{jt}$. The profit of an ASH $\mathscr{H}$ is given by Equation (12): $\Pi_{\mathscr{H}t} = \sum_{j \in \mathscr{H}} (p_{jt} - c_{jt}) A_{jt}$.

Welfare effects of the approved merger

In Section 5.3 and 5.4, our analysis reaches the following conclusions. Merging the broadcasting services of TV channels impacts their equilibrium amounts and prices of advertising. If the joint management of broadcasting services improves the broadcasting quality of the merging channels; by the same token, it increases the value (therefore the prices) of their advertising slots. At equilibrium, the negative externalities that advertisers generate for viewers incentivize the ASHs to increase the amount of advertising following an increase in TV channels' broadcasting quality. Therefore, prohibiting the merger of ASHs is not enough to keep the equilibrium amounts and prices of advertising at their levels before the acquisition. If the goal was to leave the TV advertising market unchanged, the acquisition - merging the broadcasting services of TV channels - should not have been approved. However, the competition authority expected the merger decision could improve the broadcasting quality of the two acquired channels (NT1 and TMC), an objective which has been reached post-acquisition (see the results presented in Section 5.3). We must then establish whether the decision ultimately increased the surplus of TV viewers: Is the benefit of the increase in broadcasting quality sufficiently large to outweigh the associated detrimental effects due to the increase in the total amount of advertising?

The complete estimates of the welfare effects of the acquisition under the behavioral remedy are presented in Panel 1 of Table 10. We note that the total surplus of TV viewers has decreased post-acquisition. It means that the positive effects of the increase in broadcasting quality on the viewers' surplus were not sufficiently large to outweigh the associated detrimental effects of the increase in the amount of advertising. This result does not support the competition authority's

[41] Note that Panel 4 of Table 9 shows the overall impacts of the acquisition without the behavioral remedy (i.e., the impact of merging both the broadcasting side and the advertising side of the three channels). Table A11 presents the impacts of merging the ASHs of the three channels, holding the broadcasting quality $\bar{q}_{jt}$ at the post-acquisition level.

decision, as the approved merger harms the surplus of TV viewers. Besides, the total costs of advertisements have increased, since both the market average amount and price of advertising have increased. However, the advertising profit of TF1 Group and the other TV groups have all increased following the concentration of the TV market. We can therefore conclude that the approved merger harms consumers (both viewers and advertisers) but benefits the TV stations.

Table 10: Welfare effects of the acquisition

Viewers' surplus	Total cost of advertisements	Total profit (TF1 Group)	Total profit (others)
Panel 1: Observed equilibrium under the behavioral remedy			
−4.52%	19.52%	23.58%	41.26%
Panel 2: Simulated equilibrium in the absence of the behavioral remedy			
−5.18%	24.40%	28.35%	50.92%

Note: The percentage changes compare the observed equilibirum pre-acquisition (i.e, in 2009) to the simulated equilibirum post-acquisition (i.e, averaged between 2011 and 2013)

In Table A12 in Appendix A, we compare the observed welfare changes post-acquisition (i.e., the results presented in Panel 1 of Table 10) to the simulated welfare changes for the case in which the broadcasting qualities of the merging channels remain at their pre-acquisition levels. We note that the approved merger would not significantly damage the surplus of consumers (viewers and advertisers) if there are no ex-post changes in the broadcasting quality. This is because the increase in the total amount of advertising, which negatively impacted the consumer surplus post-acquisition, is mainly caused by the increase in the broadcasting quality of the three merging channels. (See the discussion in Section 5.3.) This result is useful from a competition policy perspective. We show that the post-merger changes in product quality impact the market competition. In the context of a two-sided market in particular, the negative network externalities that one side of consumers generate for the other side incentivize the platforms to increase the prices for both sides of the market, in response to the increase in product quality.[42]

Welfare effect of the behavioral remedy

The behavioral remedy was implemented to prevent the anti-competitive effects that a common ASH for the three merging channels could potentially cause in the TV advertising market. However, our analysis in Section 5.5 shows that the remedy, which blocked a merger between two complementary firms, had very limited impact on the market equilibrium amounts and prices of advertising. In Panel 2 of Table 10, we present the estimated welfare effects of the acquisition in the absence of this remedy. Comparing the numbers in Panel 2 to those in Panel 1, we can see that the welfare outcomes of the remedy are relatively small.

In Table A13 in Appendix A, we report the ex-post welfare changes induced by the merger of the ASHs of the three channels. There, we compare the simulated post-acquisition equilibrium in the absence of the remedy to the observed post-acquisition equilibrium under the remedy. We find that merging the ASHs of the three channels reduces the surplus of TV viewers by less than 1 percent and increases the total cost of advertisers by 4.08 percent. As expected, a concentration of the advertising market increases the profits of both the merging firms (i.e., the ASH of TF1 Group)

[42]Recall that, here, the amount of advertising A_{jt} can be viewed as a price that TV channels charge their viewers.

and the non-merging firms (i.e., the ASHs of the other TV groups). More precisely, the simulated merger increases the advertising profit of TF1 Group by 3.86 percent and the total advertising profits of other TV groups by 6.84 percent. Given the small impact of this merger on the surplus of TV viewers and considering its benefits to the broadcast TV stations, we conclude that the implemented behavioral remedy is not effective when the broadcasting side of the three channels is consolidated.

6 Conclusion

This paper contributes to the analysis of mergers in two-sided markets by assessing a decision of the French competition authority, which approved the merger of the broadcasting services of three TV channels but has de facto prohibited the merger of their ASHs via a behavioral remedy.

To do so, we first build a structural model which accounts for the multi-homing behavior of advertisers. We then estimate the demands of viewers and advertisers using a comprehensive data set. This step allows us to confirm that one should consider TV channels as two-sided market platforms since we show that advertising has significant negative externalities on TV viewers. Using ex-post data, we evaluate the consequences of the acquisition. We show that the acquisition had a positive effect on the broadcasting qualities of merging channels; however, merging the broadcasting services of TV channels impacts their equilibrium amounts and prices of advertising.

Based on a counterfactual analysis, we show that the observed changes in the amounts and prices of advertising post-acquisition are mainly due to the changes in the merging channels' broadcasting quality. An additional counterfactual simulation of the market equilibrium in the absence of the negative externalities that advertisers generate for viewers shows how the ASHs respond to the increase in advertisers' willingness to pay (as a result of the increase in the merging channels' broadcasting quality and therefore their viewership) by restricting the total amount of advertising slots on the merging channels and thereby increasing their prices.

We further show that the negative externalities that advertisers generate for viewers incentivize the ASHs to increase the amounts of advertising of the merging channels as well (as a result of the increase in their broadcasting quality) since viewers are less sensitive to the amounts of advertising during programs of better quality. Regardless of the behavioral remedy aiming at limiting any detrimental effect of the acquisition on the advertising side of the market, the joint effect of the increase in the broadcasting quality of the merging channels and the two-sided network externalities between viewers and advertisers results in an increase in both the amounts and prices of advertising of the merging channels.

Welfare analysis suggests that the positive effects of the increase in broadcasting quality on the viewers' surplus are not sufficiently large to outweigh the associated detrimental effects of the increase in the amount of advertising. Overall, the approved merger harms consumers (both viewers and advertisers) but benefits the TV stations.

To comment on the effectiveness of the behavioral remedy, we counterfactually simulate the acquisition under the assumption that the merger on the advertising side was also approved. Our results suggest that the remedy enforced by the French competition authority did not have any significant impact at equilibrium. Welfare analysis confirms that the implemented behavioral remedy is not effective, provided that the broadcasting side of the market is already consolidated.

The main lesson of our analysis is that, in the process of designing competition or regulatory policy for two-sided markets, ignoring the interaction between the two sides of platforms can result in unexpected outcomes.

This conclusion is drawn from the study of the digital TV industry. Provided more disaggregated data on audience and advertising were available, further investigation to refine this analysis could be undertaken. We expect our methodology could also be helpful for examining similar markets, especially those in which the usage of services on one side is free and all the revenues come from the other side.

Appendix A: Additional tables and figures

Table A1: Ratio of observed amounts of advertising to authorized ceilings

		2008	2009	2010	2011	2012	2013
Incumbents	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%
New entrants	Channel 6	23.5%	33.6%	39.6%	43.5%	59.0%	74.7%
	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	36.6%	45.2%	48.7%	52.0%	70.0%	77.5%
	Channel 12	41.9%	44.3%	52.0%	50.1%	69.0%	77.9%

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

Table A2: Audience shares of incumbent channels and new-entrant channels

Year	Channel	Audience shares	
		Mean	Std. Dev.
2008	Incumbent	13.2%	0.074
	New	1.2%	0.005
2009	Incumbent	12.7%	0.071
	New	1.5%	0.006
2010	Incumbent	12.1%	0.067
	New	1.7%	0.007
2011	Incumbent	11.6%	0.063
	New	2.2%	0.007
2012	Incumbent	11.5%	0.060
	New	2.2%	0.007
2013	Incumbent	11.2%	0.060
	New	2.2%	0.008

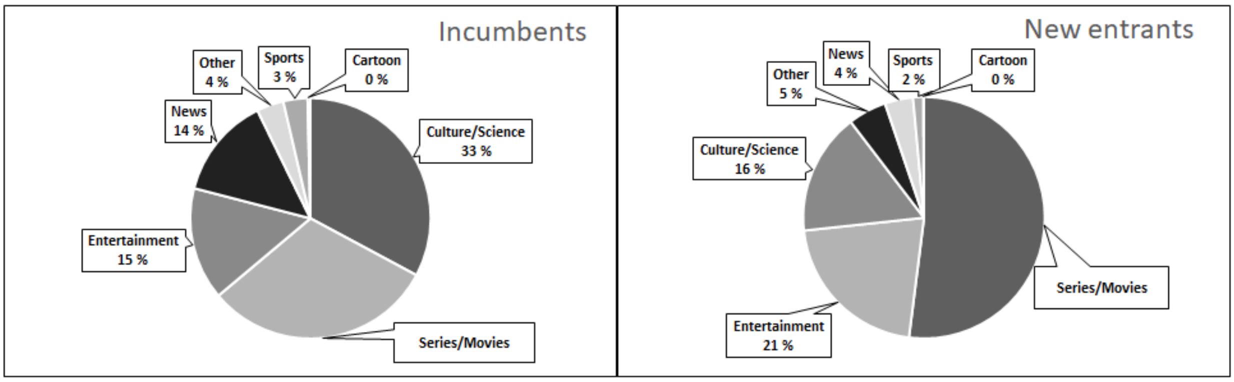

Figure A.1: Distribution of program genres of incumbents and new entrants

Table A3: First stage estimation of TV viewers' demand

	A_{jt}	$\ln \bar{s}_{jt/g}$
Entertainment of all competing channels	-0.529*** (0.056)	0.034*** (0.012)
News of all competing channels	0.596*** (0.107)	-0.029 (0.024)
Entertainment of competing channels in a group	-0.252*** (0.032)	0.046** (0.023)
News of competing channels in a group	0.197*** (0.049)	-0.022* (0.012)
Broadcasting hours of different programs	Yes	Yes
Channel FE	Yes	Yes
Month FE	Yes	Yes
Year FE	Yes	Yes
No. observations	840	840

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

Table A4: OLS versus IV estimation of TV viewers' demand

	(OLS) $\ln s_{jt} - \ln s_{0t}$	(IV) $\ln s_{jt} - \ln s_{0t}$
Amount of advertising (α)	0.052***	-0.111***
	(0.008)	(0.031)
Within-nest share (σ)	1.025***	0.636***
	(0.038)	(0.192)
Broadcasting hours of different programs	Yes	Yes
Channel FE	Yes	Yes
Month FE	Yes	Yes
Year FE	Yes	Yes
No. observations	840	840

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

Table A5: Robustness check for the viewers' demand estimation

	Baseline estimation (same IVs as in Table 5)	Robustness check (Additional IVs)
Amount of advertising (α)	-0.111***	-0.121***
	(0.031)	(0.031)
Within-nest share (σ)	0.636***	0.659***
	(0.192)	(0.193)
TV Series/Movies	0.003	0.003
	(0.003)	(0.003)
Culture/Science	0.001	0.002
	(0.004)	(0.004)
News	0.068***	0.070***
	(0.009)	(0.009)
Entertainment	-0.255***	-0.260***
	(0.078)	(0.079)
Sports	0.011	0.012
	(0.009)	(0.009)
Cartoons	0.461**	0.473***
	(0.111)	(0.113)
Channel FE	Yes	Yes
Month FE	Yes	Yes
Year FE	Yes	Yes
No. observations	840	840
Cragg–Donald Wald F statistic	14.665	11.914
Hansen J statistic (p-value)	0.440	0.303

Note: The second column presents the estimates using monthly broadcasting hours of news and entertainment of all competing channels, as well as monthly broadcasting hours of news and entertainment of all competing channels in a group (incumbent or entrant). The third column presents the estimates using one additional set of IVs: monthly broadcasting hours of TV series/movies of all competing channels; monthly broadcasting hours of TV series/movies of all competing channels in a group (incumbent or entrant). Including more IVs than were used in Table 6 results in similar estimates but decreases the Cragg–Donald Wald F statistics. Standard errors of estimates are in parentheses: ***p <0.01, **p <0.05, *p <0.1

Table A6: Cost share input price coefficient estimates

	S^A_{TF1}	S^A_{FR2}	S^A_{FR3}	S^A_{M6}	S^A_{FR5}	S^A_{D8}	S^A_{NT1}	S^A_{FR4}	S^A_{TMC}	S^A_{Gulli}	S^A_{D17}	S^A_{W9}
$\ln p_{TF1}$	0.107	-0.023	-0.009	0.025	-0.002	-0.016	-0.014	-0.003	-0.024	-0.014	0.001	-0.029
	(0.023)	(0.008)	(0.007)	(0.017)	(0.001)	(0.005)	(0.004)	(0.001)	(0.006)	(0.0007)	(0.005)	(0.007)
$\ln p_{FR2}$	-0.023	0.036	0.002	0.012	0.000	-0.008	-0.010	-0.004	-0.004	0.001	0.001	-0.003
	(0.008)	(0.005)	(0.004)	(0.008)	(0.001)	(0.003)	(0.002)	(0.001)	(0.003)	(0.003)	(0.002)	(0.003)
$\ln p_{FR3}$	-0.009	0.002	0.025	-0.012	0.001	-0.002	0.001	0.004	-0.014	0.006	0.003	-0.005
	(0.007)	(0.004)	(0.004)	(0.006)	(0.001)	(0.002)	(0.002)	(0.001)	(0.003)	(0.002)	(0.002)	(0.003)
$\ln p_{M6}$	0.025	0.012	-0.012	0.064	0.000	0.001	-0.001	0.003	0.008	-0.024	-0.009	-0.010
	(0.017)	(0.008)	(0.006)	(0.022)	(0.001)	(0.005)	(0.004)	(0.001)	(0.007)	(0.007)	(0.005)	(0.007)
$\ln p_{FR5}$	-0.002	0.000	0.001	0.000	0.004	-0.001	0.006	-0.001	0.000	0.001	0.001	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)
$\ln p_{D8}$	-0.016	-0.008	-0.002	0.001	-0.001	0.018	0.000	0.001	-0.003	-0.005	0.007	0.008
	(0.005)	(0.003)	(0.002)	(0.005)	(0.000)	(0.002)	(0.001)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)
$\ln p_{NT1}$	-0.014	-0.010	0.001	-0.001	0.006	0.000	0.037	-0.000	0.003	-0.004	-0.007	0.000
	(0.004)	(0.002)	(0.002)	(0.004)	(0.001)	(0.001)	(0.002)	(0.000)	(0.002)	(0.001)	(0.001)	(0.002)
$\ln p_{FR4}$	-0.003	-0.004	0.004	0.003	-0.001	0.001	-0.000	0.003	0.000	-0.003	-0.001	-0.009
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)
$\ln p_{TMC}$	-0.024	-0.004	-0.014	0.008	0.000	-0.003	0.003	0.000	0.042	-0.005	-0.006	0.008
	(0.006)	(0.003)	(0.003)	(0.007)	(0.001)	(0.002)	(0.002)	(0.001)	(0.004)	(0.003)	(0.002)	(0.003)
$\ln p_{Gulli}$	-0.014	0.001	0.006	-0.024	0.001	-0.005	-0.004	-0.003	-0.005	0.057	-0.003	-0.007
	(0.007)	(0.003)	(0.002)	(0.007)	(0.000)	(0.002)	(0.001)	(0.001)	(0.003)	(0.005)	(0.002)	(0.003)
$\ln p_{D17}$	0.001	0.001	0.003	-0.009	0.001	0.007	-0.007	-0.001	-0.006	-0.003	0.019	-0.007
	(0.005)	(0.002)	(0.002)	(0.005)	(0.000)	(0.002)	(0.001)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)
$\ln p_{W9}$	-0.029	-0.003	-0.005	-0.010	-0.002	0.008	0.000	-0.009	0.008	-0.007	-0.007	0.047
	(0.007)	(0.003)	(0.003)	(0.007)	(0.001)	(0.002)	(0.002)	(0.001)	(0.003)	(0.003)	(0.002)	(0.004)
$\ln Y$	0.836	-0.031	-0.079	-0.089	-0.029	-0.171	-0.068	-0.011	-0.075	-0.235	0.046	-0.090
	(0.251)	(0.073)	(0.049)	(0.161)	(0.009)	(0.071)	(0.031)	(0.010)	(0.053)	(0.129)	(0.041)	(0.009)
	Number of observations per equation: 69											

Note: Standard errors of estimates are in parentheses.

Table A7: First stage estimation of advertisers' demand with twice lagged prices as IVs

	$\ln p^t_{TF1}$	$\ln p^t_{FR2}$	$\ln p^t_{FR3}$	$\ln p^t_{M6}$	$\ln p^t_{FR5}$	$\ln p^t_{D8}$	$\ln p^t_{NT1}$	$\ln p^t_{FR4}$	$\ln p^t_{TMC}$	$\ln p^t_{Gulli}$	$\ln p^t_{D17}$	$\ln p^t_{W9}$
$\ln p^{t-2}_{TF1}$	0.248	0.181	0.501	0.265	0.481	0.328	0.075	-1.245	-0.176	0.329	0.333	-0.134
	(0.10)	(0.47)	(0.55)	(0.44)	(0.61)	(0.38)	(0.27)	(0.60)	(0.28)	(0.44)	(0.31)	(0.45)
$\ln p^{t-2}_{FR2}$	-0.869	-0.935	-1.183	-0.980	-1.525	-0.914	-0.565	-0.379	-0.553	-0.236	-0.481	-0.968
	(0.04)	(0.41)	(0.49)	(0.39)	(0.54)	(0.34)	(0.24)	(0.53)	(0.25)	(0.38)	(0.27)	(0.40)
$\ln p^{t-2}_{FR3}$	0.513	-0.105	0.434	0.252	0.351	0.395	0.221	0.321	0.220	0.198	0.185	0.194
	(0.40)	(0.41)	(0.28)	(0.39)	(0.53)	(0.33)	(0.23)	(0.53)	(0.25)	(0.38)	(0.27)	(0.39)
$\ln p^{t-2}_{M6}$	-0.09	0.445	0.068	0.351	-0.121	-0.019	0.012	0.775	0.312	0.569	-0.005	0.925
	(0.44)	(0.45)	(0.54)	(0.23)	(0.59)	(0.37)	(0.26)	(0.58)	(0.27)	(0.42)	(0.30)	(0.44)
$\ln p^{t-2}_{FR5}$	-0.178	0.014	-0.210	-0.106	0.230	-0.097	-0.150	0.058	-0.234	-0.890	-0.338	-0.324
	(0.29)	(0.30)	(0.35)	(0.28)	(0.18)	(0.24)	(0.17)	(0.38)	(0.18)	(0.28)	(0.20)	(0.29)
$\ln p^{t-2}_{D8}$	-0.285	-0.652	-0.433	-0.289	-0.738	0.569	-0.106	-0.197	0.007	-0.032	-0.107	-0.300
7	(0.18)	(0.19)	(0.22)	(0.18)	(0.24)	(0.15)	(0.11)	(0.24)	(0.11)	(0.17)	(0.12)	(0.18)
$\ln p^{t-2}_{NT1}$	0.422	0.158	0.085	0.334	0.481	0.339	0.943	0.646	0.196	0.501	1.250	0.231
	(0.37)	(0.38)	(0.45)	(0.36)	(0.49)	(0.31)	(0.022)	(0.48)	(0.23)	(0.35)	(0.25)	(0.36)
$\ln p^{t-2}_{FR4}$	-0.078	-0.140	0.016	-0.012	-0.114	-0.133	-0.051	0.691	-0.009	-0.131	-0.064	-0.170
	(0.10)	(0.10)	(0.12)	(0.10)	(0.13)	(0.08)	(0.06)	(0.13)	(0.06)	(0.10)	(0.07)	(0.10)
$\ln p^{t-2}_{TMC}$	-0.367	-0.340	-0.575	-0.287	-0.523	-0.132	-0.061	-0.888	0.366	-0.829	-0.723	-0.428
	(0.43)	(0.44)	(0.52)	(0.42)	(0.57)	(0.36)	(0.25)	(0.56)	(0.21)	(0.41)	(0.29)	(0.42)
$\ln p^{t-2}_{Gulli}$	0.217	0.239	0.297	0.296	0.128	-0.171	0.107	0.453	0.228	0.384	-0.034	0.264
	(0.17)	(0.17)	(0.20)	(0.16)	(0.22)	(0.14)	(0.10)	(0.22)	(0.10)	(0.16)	(0.11)	(0.17)
$\ln p^{t-2}_{D17}$	0.215	0.351	0.273	0.170	0.449	0.290	0.184	-0.037	0.121	-0.034	0.280	0.350
	(0.22)	(0.23)	(0.27)	(0.22)	(0.29)	(0.18)	(0.13)	(0.29)	(0.14)	(0.21)	(0.15)	(0.22)
$\ln p^{t-2}_{W9}$	-0.008	0.265	0.158	0.059	0.348	0.044	-0.173	-0.101	-0.072	0.105	0.024	0.304
	(0.26)	(0.26)	(0.31)	(0.25)	(0.34)	(0.21)	(0.15)	(0.34)	(0.16)	(0.24)	(0.17)	(0.15)
$\ln Y$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Number of observations per equation: 67											

Note: Standard errors of estimates are in parentheses.

Table A8: First stage estimation of advertisers' demand with competitors' broadcasting content as IVs

	$\ln p^t_{TF1}$	$\ln p^t_{FR2}$	$\ln p^t_{FR3}$	$\ln p^t_{M6}$	$\ln p^t_{FR5}$	$\ln p^t_{D8}$	$\ln p^t_{NT1}$	$\ln p^t_{FR4}$	$\ln p^t_{TMC}$	$\ln p^t_{Gulli}$	$\ln p^t_{D17}$	$\ln p^t_{W9}$
News_TF1	0.148	0.186	0.113	0.066	0.167	-0.041	0.037	-0.040	0.024	-0.021	0.098	0.158
	(0.04)	(0.05)	(0.07)	(0.04)	(0.05)	(0.06)	(0.05)	(0.11)	(0.05)	(0.07)	(0.06)	(0.06)
News_FR2	0.011	-0.043	-0.013	-0.037	-0.035	0.117	-0.028	-0.050	0.009	0.051	-0.003	-0.025
	(0.03)	(0.04)	(0.06)	(0.03)	(0.04)	(0.05)	(0.04)	(0.09)	(0.04)	(0.06)	(0.05)	(0.05)
News_FR3	0.045	0.024	-0.057	0.008	0.020	0.188	0.094	-0.037	0.101	-0.014	0.078	0.089
	(0.04)	(0.05)	(0.06)	(0.04)	(0.05)	(0.05)	(0.04)	(0.10)	(0.04)	(0.06)	(0.05)	(0.06)
News_M6	0.139	0.206	0.112	0.090	0.190	0.039	0.083	-0.044	0.068	0.082	0.100	0.150
	(0.04)	(0.04)	(0.06)	(0.03)	(0.05)	(0.05)	(0.04)	(0.10)	(0.04)	(0.06)	(0.05)	(0.06)
News_FR5	-0.022	-0.168	0.274	0.068	0.098	0.042	-0.239	0.669	0.178	0.410	-0.604	-0.217
	(0.23)	(0.27)	(0.39)	(0.21)	(0.31)	(0.32)	(0.26)	(0.61)	(0.25)	(0.38)	(0.32)	(0.36)
News_D8	0.047	0.040	0.011	0.006	0.077	0.057	0.017	-0.055	0.011	-0.033	0.020	0.028
	(0.02)	(0.03)	(0.04)	(0.02)	(0.03)	(0.02)	(0.03)	(0.06)	(0.03)	(0.04)	(0.03)	(0.04)
News_NT1	0.077	0.060	0.029	0.030	0.055	0.180	0.058	0.016	0.076	-0.015	0.077	0.090
	(0.03)	(0.04)	(0.06)	(0.03)	(0.04)	(0.05)	(0.03)	(0.09)	(0.04)	(0.06)	(0.05)	(0.05)
News_FR4	0.142	0.127	0.299	0.280	0.010	-0.282	0.149	0.576	0.130	0.059	-0.083	0.180
	(0.13)	(0.15)	(0.22)	(0.12)	(0.17)	(0.18)	(0.14)	(0.34)	(0.14)	(0.22)	(0.18)	(0.20)
News_TMC	0.079	0.117	0.058	0.035	0.125	0.053	0.039	-0.045	0.015	0.022	0.114	0.060
	(0.03)	(0.03)	(0.05)	(0.03)	(0.04)	(0.04)	(0.03)	(0.08)	(0.03)	(0.05)	(0.04)	(0.04)
News_Gulli	-0.447	-0.462	-0.528	-0.370	-0.590	0.002	-0.017	-0.875	-0.253	0.250	0.258	-0.227
	(0.16)	(0.19)	(0.27)	(0.15)	(0.21)	(0.22)	(0.18)	(0.42)	(0.18)	(0.17)	(0.23)	(0.25)
News_D17	-0.265	-0.142	-0.345	-0.199	-0.241	-0.216	-0.219	-0.281	-0.311	-0.614	-0.470	-0.274
	(0.13)	(0.04)	(0.22)	(0.12)	(0.18)	(0.19)	(0.15)	(0.35)	(0.15)	(0.22)	(0.19)	(0.11)
News_W9	0.122	0.142	0.078	0.051	0.214	-0.060	0.079	0.127	-0.003	-0.053	0.073	0.161
	(0.04)	(0.04)	(0.06)	(0.03)	(0.05)	(0.05)	(0.04)	(0.09)	(0.04)	(0.06)	(0.05)	(0.06)
Ent_TF1	0.018	0.041	0.026	0.008	0.041	-0.075	-0.010	-0.057	-0.022	-0.034	-0.030	-0.030
	(0.02)	(0.02)	(0.04)	(0.02)	(0.03)	(0.03)	(0.02)	(0.05)	(0.02)	(0.03)	(0.03)	(0.03)
Ent_FR2	-0.015	0.041	-0.013	-0.031	0.028	-0.131	-0.037	-0.074	-0.090	-0.106	-0.022	-0.085
	(0.02)	(0.03)	(0.04)	(0.022)	(0.03)	(0.03)	(0.03)	(0.06)	(0.03)	(0.04)	(0.03)	(0.04)
Ent_FR3	0.021	0.013	0.045	0.009	0.022	-0.074	-0.051	0.088	-0.004	-0.069	-0.066	-0.047
	(0.03)	(0.04)	(0.06)	(0.03)	(0.04)	(0.05)	(0.04)	(0.09)	(0.04)	(0.06)	(0.05)	(0.05)
Ent_M6	0.028	0.059	0.050	-0.002	0.036	-0.138	-0.029	-0.097	-0.047	-0.025	-0.008	-0.026
	(0.03)	(0.03)	(0.05)	(0.03)	(0.04)	(0.04)	(0.03)	(0.08)	(0.03)	(0.05)	(0.04)	(0.05)
Ent_FR5	-0.122	-0.340	-0.230	0.041	-0.295	0.849	0.214	0.723	0.421	0.404	0.213	0.478
	(0.18)	(0.22)	(0.32)	(0.18)	(0.03)	(0.26)	(0.21)	(0.50)	(0.21)	(0.31)	(0.26)	(0.30)
Ent_D8	-0.037	-0.001	-0.038	-0.031	-0.005	-0.047	-0.009	-0.105	-0.065	-0.027	-0.003	-0.049
	(0.02)	(0.029)	(0.04)	(0.02)	(0.03)	(0.03)	(0.03)	(0.06)	(0.03)	(0.04)	(0.03)	(0.04)
Ent_NT1	0.042	0.031	0.050	0.022	0.056	-0.111	-0.027	-0.020	-0.059	-0.062	-0.062	-0.100
	(0.03)	(0.04)	(0.05)	(0.03)	(0.04)	(0.04)	(0.03)	(0.08)	(0.03)	(0.05)	(0.04)	(0.05)
Ent_FR4	0.024	0.022	0.009	0.004	0.023	-0.017	-0.024	-0.116	-0.050	-0.093	0.008	-0.037
	(0.02)	(0.03)	(0.04)	(0.02)	(0.03)	(0.03)	(0.03)	(0.06)	(0.03)	(0.04)	(0.03)	(0.04)
Ent_TMC	0.020	0.084	0.054	-0.007	0.060	-0.189	-0.028	0.150	-0.059	-0.054	-0.059	-0.024
	(0.04)	(0.04)	(0.06)	(0.04)	(0.05)	(0.05)	(0.04)	(0.10)	(0.03)	(0.06)	(0.05)	(0.06)
Ent_Gulli	-0.012	0.014	0.017	-0.037	0.000	-0.042	-0.026	-0.090	-0.013	-0.062	-0.011	-0.066
	(0.03)	(0.04)	(0.054)	(0.03)	(0.04)	(0.04)	(0.04)	(0.08)	(0.04)	(0.05)	(0.04)	(0.05)
Ent_D17	0.032	0.026	0.017	0.021	0.024	-0.019	-0.015	-0.121	-0.023	0.018	-0.006	-0.029
	(0.02)	(0.02)	(0.05)	(0.02)	(0.03)	(0.03)	(0.03)	(0.05)	(0.02)	(0.03)	(0.03)	(0.03)
Ent_W9	0.016	0.038	0.049	0.003	0.027	-0.067	0.024	-0.063	-0.025	-0.038	0.037	-0.031
	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.06)	(0.03)	(0.04)	(0.03)	(0.04)
$\ln Y$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Number of observations per equation: 69											

Note: Standard errors of estimates are in parentheses.

Table A9: Own- and cross-price elasticities of advertisers' demand

	TF1	FR2	FR3	M6	FR5	D8	NT1	FR4	TMC	Gulli	D17	W9
TF1	**−0.30**	0.00	0.01	0.28	0.00	−0.00	*-0.04*	−0.00	*-0.06*	−0.01	0.02	−0.01
	(0.05)	(0.02)	(0.01)	(0.04)	(0.00)	(0.01)	*(0.01)*	(0.00)	*(0.01)*	(0.01)	(0.01)	(0.01)
FR2	−0.02	**−0.21**	0.06	0.46	0.01	*-0.14*	*-0.17*	*-0.07*	−0.04	0.05	0.04	−0.02
	(0.16)	**(0.10)**	(0.07)	(0.16)	(0.02)	*(0.05)*	*(0.04)*	*(0.01)*	(0.07)	(0.07)	(0.05)	(0.07)
FR3	0.20	0.10	**−0.18**	−0.16	0.02	−0.04	0.06	0.13	*-0.38*	0.21	0.12	−0.10
	(0.22)	(0.12)	**(0.10)**	(0.20)	(0.03)	(0.07)	(0.06)	(0.02)	*(0.10)*	(0.08)	(0.07)	(0.09)
M6	0.59	0.10	−0.02	**−0.75**	0.01	0.04	0.02	0.02	0.09	*-0.08*	−0.02	0.00
	(0.08)	(0.04)	(0.03)	**(0.10)**	(0.01)	(0.02)	(0.02)	(0.01)	(0.03)	*(0.03)*	(0.02)	(0.03)
FR5	0.07	0.11	0.17	0.29	**−0.33**	*-0.21*	−0.02	*-0.10*	0.05	0.13	0.13	*-0.26*
	(0.22)	(0.15)	(0.14)	(0.22)	**(0.10)**	*(0.07)*	(0.12)	*(0.03)*	(0.15)	(0.08)	(0.09)	*(0.11)*
D8	−0.05	*-0.23*	−0.04	0.27	*-0.04*	**−0.37**	0.04	0.03	−0.04	*-0.13*	0.25	0.30
	(0.17)	*(0.09)*	(0.07)	(0.17)	*(0.01)*	**(0.07)**	(0.04)	(0.01)	(0.06)	*(0.08)*	(0.05)	(0.07)
NT1	*-0.35*	*-0.28*	0.06	0.19	0.20	0.04	**−0.29**	0.19	0.31	0.05	*-0.21*	0.05
	(0.12)	*(0.06)*	(0.07)	(0.12)	(0.02)	(0.04)	**(0.07)**	(0.02)	(0.08)	(0.12)	*(0.05)*	(0.06)
FR4	−0.16	*-0.65*	0.83	0.83	*-0.11*	0.20	0.02	**−0.47**	0.06	*-0.54*	*-0.14*	0.07
	(0.27)	*(0.13)*	(0.13)	(0.26)	*(0.03)*	(0.08)	(0.09)	**(0.04)**	(0.14)	*(0.10)*	*(0.09)*	(0.13)
TMC	*-0.49*	−0.04	*-0.24*	0.39	0.03	−0.03	0.17	0.20	**−0.09**	*-0.08*	*-0.10*	0.21
	(0.13)	(0.07)	*(0.06)*	(0.13)	(0.02)	(0.04)	(0.05)	(0.01)	**(0.03)**	*(0.05)*	*(0.05)*	(0.07)
Gulli	−0.11	0.11	0.28	0.11	0.03	−0.16	0.14	*-0.11*	0.02	**−0.38**	−0.09	−0.00
	(0.30)	(0.14)	(0.10)	(0.30)	(0.02)	(0.10)	(0.06)	*(0.02)*	(0.10)	**(0.22)**	(0.08)	(0.13)
D17	0.53	0.11	0.19	−0.22	0.04	0.38	*-0.30*	−0.03	*-0.25*	−0.11	**−0.06**	*-0.30*
	(0.24)	(0.12)	(0.11)	(0.24)	(0.02)	(0.08)	*(0.07)*	(0.02)	*(0.11)*	(0.10)	**(0.01)**	*(0.11)*
W9	−0.10	−0.02	−0.06	0.02	*-0.03*	0.19	0.03	0.01	0.21	*-0.12*	*-0.12*	**−0.05**
	(0.15)	(0.07)	(0.06)	(0.14)	*(0.01)*	(0.05)	(0.04)	(0.01)	(0.07)	*(0.06)*	*(0.05)*	**(0.02)**

Note: The estimates of elasticities are averaged over the entire period of observations.
Own-price elasticities are in bold. Negative cross-price elasticities statistically significant at 10% are in italic.
Standard errors of these average estimates of elasticities computed by the delta method are in parentheses.

Table A10: Effects of the acquisition on the amounts and prices of advertising (01.2011–12.2013)

	Advert Quantity (percent change) coeff.	(s.e.)	Advert Price (percent change) coeff.	(s.e.)
$TF1 \times Acquisition$	27.05***	(0.096)	23.83***	(0.096)
$NT1 \times Acquisition$	52.60***	(0.116)	134.44***	(0.182)
$TMC \times Acquisition$	43.74***	(0.109)	115.84***	(0.168)
$Others \times Acquisition$	41.56***	(0.091)	55.16***	(10.269)
Channel FE	Yes		Yes	
Month -Year FE	Yes		Yes	

Note: The percentage amount of advertising and price effects are obtained from a transformation of the parameters ρ_j and λ_j using $\exp(\rho_j) - 1$ and $\exp(\lambda_j) - 1$. $Others \times Acquisition$ presents the estimated average effect of the acquisition on the non-merging channels. Standard errors are computed using the delta method. ***p <0.01, **p <0.05, *p <0.1

Table A11: Simulated impacts of the merger of ASHs

	TF1	NT1	TMC	TF1 Group average
Panel 1: Merger effects with two-sided network externalities				
% Changes in amount of advertising	6.17%	0.37%	2.22%	2.90%
% Changes in price of advertising	−0.67%	−2.37%	−0.61%	−0.77%
Panel 2: Merger effects in the absence of two-sided externalities				
% Changes in amount of advertising	2.97%	2.11%	1.06%	2.04%
% Changes in price of advertising	−1.52%	−3.74%	−4.22%	−2.03%

Note: The percentage changes compare the equilibrium outcomes under joint advertising sales for channel TF1, NT1 and TMC to the equilibirum outcomes under independent advertising sales for the three channels. All the simulations are performed using post-acquisition data (i.e., between 2011 and 2013).

Table A12: Welfare effets of the acquisition

Viewers' surplus	Total cost of advertisements	Total profit (TF1 Group)	Total profit (others)
Panel 1: Observed equilibrium under the behavioral remedy			
−4.52%	19.52%	23.58%	41.26%
Panel 2: Simulated equilibrium in the absence of changes in broadcasting quality			
−0.74%	−0.76%	0.16%	−3.96%

Note: Panel 1 is the same as in Table 10. Panel 2 use the broadcasting quality, amount and prices of advertising presented in Panel 2 of Table 9.

Table A13: Welfare impacts of the merger of ASHs

% Changes in viewers surplus	% Changes in total advert cost	% Changes in profit of TF1 Group	% Changes in profit of other TV Group
−0.71%	4.08%	3.86%	6.84%

Note: The percentage changes compare the post-acquisition equilibrium (i.e., between 2011 and 2013) under and without the behavioral remedy.

Appendix B.1: Simulating post-merger equilibrium

The merger simulation is performed using the FOCs described in Section 5.2, namely, Equation (13). Note that the viewership y_{jt} depends on the broadcasting quality q_{jt} according to the nested logit model for viewers' demand defined in Equation (5). In particular, $q_{jt} = X_{jt}\beta + \xi_{jt}$, where ξ_{jt} is a random term capturing the unobserved quality of channel j in period t and X_{jt} is a matrix of variables including observed content characteristics, channel-fixed effects, as well as month- and year-fixed effects. In the simulation, we hold fixed the estimated preference parameters (α, σ, γ_{jj}) and marginal costs (c_{jt}), but vary the numbers of TV viewers y_{jt}, amounts of advertising A_{jt}, and prices p_{jt}, until we find their optimal levels at the counterfactual equilibrium.

In practice, we can write down y_{jt} and p_{jt} of channel j at time t as functions of the $\mathbf{A}_t = (A_{1t}, ..., A_{Jt})$: $y_{jt} = f_1(\mathbf{A}_t, \bar{q}_{jt})$ according to the nested logit model for viewers' demand defined in Equation (5) and $p_{jt} = f_2(\mathbf{A}_t, Y_t(\mathbf{A}_t))$ according to the advertisers' cost share equations given by Equation (8). In other words, Equations (13) can be written as:

$$\mathscr{F}(\mathbf{A}_t, p_{jt}(\mathbf{A}_t, Y_t(\mathbf{A}_t))) = 0, \forall j. \tag{14}$$

We numerically search for $\mathbf{A}_t^*$ which solves the Equation (14). The detailed simulation procedure is as follows:

1. Guess a vector of starting values of $\mathbf{A}_t$: $\mathbf{A}_t^0$ (we use the observed $\mathbf{A}_t$);
2. Compute $y_{jt}(\mathbf{A}_t^0, \bar{q}_{jt})$, $\forall jt$ according to the nested logit model: $y_{jt} = \dfrac{T_t \exp(\delta_{jt}/(1-\sigma))}{D_{gt}^{\sigma}[\sum_g D_{gt}^{(1-\sigma)}]}$, where T_t denotes the total population, $D_{gt} = \sum_{j \in g} \exp[\delta_{jt}/(1-\sigma)]$, $\delta_{jt} = \bar{q}_{jt} + \alpha A_{jt}^0$;
($\bar{q}_{jt}$ is estimated as in Section 5.1; we hold its value fixed in the simulation)
3. Compute $Y_t^0 = \sum_j^J y_{jt}(\mathbf{A}_t^0, \bar{q}_{jt})$;
4. Search for $\mathbf{p_t^0}$ which solve the FOCs: $\mathscr{F}(\mathbf{A}_t^0, p_{jt}(\mathbf{A}_t^0, Y_t^0(\mathbf{A}_t^0))) = 0$;
5. Find the corresponding advertisers' demand $\mathbf{A}_t^{'}$, which satisfies: $\frac{p_{jt}^0 A_{jt}^{'}}{\sum_j p_{jt}^0 A_{jt}^{'}} = \gamma_j + \sum_i^J \gamma_{ij} \ln p_{it}^0 + \theta_j (\ln Y_t^{'})$, with $Y_t^{'} = \sum_j^J y_{jt}(\mathbf{A}_t^{'}, \bar{q}_{jt})$ and $y_{jt}(\mathbf{A}_t^{'}, \bar{q}_{jt})$ computed as in step 2;
6. Stop if $\mathbf{A}_t^0 = \mathbf{A}_t^{'}$; restart otherwise, until we find the $\mathbf{A}_t^* = \mathbf{A}_t^0 = \mathbf{A}_t^{'}$.

Appendix B.2: Simulating post-merger equilibrium under inelastic viewers' demand

The simulation can be performed using the FOCs derived in Section 5.1, namely, Equation (13). Assuming that the viewers' demand is inelastic to advertising implies that the term $\frac{\partial y_i}{\partial A_j}$ is equal to 0, $\forall i$. Omitting the time index t for the sake of clarity, Equation (13) can be simplified as:

$$(p_j - c_j) + \sum_{k \in \mathscr{H}} A_k \frac{\partial p_k}{\partial A_j} = 0, \forall j. \tag{15}$$

In more detail, we first set the disutility of advertising to TV viewers, α, to 0 and compute the resulting viewership of the different TV channels $y_{jt}(\bar{q}_{jt})$ according to the nested logit model: $y_{jt} = \dfrac{T_t \exp(\delta_{jt}/(1-\sigma))}{D_{gt}^{\sigma}[\sum_g D_{gt}^{(1-\sigma)}]}$, where T_t denotes the total population, $D_{gt} = \sum_{j \in g} \exp[\delta_{jt}/(1-\sigma)]$, and $\delta_{jt} = \bar{q}_{jt}$ ($\bar{q}_{jt}$ is estimated as in Section 5.3.) Next, we hold fixed the value of $y_{jt}(\bar{q}_{jt})$, the estimated preference parameters (σ, γ_j, γ_{ij}, θ_j), and marginal costs (c_{jt}), but vary A_{jt} and p_{jt} until we find their optimal levels at the counterfactual equilibrium. In practice, we can write down the advertising price p_{jt} of channel j at time t as a function of $\mathbf{A}_t = (A_{1t}, ..., A_{Jt})$: $p_{jt} = f(\mathbf{A}_t, \bar{Y}_t)$, where $\bar{Y}_t = \sum_j^J y_{jt}(\bar{q}_{jt})$, according to the advertisers' cost share equations defined by Equation (8). In other words, Equations (15) can be written as:

$$\mathscr{F}(\mathbf{A}_t, p_{jt}(\mathbf{A}_t, \bar{Y}_t)) = 0, \forall j. \tag{16}$$

We numerically search for $\mathbf{A}_t^*$ which solves Equation (16). The detailed simulation procedure is as follows:

1. Guess a vector of starting values of $\mathbf{A}_t$: $\mathbf{A}_t^0$ (we use the observed $\mathbf{A}_t$);
2. Search for $\mathbf{p_t^0}$ which solve the FOCs: $\mathscr{F}(\mathbf{A}_t^0, p_{jt}(\mathbf{A}_t^0, \bar{Y}_t)) = 0$;
3. Find the corresponding advertisers' demand $\mathbf{A}_t^{'}$, which satisfies: $\frac{p_{jt}^0 A_{jt}^{'}}{\sum\limits_j p_{jt}^0 A_{jt}^{'}} = \gamma_j + \sum_i^J \gamma_{ij} \ln p_{it}^0 + \theta_j (\ln \bar{Y}_t)$;
4. Stop if $\mathbf{A}_t^0 = \mathbf{A}_t^{'}$; restart otherwise, until we find the $\mathbf{A}_t^* = \mathbf{A}_t^0 = \mathbf{A}_t^{'}$.

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