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Estimation of the indirect network effect: On the example of television advertising

The platform is an intermediary between groups of users whose direct interaction without the platform would be complicated or unachievable. A distinctive feature of platform markets is the presence of indirect network effects (or cross-platform effects), which consist of the fact that the demand of one group of users for platform services affects the demand of another group of users. In the presence of multidirectional network effects, an important platform's business decision is to determine the optimal volume of services that create negative network effects, since after a certain amount of effects the company starts to lose users on the other side of the platform. For the business model to be successful and profitable, the platform should take this relationship into account. This study makes a quantitative assessment of cross-platform network effects using data from the Russian television market. The author of the study obtained statistically significant positive audience effect and negative advertising effect.

Keywords: non-transactional platform; audience platform; indirect network effects; television market; advertising; Russia.

JEL classification: L10; L40; L51; L82.

1. Introduction

A platform is an intermediary between different groups of users whose direct interaction without the participation of the platform would be difficult or not possible at all. In this case, the platform's advantage, which generates its profit, is to reduce the transaction costs of such interactions. A distinctive feature of platform markets, reflecting their value, is the presence of indirect network effects. The essence of such effects is that the demand of one group of users for the services or products of the platform affects the demand of another group of users. Positive network effects act as economies of scale in consumption and create incentives to increase the size of the company. In the presence of multidirectional network effects, an important business decision of the platform is to determine the optimal volume of services that create negative network effects, since after a certain amount of them, the company starts to lose users on the other side of the platform. According to Gabszewicz et al. (2014), the first problem a TV channel faces is determining the optimal ratio between content and advertising (taking into account the legislative quantitative restrictions on the amount of advertising). The second problem is related to pricing: the "non-neutrality" of prices resulting from indirect network effects (the audience receives content for free, advertisers pay for advertising). In order for the business model to be successful and profitable, the platform should take into account the relationships between its users. Rochet and Tirole (2003)

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develop a model that demonstrates how the platform's decisions correspond to network effects. The authors claim that the economic value of the platform is created by transactions between pairs of end users; all sides are interested in making a deal. With the increase in the number of participants on one side of the platform, the utility of participants on the other side increases since every user has the opportunity to conclude more transactions. The demand is assumed to be proportional to the number of users. In turn, the number of users depends on the assessment of the utility of the transaction and the price assigned to the platform. The consumer decides to connect to the platform, provided that the utility of the transaction exceeds the price. Thus, the authors emphasize that not only price levels are important but also the price structure. Platforms should get both sides on board to maximize the number of transactions. However, quantitative assessment of network effects is not a trivial task.

The purpose of the research is to quantify the indirect network effects on the example of the Russian television market.

The paper is organized as follows. Section 2 is devoted to the theory of multi-sided markets. Section 3 describes the TV channel business model in accordance with the platform's theory. Section 4 provides a review of the literature with applied approaches to indirect network effect assessment on non-transaction platforms. Section 5 presents the data, and Section 6 introduces the methodology. Section 7 reports the estimation results. Finally, in Section 8, I present the conclusions of the analysis.

2. Theoretical aspects of the platforms concept

Media firms traditionally follow a business model that is based on their role as an intermediary between several sides of the market. Here, it should be highlighted that the terms platforms and multi-sided (or two-sided) markets are frequently used as synonyms, but these terms are different, although very close. A multi-sided market is a kind of market structure, while a platform provides the interaction between the sides of such a market. One of the first to show great interest in studying the concept of multi-sided markets were J. Tirole and J. Rochet. They have published several works devoted mainly to pricing in such markets (2003, 2006). The authors argue that, when developing a business model of the platform, it is necessary to take its structure into account. Platforms often treat one side as a profit center and the other as a loss-leader. The authors demonstrate that the platform's price structure (the decomposition of the total price between the sides) depends on the elasticity of usage volume with respect to the total price.

Most authors identify the following features of the platforms when defining them (Rochet, Tirole, 2003, 2006; Yablonsky, 2013; Hagiu, Wright, 2015; Shastitko, Parshina, 2016; Jullien et al., 2021):

1) intermediation of direct interactions between two or more sides;
2) the platform offers several products or services — one for each side;
3) network effects;
4) the pricing strategy is based on the network effects.

Within the framework of this study, indirect network effects are of the greatest interest. In fact, indirect network effects are the basis of the platform's business model and underlie the value of its services. Network effects can be classified as direct/indirect and positive/negative. Direct effects depict how an increase/decrease in the number of users in one group affects

the utility of this group; indirect effects, in turn, show how an increase/decrease in the number of users on one side of a platform affects the utility on the other side (Evans, Noel, 2008). A positive network effect emerges when an increase in the number of users leads to an increase in the utility of the same or another group of users; a negative effect leads to a decrease in the utility.

A TV channel has all the platform's chief characteristics: the first side of the platform is the audience, who demands for content; the second side is advertisers, who demand for audience to promote their product/service. These groups of users interact with each other through TV channels. The audience gets the content for free, while the advertisers have to pay for the ad placement. As for the indirect network effects, in this example two effects can be distinguished: (i) the amount of advertisement affects the audience demand (advertising effect), and (ii) the audience size, in turn, affects the demand of advertisers (audience effect).

3. The TV channel's business model as a non-transactional platform

The business model of the TV channel is based on its role as an intermediary between the audience and advertisers; the interaction of these groups leads to the emergence of indirect network effects.

The major product that the TV channel offers is audiovisual content demanded by the audience. At the same time, TV channels "provide advertisers with access" to the audience by selling airtime for the advertisement placement. Advertisers are interested in a large audience since the viewers can be potential buyers of their product. However, frequent and prolonged ad blocks can negatively affect the utility of the audience. So, the channel needs to determine the optimal ratio of main content and advertising on the air. Also, the audiovisual content itself and the content and duration of advertising may, to some extent, be a subject to regulation by the authorities. That is why the state, represented by regulatory bodies (for example, the Ministry of Culture), can potentially influence and define the business model. An obvious example is the ban on TV advertising of tobacco and alcohol products. It should also be noted that Russian TV channels systematically receive subsidies from the state budget, so the state undoubtedly influences the environment in which TV channels function. In addition to selling airtime for advertising, the channel can gain income from subscriptions (access to unique content with smaller amounts of advertising), trade (products from TV shows, movies, and series), product placement, and sales of produced programs. Still, from a platform profit maximization point of view, the audience is the most important group of users. Viewers determine the value of TV shows and advertising, since advertisers are interested in higher-rated programs (McPhillips, Merlo, 2008). In other words, the success of a TV channel is determined by how it manages to attract both the audience and advertisers.

The existing classifications of platforms are examined in order to give a brief description of such a type of platform as a TV channel. Rochet and Tirole (2003) distinguish four types of platforms' business models depending on the product offered: software, media, payment systems and others (including shopping malls). Moreover, the authors emphasize that for each type of platform the sides can be divided into subsidized and subsidizing ones. Table 1 presents the authors' classification with examples and the allocation of subsidizing and subsidized sides.

Table 1. Classification of platforms' business models proposed by Rochet and Tirole (2003)

Product/Service	Platform example	Subsidized side	Subsidizing side
Software	Operating system	Application Developers	Clients
Portals, media	TV channels	Audience	Advertisers
Payment systems	Credit cards	Card holders	Merchants
Others	Shopping malls	Buyers	Shops

Regarding audience platforms, the authors focus on the fact that the audience, as a rule, receives content for free (if we are not talking about cable or other pay TV), and advertisers pay to advertise on the TV channel, i.e. pay for the attention of the audience. Cash flows from advertisers to the channel depend on the size of the audience (the number of viewers) and its characteristics (the target audience of the company); cash flows from the audience to the channel depend on the quality and quantity of content and the amount of advertising (if we are talking about pay TV).

The second well-known classification, which also deserves attention, is based on whether a transaction between user groups is visible for the platform (transaction platform) or not (non-transaction platform). In turn, non-transaction platforms can be divided into matching platforms and the audience platforms (Pontual Ribeiro, Golovanova, 2020). A brief description of the above types of platforms with examples is presented in Table 2.

Under the above classification, the TV channel is a non-transaction platform operating in two interrelated markets: the audiovisual content market and the advertising market. Indirect network effects in this case can have different signs: presumably the audience effect (the influence of audience size on the advertisers' demand) is positive, and the advertising effect (the influence of the number of advertisers on the audience demand) is negative or absent.

Table 2. Classification of platforms based on observability of transactions between user groups and the direction of indirect network effect

Characteristic	Transaction platforms	Matching platforms	Audience-providing platforms
Transaction	Transactions are concluded; the transaction is clearly identified by the platform	Transactions can be concluded, but the platform cannot identify them	No transactions are made
Definition	A multi-sided business, the product of which is the ability to make transactions	A multi-sided business that allows the parties to "find each other"	Separate but linked markets. One side makes a demand for content, the other — for the first side (the audience)
Network effects	The effects for all sides are positive		They may be different signs
Pricing strategy	The price affects the trading volume, so commissions from different parties are charged separately	Participation fee only or third party fee. The participation fee is different for each party.	Participation fee only. If the audience generates strong positive indirect network effects, it is reasonable to minimize the fee
Example	Ali Express, Alibaba, Amazon	HeadHunter	TV, radio, Internet

Source: (Pontual Ribeiro, Golovanova, 2020).

4. Approaches to the quantitative assessment of indirect network effects in the case of non-transactional platforms

TV channels operate in two related markets: the audiovisual content market and the advertising market. Therefore, in order to assess the network effects between the sides, it is necessary to estimate the demand of the two groups of TV channel users. The first group of users is the audience, which demand for the platform's services in the provision of content (taking into account the amount of advertising). The second group is advertisers, who demand for the platform's services for ad placement. A distinctive feature of audience platforms as non-transaction ones is that indirect network effects can be of different signs. The audience effect is, as a rule, positive, while the advertising effect can be different. A positive advertising effect was revealed in the case of specialized magazines (Song, 2013) and "Yellow Pages" catalogues (Rysman, 2004), since the ad might be interesting and beneficial to the readers. For some audience platforms, the advertising effect was found to be not statistically significant with the ability of consumers to ignore the ad being the main explanation of the result (Argentesi, Filistrucchi, 2007; Fan, 2013). In the case of a TV channel, it is obvious to assume a negative effect of advertising because it interrupts the viewing of a TV program and viewers can not avoid the ad (Wilbur, 2008).

An important feature of the research on this topic is the panel structure of the data used. At least aggregate data was explored. However, some research also analyzes data by region, which influences the specifications of regression models because, in this case, there were prerequisites for assuming endogeneity in the models (Wilbur, 2008). For instance, the preferences of the audience from large regions could have a greater influence on the choice of content by the platform, as large regions contain more viewers.

As in (Berry, Waldfogel, 1999), in order to assess audience demand, researchers usually follow a unified methodology for demand assessment. In general, the equation for estimating audience demand can be represented as follows:

$$\ln(s_{jt}) - \ln(s_{0t}) = \alpha q_{jt} + \beta x_{jt} + \varepsilon_{jt}, \quad (1)$$

where (on the TV market example) s_{jt} is the market share of the channel j in time period t; s_{0t} is the market share of "outside good" (calculated as $1 - \sum_j s_{jt}$); x_{jt} is the vector of observed characteristics of the TV program (type, number of awards, etc.) on TV channel j during time period t; q_{jt} — the amount of advertising on channel j during time period t (α is the indirect network effect of advertising); ε_{jt} — an error term.

There are several approaches to estimating the advertisers' demand. One of them is similar to what is applied to estimate parameters of audience demand. For example, in the paper (Argentesi, Filistrucchi, 2007) the authors estimate the following equation:

$$\ln(s_{it}^A) - \ln(s_{0t}^A) = \beta^A x_{it}^A + \alpha^A p_{it}^A + \xi_{it}^A + \rho y_{it}^N, \quad (2)$$

where s_{it}^A is the number of advertising slots of newspaper i at time t relative to the total potential market size; $s_{0t}^A = 1 - \sum_i s_{it}^A$ is the market share of "external good"; x_{it}^A is observed newspaper's i characteristics; p_{it}^A is the advertising price; ξ_{it}^A is unobserved newspaper's i characteristics; y_{it}^N is the newspaper's i circulation. It is worth noting that in order to implement this approach, data on the shares of the newspapers in the advertising market is needed.

Another most common approach is the estimation of the inverse advertisers' demand function, represented by the following equation on the example of the television market (Willbur, 2008):

$$p_s = \lambda_q q_s + \lambda_V V_s + \lambda_d d_s + \lambda_x x_s + \varphi_s, \quad (3)$$

where p_s is the cost of advertising during the program s; q_s is the volume of advertising during the program s; V_s is the program's s audience size; d_s is the vector of audience demographic characteristics; x_s is the vector of characteristics of the program that affect the audience preferences; φ_s is a standard error. The coefficient λ_V reflects the indirect network effect of the audience. This approach is considered more universal as it does not require data on the shares of TV channels in the advertising market.

In recent papers devoted to the quantitative assessment of indirect network effects, an alternative approach to assessing the demand of advertisers was introduced. This approach is a kind of improvement of the equation presented in (3). This approach is an analysis of the advertiser's cost function, taking into account the audience of channels and the cost of ad placement. The final demand equation has the form (Zhang, 2022):

$$s_{jt}^A = \gamma_j + \sum_{i=1}^{J} \gamma_{ij} \ln(p_{it}) + \sum_{i=1}^{J} k_{ij} \ln(y_{it}) + \xi_{jt}^A, \quad (4)$$

where s_{jt}^A is the share of advertising costs spent on channel j in hour t in the total cost of advertising of hour t; p_{it} is the price of advertising on channel i in hour t; y_{it} is the audience of channel i of hour t; J is the total number of TV channels; γ_{it} and k_{it} are regression coefficients reflecting the relationship between other channels' prices and audience, respectively, and the share of advertising on channel j; ξ_{jt}^A is an error term.

The problem of endogeneity deserves special attention. In many papers devoted to the assessment of indirect network effects, the authors study data from several geographically defined regions that differ in size, demographic characteristics, consumers' preferences, etc., which is assumed to be the source of endogeneity. Prices, being used as explanatory variables, are another possible source of endogeneity. If these variables are included in the model, it is recommended

Table 3. Generalization of the results of the considered empirical studies

Paper	Market in question	Advertisers' demand equation	Advertising effect	Audience effect
Rysman (2004)	Directories Yellow Pages	(3)	Positive	Positive
Argentesi, Filistrucchi (2007)	Newspapers	(2)	Not estimated	Positive
Wilbur (2008)	TV	(3)	Negative	Positive
Jeziorski (2010)	Radio	(3)	Negative	Positive
Fan (2013)	Newspapers	(3)	Not estimated	Positive
Song (2013)	Magazines	(2)	Positive	Positive
Zhang (2022)	TV	(4)	Negative	Positive

Source: Rozhkina et al. (2022) updated by the author.

using instruments for them, for example, characteristics of other channels/newspapers not included in the sample (Argentesi, Filistrucchi, 2007). The characteristics of competitors can be used as a proxy for the closeness of competition in oligopolistic markets (Berry et al., 1995).

Table 3 provides a brief overview of studies on the topic. It can be noted that the approaches to assessing the demand of advertisers, represented by equations (2) and (3), are both widely used in research on the assessment of indirect network effects. The choice between them is mostly based on the data available to researchers. The approach outlined in equation (4) is currently represented by only one paper (Zhang, 2022).

As the equations are linear, they are evaluated either by the Ordinary Least Squares method or by the Two Stage Least Squares method with instrumental variables if the presence of endogenous variables is assumed. Specifications with fixed effects are also evaluated.

5. Data

The information base of the current study consists of data on three of the most popular Russian TV channels[2]: Channel Pervyj, Russia 1 and NTV. The author has collected data on ratings, characteristics of TV programs, duration and cost of advertising on these TV channels.

Audience. The source of audience demand data is Mediascope reports[3]. This company has been researching Russian media markets for more than 25 years: television, radio, printed media and the Internet. The company publishes five reports on the television market on a weekly basis: the 100 most popular programs, genre-leading programs, channel-leading programs, daily averages, and prime-time indicators. The basis for the information base of the current research is mainly the first report. This report is a list of the 100 most popular (according to ratings) TV programs for the week among 28 TV channels. For each program in the 100 most popular programs report, the date and time of airing, TV channel, rating and share are indicated[4]:

- *rating* is the average number of people who watched a TV channel/TV program, expressed as a percentage of the population (within the selected target audience);
- *share* is the average number of people who watched a TV channel/TV program, expressed as a percentage of the entire TV audience at a given time.

The reports are available in the context of two target audiences: the population over four years old and the population aged 18 to 54 years. It is not possible to select a region, but at the moment only two options are possible: reports on Moscow and Russia 100+ (Russian cities with a population of 100 thousand or more inhabitants), i.e. aggregated data. The sample of this study is based on data on the population over four years old living in cities with a population exceeding 100 thousand people. According to Mediascope analysts, the sample is representative: the TV Index project participants (about 22 thousand participants from about 10 thousand households) are selected in such a way as to preserve the gender-age and socio-demographic structure of the general population. The measurement of TV viewing indicators is carried out using special devices and software that are installed on all devices used by the households — peoplemeters. With the help of a special

[2] See https://www.rbc.ru/technology_and_media/07/12/2022/638f2ce79a79474841ee0985.

[3] See https://mediascope.net/data/.

[4] See https://mediascope.net/.

control panel, the project participants register the start and end times of watching television programs. The device automatically records which channel each of the family members is watching, when and for how long the viewing takes place.

The unit of observation is the channel/day/program/hour. Data on characteristics of television viewing and characteristics of TV programs for two 'composite' days (weekday and weekend) in 2022 and 2023 were collected. The author has collected data for the time interval from 10:00 to 00:00 (for 2023) and from 7:00 to 00:00 (for 2022). In total, there are 84 observations in the current database for the year 2023 (3 channels × 2 days × 14 hour intervals) and 102 observations for the year 2022 (3 channels × 2 days × 17 hour intervals). In addition to data on TV viewing indicators, data on program characteristics (type, duration) were collected. The Mediascope report identifies 12 program types: news, analytical programs, films, TV series, humorous programs, musical programs, educational programs, socio-political programs, sports, entertainment programs, kids' programs, and documentary programs. Another characteristic of TV programs is their duration; the longest TV shows in this study include those with a duration of an hour or more.

Table 4 presents the average ratings of programs on the TV channels in question. In 2023, compared to 2022, there is a decrease in the average programs' ratings on the weekend for all of them. As for the programs' ratings on a weekday, they decrease in the case of Pervyj Channel and Russia 1 and increase in the case of NTV.

Table 5 shows the average ratings of TV channels by TV program type. On the Pervyj channel, the highest-rated programs are TV series (weekday) and news (weekend), on Russia 1 — TV series and entertainment programs, respectively, and on NTV — TV series and socio-political

Table 4. Average ratings of TV channels programs, %

Channel	2022		2023	
	Weekday	Weekend	Weekday	Weekend
Pervyj	2.14	2.37	1.92	1.79
Russia 1	3.89	3.98	3.48	3.01
NTV	1.90	2.97	1.94	2.51

Note. Calculation for 2022 on a comparable sample (hourly intervals from 10:00 to 00:00).

Table 5. Average ratings by TV channels and types in 2023, %

Types	Pervyj channel		Russia 1		NTV	
	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
News	2.04	2.18	3.62	3.57	1.90	—
Analytical	—	—	—	—	1.60	2.10
Films	—	—	—	3.30	1.70	—
TV series	2.70	1.50	4.60	2.00	2.40	—
Humorous	—	1.90	—	—	—	—
Educational	1.20	1.50	1.50	1.90	—	1.60
Socio-political	1.83	—	3.68	—	1.50	3.43
Sports	—	1.60	—	—	—	—
Entertainment	—	—	2.40	3.87	2.30	2.67
Documentary	—	1.80	—	—	—	1.80

programs, respectively. On weekends, the ratings of TV series on Pervyj and Russia 1 are lower (on NTV the series are not presented on the weekend); the ratings of entertainment programs on Russia 1 are the highest among the considered channels; the ratings of socio-political programs on NTV are higher compared to weekdays.

Table 6 depicts the distribution of TV programs by type in 2022 and 2023. On weekdays in 2023, as in 2022, most of the air was occupied by news and socio-political programs (about 70%). Also, more TV series have been put on the air, which have replaced analytical and entertainment programs. On weekends, entertainment programs are dominant (about 20%).

Table 6. The share of TV programs by type, %

Types	2022		2023	
	Weekday	Weekend	Weekday	Weekend
News	31	19	31	17
Analytical	0	14	2	2
Films	0	26	5	7
TV series	5	0	14	17
Humorous	0	0	0	5
Musical	0	0	0	0
Educational	3	5	5	12
Socio-political	45	7	38	7
Sports	0	0	0	5
Entertainment	14	22	5	21
Kids	0	0	0	0
Documentary	2	7	0	7

Note. Calculation for 2022 on a comparable sample (hourly intervals from 10:00 to 00:00).

So, the analysis of descriptive statistics shows that in 2023, as in 2022, socio-political programs and news predominate on the air of all TV channels in question. At the same time, the share of films and television series has increased. In 2023, the highest ratings of the considered TV channels are observed on the channel Russia 1. Note that according to the data of 2022, this channel was also the leader, and Channel Pervyj lost its position compared to last year.

Advertisers. Data on the duration of advertising was taken from the AdMonitor[5] website, which publishes a broadcast grid with ad blocks for one channel with a time lag of one day. Also, the site indicates that the data are provided for Moscow, but these data are also true for the regions since 1) federal advertising is the same for all regions; 2) the type of advertising (federal/regional) is not important; data are needed only on the duration of the ad blocks themselves.

Table 7 demonstrates data on the average duration of advertising on the TV channels in question. The average duration of advertising in 2023, compared to 2022, on Channel Pervyj and NTV has increased both on the weekday and on the weekend. Russia 1 is the only channel that reduces the advertising quantity both on a weekday and on the weekend. The fact that, on average, the least advertising is broadcast on this TV channel may explain the reason for the high ratings among the population. Another reason may be that channel Russia 1 charges the highest prices for ad placement (however, further data analysis rejects this hypothesis).

[5] See https://www.admonitor.ru/.

Table 7. The average duration of advertising per hour, min.

	Channel					
	Pervyj		Russia 1		NTV	
	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
2022	5.09	5.09	5.09	5.09	5.11	5.11
2023	7.72	7.29	4.81	4.61	8.77	8.96

Note. The data for the weekend and the weekday are the same. Calculation for 2022 on a comparable sample (hourly intervals from 10:00 to 00:00).

The cost of advertising on a TV channel is based on several factors, the main of which are the program rating and the price of one rating point (CPP) for a twenty-second video. The CPP is set by the channel at the beginning of each month. All advertising placement contracts are concluded through advertising agencies, and the number of rating points that the advertiser buys is fixed in the contracts. The data on the prices of one rating point (CPP) are taken from the website of the Brand Media[6] advertising agency. Table 8 shows the prices per unit of one rating point. Channel Pervyj retains the leading position among three of the most popular channels. Russia 1 and NTV set approximately the same CPP. For the TV channel Russia, the least difference in price is noticeable compared to the same period last year. This might be the reason for the observed reduction in the number of ads on this channel among the channels under consideration, since CPP on the other two channels has decreased.

Table 8. The price of one rating point (CPP) for a twenty-second video, rub.

Channel	2022	2023	Change, %
Pervyj	234200	190000	–18.87
Russia 1	78370	73731	–5.92
NTV	70420	61700	–12.38

Note. The Change is calculated as a growth rate of CPP.

Table 9 depicts the average cost of advertising by type of day in 2022 and 2023. Channel Pervyj is characterized by a significant decrease in the indicator, which is due to both a sharp decrease in CPP and a decrease in average ratings. Smaller losses are observed for the other two channels. In the case of Russia 1, an important role is played by the fact that this channel in 2023 has reduced the CPP the least compared to 2022. For NTV, there is an increase in ratings in 2023. The author

Table 9. The average cost of placing a 20-second commercial on channels, thousand rubles

Channel	2022		2023	
	Weekday	Weekend	Weekday	Weekend
Pervyj	478.04	497.33	365.07	339.29
Russia 1	273.37	274.30	256.48	221.72
NTV	125.51	189.72	119.43	155.13

[6] See http://www.brandmedia.ru/.

also notes that in 2023, on channels Pervyj and Russia 1, the average cost of placing a commercial lasting 20 seconds is higher on a working day.

6. Methodology

The methodology of the research is based on a review of the most well-known studies devoted to the quantitative assessment of indirect network effects in the media markets. The papers closest to the current study and focused on the television market are (Wilbur, 2008; Zhang, 2022).

In order to assess audience demand, this study follows the commonly accepted methodology presented by the equation (Berry, Waldfogel, 1999):

$$\ln(s_{jt}) - \ln(s_{0t}) = \alpha \cdot ad\_s_{jt} + \beta_1 fun_{jt} + \beta_2 poly_{jt} + \beta_3 long_{jt} + \gamma \cdot weekday_t + \varepsilon_{jt}, \quad (5)$$

where s_{jt} is the share of TV channel j at time t; s_{0t} is the share of all channels not included in the sample at time t; ad_s_{jt} is the share of advertising on the air on channel j at time t; fun_{jt} — binary variable for entertainment programs; $poly_{jt}$ — binary variable for socio-political, analytical programs and news; $long_{jt}$ — binary variable for programs that lasts more than hour; $weekday_t$ is a binary variable for weekday; ε_{jt} is an error term. The coefficient α reflects the indirect network effect of advertising, it is assumed that $\alpha < 0$.

To assess the advertisers' demand this study follows the approach applied in Wilbur (2008), described in equation (6):

$$\begin{aligned} \ln(p_{jt}) = \lambda_q ad\_q_{jt} + \lambda_r rate_{jt} + \lambda_f fun_{jt} + \lambda_p poly_{jt} + \lambda_k kino_{jt} + \\ + \lambda_l long_{jt} + \gamma \cdot weekday_t + \varphi_{jt}, \end{aligned} \quad (6)$$

where p_{jt} is the advertising cost on channel j at time t; ad_q_{jt} is the duration (in seconds) of advertising on TV channel j at time t; $rate_{jt}$ is the rating of the broadcast on channel j at time t; fun_{jt} — binary variable for entertainment programs; $poly_{jt}$ — binary variable for socio-political, analytical programs and news; $long_{jt}$ — binary variable for programs that lasts more than hour; $weekday_t$ is a binary variable for weekday, φ_{jt} is an error term. The coefficient λ_r reflects the audience indirect network effect, it is assumed that $\lambda_r > 0$.

A comment on the problem of endogeneity is also required. According to the review of studies on the evaluation of indirect network effects presented above, a number of variables might be endogenous. First, these might be prices (both of the product and advertising), as they might depend on unobserved factors revealing the broadcasting quality of the channel. The second reason for endogeneity is cross-regional differences (audience size, demographics, etc.) in the areas in question. The authors claim that in this case, the larger markets' tastes are of a great importance because they contain more viewers (Wilbur, 2008). Finally, several authors consider the amount of advertising in advertisers' demand model potentially endogenous. The reason is that an error term φ_{jt} may include unobserved program and audience characteristics (for instance, the audience fraction that consumes the advertised product) affecting the advertisers' demand (Wilbur, 2008; Zhang, 2017). In this case, the econometrician does not have this information, while the TV

channel is likely to have more data and take it into account when setting the advertising quantity. Wilbur (2008) uses the observed program's characteristics as instruments. Zhang (2017) chooses the number of films during prime time, the total amount of broadcast programs and the total ad quantity on the radio as instruments. As for the audience size, there are no obvious reasons to assume this variable is highly correlated with unobserved audience characteristics in advertisers' demand equation, but this variable might be endogenous only due to audience demand dependence on the ad quantity (Wilbur, 2008; Zhang, 2017). Wilbur (2008) uses the same instruments as for the ad quantity variable, while Zhang (2017) uses the published indicator "the average watching time per day per individual".

In this study, the author uses only prices for advertisers, which act as a dependent variable. Thus, this variable is not considered to be a source of endogeneity. The sample contains only aggregated data, so there is no information in the context of regions, which differences should be controlled. To deal with the potential endogeneity problem in advertisers' demand model, the author includes control variables, which are programs' characteristics (type and duration), following the approach of Wilbur (2008). Moreover, many of the instruments proposed by the researchers cannot be used in the models due to the limitations of the available data. There is a lack of public data on TV channels (otherwise they might be included in the sample) or relevant markets (as radio in (Zhang, 2017)).

The equations are evaluated separately by the ordinary least squares method. Given that the dataset has the form of panel data, specifications with fixed effects for TV channels are also tested. The preferences of both groups of users in relation to certain channels can be explained, for example, by the reputation/brand of TV channels. For advertisers, the history of cooperation with the TV channel may be significant, for example, the provision of discounts for multiple placement of advertising.

Data description and statistics for the 2022 and 2023 years are presented in Appendix.

7. Results

Tables 10 and 11 present the results of evaluating the audience and advertisers' demand models, respectively.

The evaluation of models for both samples, as expected, shows a negative statistically significant effect of advertising, except from models based on 2023 data with the inclusion of fixed effects of channels. In this model, the effect of advertising is statistically insignificant. For both samples, the evaluation of the models demonstrates a statistically significant positive audience effect underlying the platform's business model. Results of evaluation on the united sample, including data from 2022 and 2023, show a statistically significant negative advertising effect and a statistically significant positive audience effect. For example, with an increase in ratings by one unit (all other things being equal), advertisers' willingness to pay will increase by 35% (model 6 in the Table 11). And the increase in advertising share by 0.01 the audience loss will be 1.8% (model 6 in the Table 10).

There are also several interesting results related to control variables in the audience demand model.

• Unlike the results obtained in models based on the data from 2022, the program types are statistically significant in 2023. More detailed analysis shows that audience preferences changed

Table 10. Audience demand assessment. Dependent variable: $\ln(s_{jt}) - \ln(s_{0t})$

Regressors	2022		2023		United sample	
	(1)	(2)	(3)	(4)	(5)	(6)
const	–1.61***	–1.60***	–1.66***	–2.05***	–1.69***	–1.92***
	(0.19)	(0.19)	(0.09)	(0.09)	(0.08)	(0.08)
ad_s	–3.89**	–4.65***	–2.17***	–0.37	–2.79***	–1.80***
	(1.49)	(1.38)	(0.49)	(0.44)	(0.70)	(0.66)
long	0.09	0.06	–0.00	–0.11*	0.01	–0.005
	(0.12)	(0.11)	(0.08)	(0.06)	(0.07)	(0.06)
weekday	0.18	0.21*	0.28***	0.23***	0.22***	0.22***
	(0.12)	(0.11)	(0.07)	(0.05)	(0.07)	(0.06)
fun	0.18	0.19	0.30***	0.23***	0.19**	0.15*
	(0.16)	(0.16)	(0.08)	(0.07)	(0.09)	(0.09)
poly	0.23	0.14	0.11*	0.14***	0.19**	0.18**
	(0.14)	(0.14)	(0.07)	(0.06)	(0.08)	(0.07)
year_2023	—	—	—	—	0.06	0.04
					(0.08)	(0.07)
Method	OLS	OLS	OLS	OLS	OLS	OLS
FE channels	No	Yes	No	Yes	No	Yes
Observations	102	102	84	84	186	186
R-squared	0.12	0.26	0.32	0.61	0.16	0.31

Note. Robust standard errors in parentheses. *** — $p < 0.01$, ** — $p < 0.05$, * — $p < 0.1$.
Source: author's calculations according to Mediascope, AdMonitor.

in favour of entertainment as well as news, analytical and socio-political programs, which have become more attractive. An explanation for the types of programs to become statistically significant is a change in audience preferences. The data of 2022 were collected at the beginning of April, when the geopolitical situation sharpened and the broadcast of TV channels only adjusted to the situation. In 2022, the air was less heterogeneous in terms of program type diversity, and consumer preferences, presumably, were focused only on getting information about the situation in the world.

• The audience seems to prefer watching TV on weekdays rather than weekends both in 2022 and 2023. This result might reflect the fact that the audience prefers other leisure activities on weekends. Average ratings, as shown above, are higher on a weekday compared to the weekend for all TV channels except NTV.

• The program's duration effect is statistically insignificant in the majority of specifications, except from model (4), estimated on data of 2023 with TV channels fixed effects (see Table 10).

Several findings related to control variables in advertisers' demand model are worth mentioning.

• Advertisers' demand seems to be unaffected by the type of day and the duration of programs, both in 2022 and 2023.

• Among the variables responsible for the type of TV shows, a statistically significant coefficient is obtained only for the entertainment programs, which is positive.

• It is noteworthy that the variable combining the films and television series is statistically significant in 2022 but not in 2023.

Table 11. Advertisers' demand assessment. Dependent variable — the log of advertising price

Regressors	2022		2023		United sample	
	(1)	(2)	(3)	(4)	(5)	(6)
const	11.67***	12.18***	12.11***	12.17***	11.90***	12.24***
	(0.25)	(0.09)	(0.23)	(0.04)	(0.18)	(0.06)
ad_q/100	–0.00	–0.00	–0.04	–0.01***	–0.03	–0.02***
	(0.00)	(0.00)	(0.03)	(0.00)	(0.02)	(0.00)
rate	0.21***	0.37***	0.18***	0.33***	0.20***	0.35***
	(0.05)	(0.02)	(0.05)	(0.02)	(0.03)	(0.02)
weekday	–0.01	0.05	–0.14	–0.03	–0.09	0.005
	(0.12)	(0.04)	(0.11)	(0.02)	(0.08)	(0.02)
long	0.17	–0.03	–0.12	0.01	0.04	0.005
	(0.12)	(0.04)	(0.14)	(0.02)	(0.08)	(0.02)
fun	0.05	0.15**	0.22**	0.07***	–0.13	0.11***
	(0.20)	(0.06)	(0.11)	(0.02)	(0.10)	(0.04)
poly	0.40**	0.08	0.11	0.03	0.24*	0.04
	(0.18)	(0.06)	(0.15)	(0.02)	(0.12)	(0.04)
kino	0.74***	0.23***	0.01	0.03	0.30**	0.12***
	(0.23)	(0.08)	(0.18)	(0.03)	(0.14)	(0.04)
year_2023	—	—	—	—	–0.12	–0.08***
					(0.08)	(0.03)
Method	OLS	OLS	OLS	OLS	OLS	OLS
FE channels	No	Yes	No	Yes	No	Yes
Observations	102	102	84	84	186	186
R-squared	0.35	0.93	0.20	0.97	0.29	0.94

Note. Robust standard errors in parentheses. *** — $p < 0.01$, ** — $p < 0.05$, * — $p < 0.1$.
Source: author's calculations according to Mediascope, AdMonitor, Brand Media.

Table 12. Fixed effects of TV channels in audience and advertisers' demand models

	2022	2023	United sample
	Audience demand models		
	(2)	(4)	(6)
Russia 1	0.42***	0.52***	0.43***
	(0.12)	(0.07)	(0.07)
NTV	–0.11	0.17***	0.04
	(0.13)	(0.06)	(0.09)
	Advertisers' demand models		
	(2)	(4)	(6)
Russia 1	–1.15***	–0.92***	–1.05***
	(0.05)	(0.02)	(0.03)
NTV	–1.21***	–1.08***	–1.16***
	(0.05)	(0.02)	(0.03)

Note. Robust standard errors in parentheses. *** — $p < 0.01$.
Source: author's calculations according to Mediascope, AdMonitor, Brand Media.

We also assess if audience demand and advertisers' demand differ between the TV channels. Binary variables for Russia 1 and NTV channels are included in the models. The Pervyj channel is used as a base for the comparison. Table 12 demonstrates the results of the evaluation of the channel's fixed effects. As for audience demand, in 2022 a statistically significant coefficient is obtained only for channel Russia 1. The audience preferred watching it more than Pervyj. In 2023, statistically significant and positive fixed effects are obtained for both Russia 1 and NTV channels. However, the results of the estimation on the united sample reflect a statistically insignificant effect for channel NTV, like in 2022.

In contrast, the results of the estimation of advertisers' demand with channels fixed effects show that in both years advertisers preferred the channel Pervyj.

8. Discussion and conclusion

This paper contributes to the literature devoted to quantitative assessments of indirect network effects on non-transactional platforms. Author uses recent Russian data that characterizes audience and advertisers' demand for services provided by a specific type of platform, which are TV channels. The methodology applied is similar to the one applied by other authors, with minor modifications resulting from the specifics and restrictions of the data available.

The results of the analysis let us conclude that there is a statistically significant negative advertising effect and a positive audience effect. The results on indirect network effects estimation are consistent with the conclusions obtained in the papers of the researchers. When advertising is not the desired content (as in the case of thematic magazines) and there is no way to avoid watching ads (as in the case of newspapers), its expected effect on the audience's utility is negative. The revealed positive impact of ratings on advertisers' demand in Russia is also consistent with the initial research hypothesis and results of other studies. Advertisers are interested in the most watched TV programs since the viewers are potential buyers of their product/service, which they advertise.

The analysis of fixed effects shows that viewers prefer the channel Russia 1 to the channel Pervyj, while advertisers, in contrast, prefer the channel Pervyj, which sets the highest cost of advertising. The preferences of the audience and advertisers in relation to TV channels can be explained, for example, by the reputation/brand of the TV channel.

Some interesting results were obtained due to the inclusion of control variables in the model. For example, it found that viewers prefer to watch TV on a working day rather than on a weekend. It is revealed that TV programs related to entertainment, news, information-analytical and socio-political types are more popular on average, other things being equal. At the same time, neither type preferences nor duration preferences provide a statistically significant effect on audience demand in models estimated on 2022-year data. Regarding the preferences of advertisers, it is found that they are more willing to pay for the placement of their commercials during the entertainment programs, and in 2022 the same was true for ad placement during films and TV series.

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References

Argentesi E., Filistrucchi L. (2007). Estimating market power in a twosided market: The case of newspapers. *Journal of Applied Econometrics*, 22 (7), 1247–1266. DOI: 10.1002/jae.997.

Berry S., Levinsohn J., Pakes A. (1995). Automobile prices in market equilibrium. *Econometrica*, 63 (4), 841–890. DOI: 10.2307/2171802.

Berry S., Waldfogel J. (1999). Free entry and social inefficiency in radio broadcasting. *RAND Journal of Economics*, 30 (3), 397–420. DOI: 10.2307/2556055.

Evans D. S., Noel M. D. (2008). The analysis of mergers that involve multi-sided platform business. *Journal of Competition Law and Economics*, 4 (3), 663–695. DOI: 10.1093/joclec/nhn017.

Fan Y. (2013). Ownership consolidation and product characteristics: A study of the U. S. daily newspaper market. *American Economic Review*, 103 (5), 1598–2628. DOI: 10.1257/aer.103.5.1598.

Gabszewicz J. J., Resende J., Sonnac N. (2014). Media as multi-sided platforms. In: *Handbook on the Economics of the Media*, 3–36. Edward Elgar Publishing.

Hagiu A., Wright J. (2015). Multi-sided platforms. *International Journal of Industrial Organization*, 43, 162–174. DOI: 10.2139/ssrn.2794582.

Jeziorski P. (2010). Merger enforcement in two-sided markets. *Working Paper* No. 570. The Johns Hopkins University. https://www.econstor.eu/bitstream/10419/49873/1/638180503.pdf.

Jullien B., Pavan A., Rysman M. (2021). Two-sided markets, pricing, and network effects. In: *Handbook of Industrial Organization*, 4 (7), 485–592.

McPhillips S., Merlo O. (2008). Media convergence and the evolving media business model: An overview and strategic opportunities. *The Marketing Review*, 8, 237–253. DOI: 10.1362/146934708X337663.

Pontual Ribeiro E., Golovanova S. (2020). A unified presentation of competition analysis in two-sided markets. *Journal of Economic Surveys*, 34 (3), 548–571.

Rochet J., Tirole J. (2003). Platform competition in two-sided markets. *Journal of the European Economic Association*, 1 (4), 990–1029. DOI: 10.1162/154247603322493212.

Rochet J., Tirole J. (2006). Two-sided markets: A progress report. *The RAND Journal of Economics*, 37 (3), 645–667. DOI: 10.1111/j.1756-2171.2006.tb00036.x.

Rozhkina V. S., Golovanova S. V., Korneeva D. V. (2022). Quantitative assessment of cross-side network effects for non-transactional platforms. *Moscow University Economics Bulletin*, 4, 17–38 (in Russian). DOI: 10.38050/01300105202242.

Rysman M. (2004). Competition between networks: A study of the market for Yellow Pages. *The Review of Economic Studies*, 71 (2), 483–512. DOI: 10.1111/0034-6527.00512.

Shastitko A., Parshina E. (2016). Two-sided markets: The subject matter specification. *Journal of Modern Competition*, 10 (1), 5–18 (in Russian).

Song M. (2013). Estimating platform market power in two-sided markets with an application to magazine advertising. *Simon School Working Paper FR* 11–22.

Wilbur K. C. (2008). A two-sided, empirical model of television advertising and viewing markets. *Marketing Science*, 27 (3), 356–378.

Yablonsky S. A. (2013). Multi-sided platforms and markets: Basic approaches, concepts and practices. *Russian Management Journal*, 11 (4), 57–78 (in Russian).

Zhang J. (2017). Competition and regulation of the advertising financed media platforms. *Economics and Finance. Université Paris sciences et lettres*. https://theses.hal.science/tel-02425680/.

Zhang J. (2022). Welfare analysis of regulation on media platform advertising. *NET Institute Working Paper*, 16–06. DOI: 10.2139/ssrn.2847856.

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Appendix

Descriptive statistics of variables for 2022–2023

Symbol	Description	Mean		Standard deviation		Min		Max	
		2022	2023	2022	2023	2022	2023	2022	2023
ad_s	The share of advertising on the air	0.09	0.12	0.04	0.05	0	0	0.19	0.23
ad_q	Duration of the ad, seconds	332.51	421.56	143.90	195.47	0	0	700	830
rate	Program rating	2.60	2.44	1.33	1.07	0.40	1.20	6.80	5.80
CPP	Price of one rating point, rub.	127663	108477	75775	58201	70420	61700	234200	190000
P	The cost of advertising, rub.	306379	242853	186325	122264	28168	80210	796280	684000
long	1 if the duration of the program is more than an hour, 0 else	0.28	0.64	0.45	0.48	0	0	1	1
workday	1 for weekday, 0 else	0.50	0.50	0.50	0.50	0	0	1	1
fun	1 for entertainment programs, 0 else	0.22	0.13	0.41	0.34	0	0	1	1
poly	1 for news, analytical and socio-political programs, 0 else	0.55	0.49	0.50	0.50	0	0	1	1
kino	1 for films and TV series, 0 else	0.11	0.15	0.31	0.36	0	0	1	1

Source: Mediascope, AdMonitor, Brand Media.