Welfare Analysis of Advertising Regulation on Media Platforms

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Backgroud

Regulation of media platforms is being highly debated among academia, industry practitioners, and policy makers

➤ How to control the spreading of misinformation or harmful content on platforms which are ad-financed (social media)

➤ Legality of ad blocking software

This paper (contributes to these ongoing policy debates):

How restricting advertising on a media platform impacts its content provision ?

TV Advertising Regulation

A widespread policy

A classical example of two-sided media platform

Common policy: EU, UK, Australia, Israel, etc.

Rationale: provide consumers a channel to learn about the world and consume a variety of cultural content, without consuming an excessive amount of advertising

Problem: Content provision relies on advert revenues

$$\Downarrow$$

How do TV broadcasters respond to the regulation policy?

Research Design

➤ French market data: observe a regulated equilibrium

➤ Structural model and estimation:

◇ demand of viewers

◇ demand of advertisers

◇ two-stage game played by TV broadcasters

- programming genre choice
- advertising level

➤ Counterfactual (removing advertising restrictions): equilibrium programming choices, advertising levels, and consumer welfare

French Example

Rules

General constraints for all content:

- an average of 9 (6) mins per hour per day on private (public) TV
- maximum 12 (8) mins for each clock hour on private (public) TV

Additional constraints

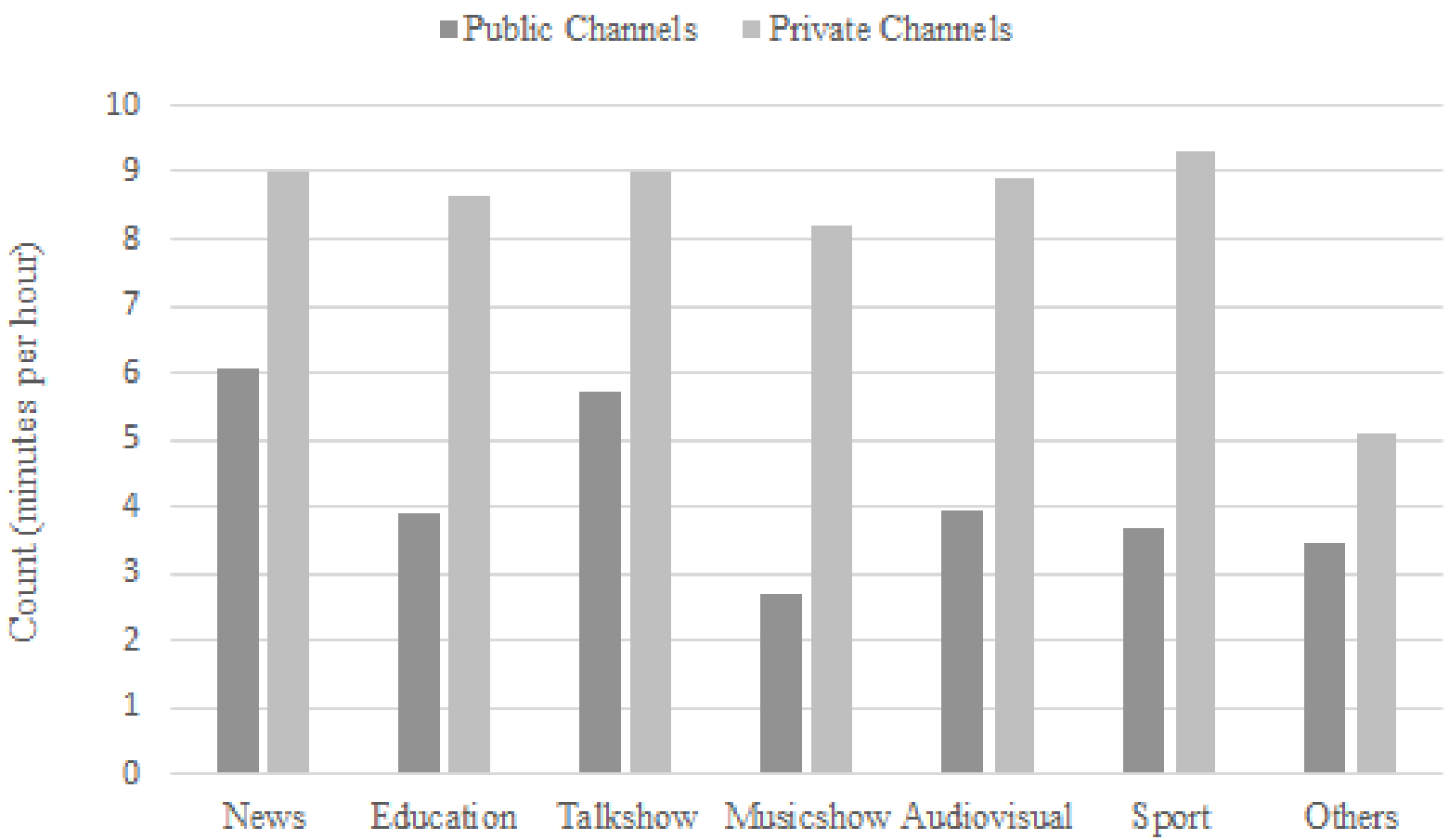
for educational and music programming, and

for all content that primarily target youth audience:

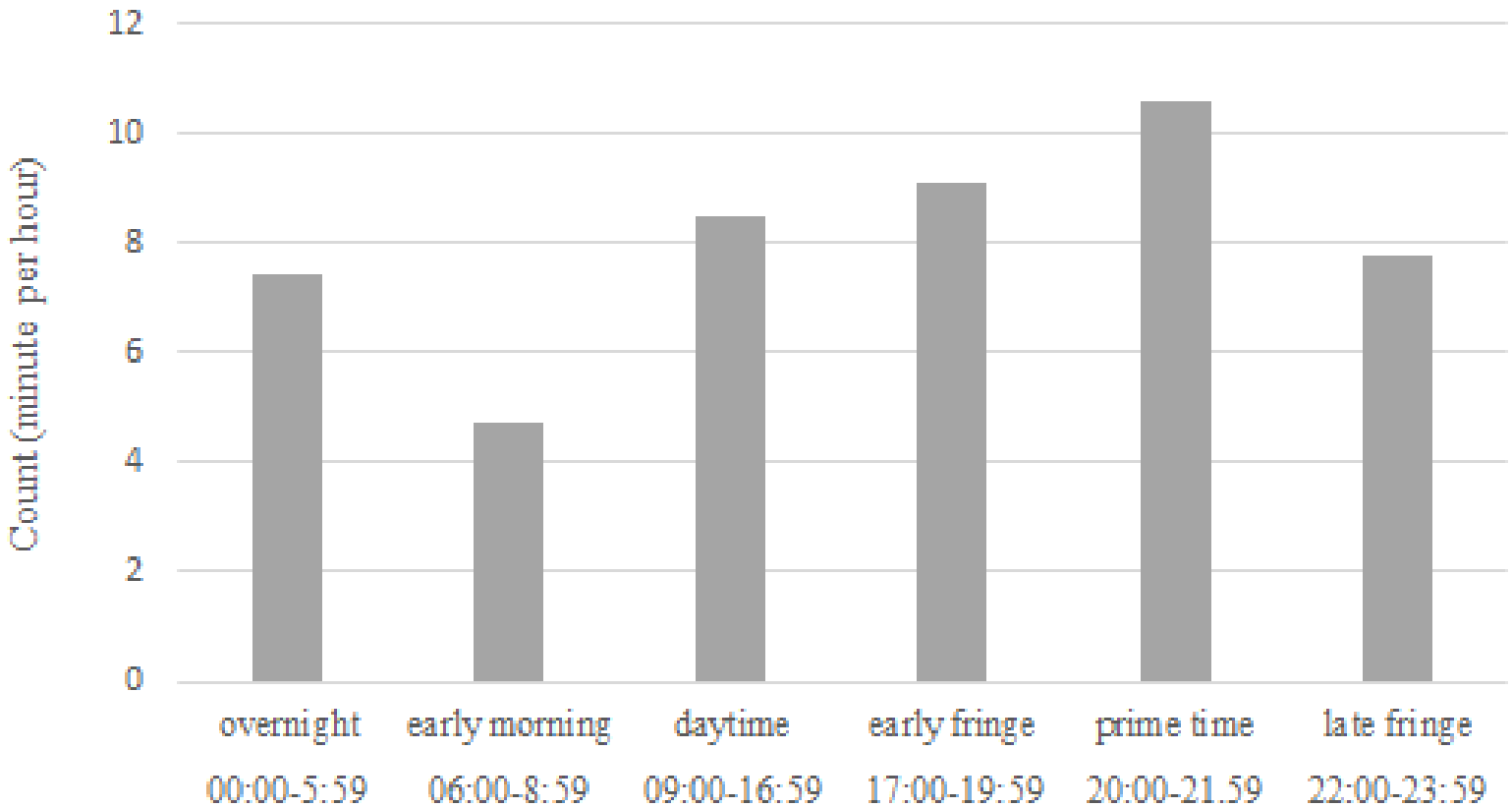
- at most 2 commercial breaks within 1 hour of broadcast

Commercial advertising ban for public TV from 8 p.m. to 6 a.m.

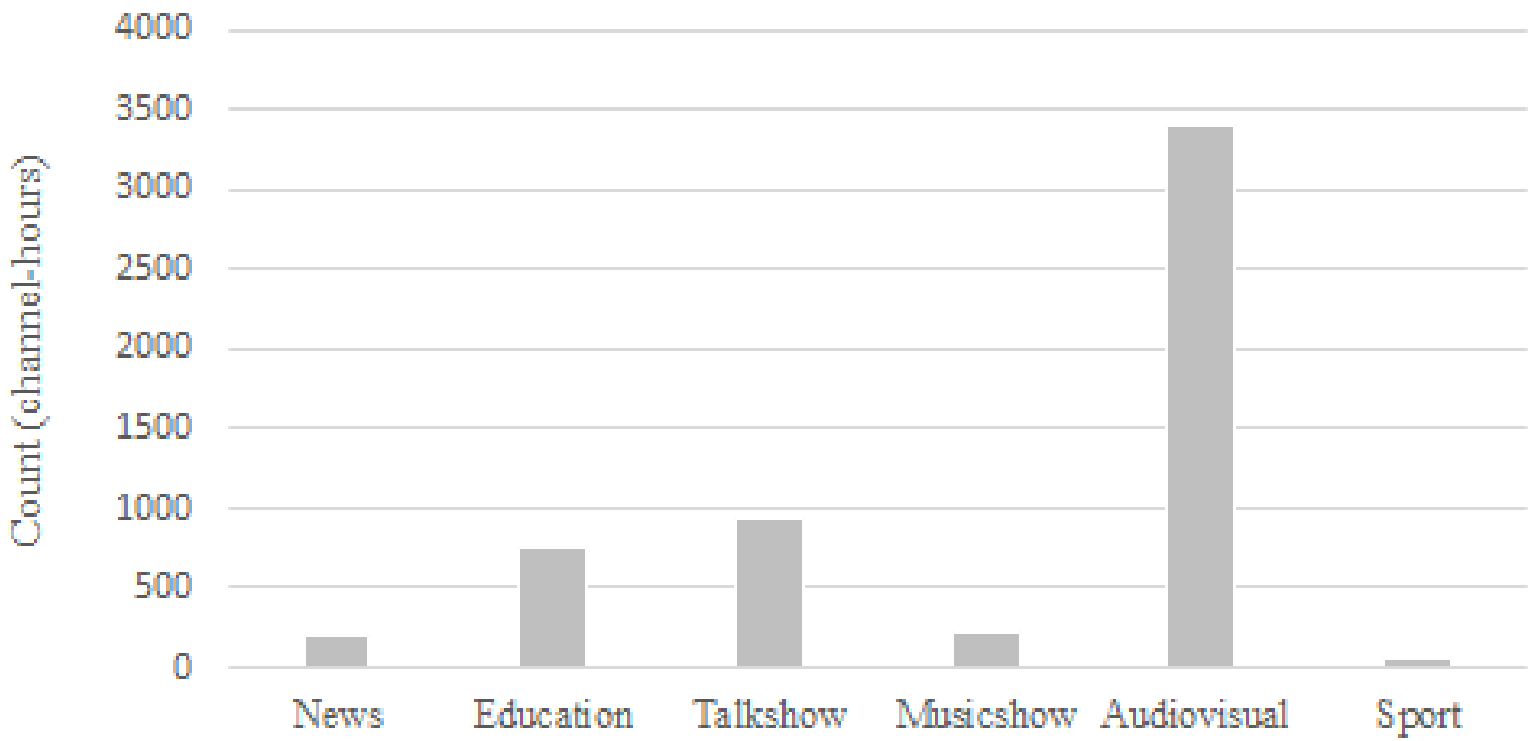
Observed advertising levels under regulation



Observed advertising levels of private broadcasters



Private prime time content offerings under advert restriction



Research Question

In the context of a repeal of the restrictions on prime time advertising levels for private channels

(i) what their content choices and advertising levels would be

(ii) what the consequences for the welfare of different demographic groups of consumers would be

Sample

Hourly observations of 12 major free-broadcast TV channels in France during one year (2014)

- make up about 90% advert revenue share in national TV market
- cable TVs are much less popular: less than 10% audience shares
- most cable TVs do not show advertising

Variables

Aggregate data:

- number of viewers per hour per channel*
- total number of TV viewers per hour (free-broadcast + cable TV)
- total number of TV viewers in different demo-groups in each hour
- programming genres per hour per channel
- number of advert minutes per hour per channel
- advertising revenue per hour per channel

Micro-data:

- number of viewers in each demo-group per channel per hour

Programming genres

Genre	Programs	Availability
News	current affairs, political debates	6 channels
Education	documentaries about culture and science	12 channels
Talk Show	situation comedies, games	11 channels
Music show	concerts, variety shows	11 channels
Audiovisual	fiction series, films	12 channels
Sport	matches	7 channels
Others	cartoon, music video, shopping	11 channels

Summary Statistics

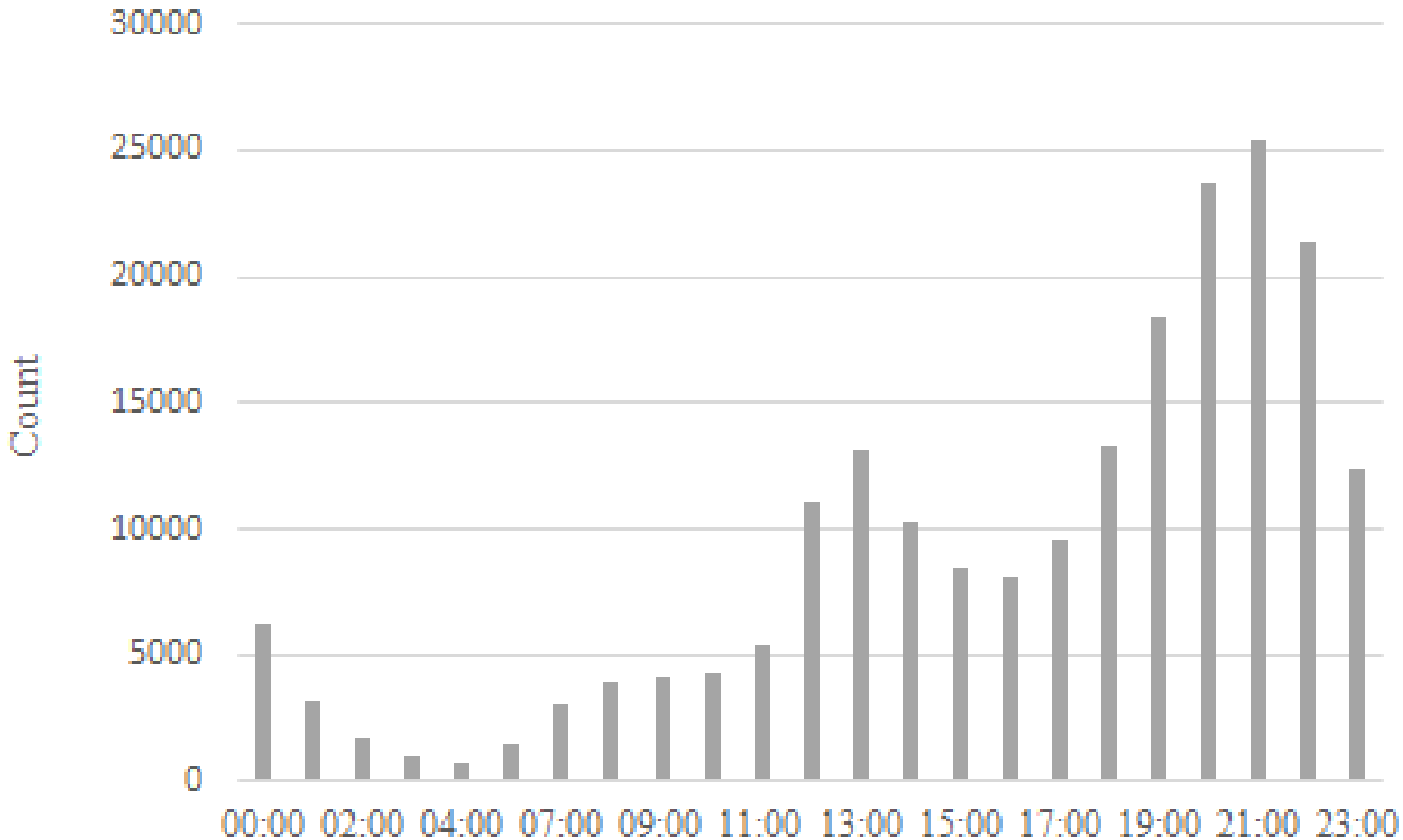
			prime time		non-prime time	
	Min.	Max.	Mean	Std.Dev.	Mean	Std.Dev.
Panel A. Market-level audience distribution (%)						
Female 4-14	0.0	15.3	3.4	0.9	3.7	2.9
Female 15-24	0.0	9.0	3.2	0.4	3.1	1.2
Female 25-49	7.8	31.2	17.1	1.6	18.2	3.2
Female 50 plus	16.4	44.3	31.6	1.1	29.6	5.1
Male 4-14	0.0	16.3	3.5	0.9	4.2	3.3
Male 15-24	0.0	8.8	2.5	0.3	2.4	1.0
Male 25-49	6.5	35.0	15.4	1.3	16.5	5.3
Male 50 plus	10.9	38.0	24.2	1.0	22.2	3.4

Summary Statistics (cont.)

			prime time		non-prime time	
	Min.	Max.	Mean	Std.Dev.	Mean	Std.Dev.
Panel B. Channel-market level viewership (%)						
Female 4-14	0	70	5.3	6.2	5.5	8.2
Female 15-24	0	100	4.1	3.6	4.7	6.6
Female 25-49	0	100	20.0	7.7	20.3	11.4
Female 50 plus	0	100	25.6	11.9	26.7	16.6
Male 4-14	0	100	5.7	7.1	6.7	10.8
Male 15-24	0	100	2.9	2.6	2.9	4.5
Male 25-49	0	100	17.1	7.4	15.0	10.0
Male 50 plus	0	100	19.3	9.7	18.2	12.9

			prime time		non-prime time	
	Min.	Max.	Mean	Std.Dev.	Mean	Std.Dev.
Panel C. Advertising levels and prices						
Amount (minutes per hour)	0.1	12.5	8.1	3.4	7.4	3.6
Per minute prices*	0.004	411.2	37.2	55.6	9.7	18.6

Total TV Viewers (hourly average)



Model

Demand of viewers

Demand of advertisers

Supply of TV broadcasters: two stage game

Demand of viewers

Model

The total utility of individual i from TV channel j in hour t is

$$U_{jt}^{i} = \alpha_i A_{jt} + \sum_{g=1}^{6} \beta_i^g G_{jt}^g + \mathbf{X}_{jt}\Delta + \xi_{jt} + \epsilon_{jt}^{i}$$

- A_{jt}: number of advertising minutes of channel j in hour t

- G_{jt}^g: a genre of TV programs with $g \in$ {News, Education, Talkshow, Musicshow, Audiovisual, Sport}

- $\mathbf{X}_{jt}$: dummies for cartoon, music video, shopping ($\in$ *Others*)
dummies for different fixed effects (channels, hours of the day, day of the week, and month of the year)

- ξ_{jt}: unobserved programming quality (channel-hour-date specific)

- ϵ_{jt}^{i}: viewer i's individual preference for program of j in t

Demand of viewers (cont.)

Model

The total utility of individual i from TV channel j in hour t is

$$U_{jt}^{i} = \alpha_i A_{jt} + \sum_{g=1}^{6} \beta_i^g G_{jt}^g + \mathbf{X}_{jt}\Delta + \xi_{jt} + \epsilon_{jt}^{i}$$

$$\alpha_i = \alpha + \pi_\alpha d_i + \sigma v_i \quad \text{and} \quad \beta_i^g = \beta^g + \pi_{\beta g} d_i$$

- $\pi_\alpha d_i$ and $\pi_{\beta g} d_i$ allow advertising and genre preferences to vary with age and gender

- $v_i \sim \mathcal{N}(0, \sigma)$ allows for heterogeneity in individual preference for advert

Choice of the outside good gives a normalized utility ϵ_{0t}^{i}

Demand of viewers (cont.)

Estimation

Closely resemble Petrin (2002) and Sweeting (2013)

First set of moments: $E[\xi_{jt}(\Theta)|\mathbf{Z}] = 0$

– **Z1**: total number of advertising minutes of channel j during the day d, excluding hours h, $h+1$ and $h-1$, $A_{jd_{-(h)-(h-1)-(h+1)}}$

✓ correlated with $A_{jt} \equiv A_{jdh}$ through common cost shocks

✓ not through common viewer dde shock ($\perp\!\!\!\perp \xi_{jt} \equiv \xi_{jdh}$) because

① hours h, $h+1$ and $h-1$ are excluded

② channels do not adjust the ads of the same day $A_{jdh'}, \forall h' \neq h$ following a negative shock

Demand of viewers (cont.)

Estimation

– **Z2**: the number of competing channels showing the same genre of programs as channel j during the same broadcasting day-hour

✓ TV stations do not know the ξ_{jt} shocks when they select the broadcasting content, so $E[\xi_{jt}(\Theta)|\mathbf{X}, \mathbf{G}] = 0$

✓ the ξ_{jt} shocks is revealed when TV stations decide on the advertising level A_{jt}

Second set of moments (demographic-specific):
$E[S_{jdt}^{survey} - S_{jdt}(A_t, \mathbf{G}_t, \mathbf{X}_t, \xi_t; \Theta)] = 0$

Demand of viewers (cont.)

Result

Genre Tastes						
	Baseline Demo	Female	Age 4-14	Age 15-24	Age 25-49	St. Dev.
Advert quantity	-2.962	0.540	0.511	0.926	0.301	0.118
	(0.469)	(0.351)	(0.075)	(0.116)	(0.170)	(0.025)
News	1.313	-13.834	3.170	-0.458	-4.314	-
	(0.116)	(0.765)	(0.606)	(0.035)	(0.327)	
Education	-1.605	5.753	3.400	1.129	12.071	-
	(0.142)	(2.102)	(0.026)	(0.004)	(0.758)	
Talkshow	0.551	-1.699	-1.370	2.192	1.529	-
	(0.136)	(1.035)	(0.027)	(0.078)	(0.941)	
Musicshow	0.516	-5.146	2.032	1.009	-1.264	-
	(0.130)	(0.019)	(0.100)	(0.775)	(0.314)	
Audiovisual	-3.072	11.489	1.382	1.690	5.048	-
	(0.112)	(0.378)	(0.001)	(0.003)	(0.042)	
Sport	1.138	-7.048	-0.413	0.072	-2.348	-
	(0.124)	(0.182)	(0.024)	(0.005)	(0.159)	
Other Programming Quality						
	Mean Tastes					
Cartoon	0.576					
	(0.118)					
Musicvideo	0.436					
	(0.120)					
Shopping	-0.783					
	(0.131)					

Demand of viewers (cont.)

Elasticities

Overall demand is rather inelastic:

For private channels

- a 10% ↑ advert → a median 8% ↓ audience during prime time
- a 10% ↑ advert → a median 6% ↓ audience during non-PT

For public channels

- a 10% ↑ advert → a median 1% ↓ audience

Cross-elasticities:

- substantial substitutions between private channels during PT
- less during non-PT, 0 for public channel in evening

Demand of advertisers

Model

Describing the aggregate market demand for advertising by the behavior of a representative advertiser.

This advertiser multihomes (i.e., combines the advertising slots of different channels) & chooses the vector of advertising levels $A_t = (A_{1t}, ..., A_{Jt})$ which minimizes the total costs c_t^A of achieving the desired overall reach of audience, $y_t = \sum_j^J y_{jt}$:

$$c_t^A(p_t, y_t) = \left\{ \min_{A_{1t},...,A_{Jt}} \sum_j^J p_{jt} \times A_{jt} | f(A_t) \geq y_t \right\}$$

- J: total number of channels

- $p_t = (p_{1t}, ..., p_{Jt})$: advertising prices

- $f(A_t)$: audience production function; $y_t \equiv$ total demand of viewers

Demand of advertisers

Model (cont.)

Approximating the optimal solution of above cost minimization problem $c_t^A(p_t, y_t)$ by a flexible translog function as: (c.f. Fuss and McFadden, 2014)

$$\ln c_t^A = \gamma_0 + \sum_j^J \gamma_j \ln p_{jt} + \sum_j^J \mu_j \ln y_{jt} + \frac{1}{2}\sum_i^J \sum_j^J \gamma_{ij}(\ln p_{it})(\ln p_{jt})$$

$$+\frac{1}{2}\sum_i^J \sum_j^J \mu_{ij}(\ln y_{it})(\ln y_{jt}) + \sum_i^J \sum_j^J \kappa_{ij}(\ln y_{it})(\ln p_{jt}) + \sum_j^J e_{jt} \ln p_{jt}$$

Demand of advertisers

Model (cont.)

Taking derivative of the translog advertising cost function with respect to $\ln p_{jt}$ and applying Shephard's lemma $\rightarrow$ advertising cost share equations:

$$s_{jt}^{A} = \gamma_j + \sum_{i}^{J} \gamma_{ij}(\ln p_{it}) + \sum_{i}^{J} \kappa_{ij}(\ln y_{it}) + e_{jt}$$

- s_{jt}^{A}: share of the advertising cost spent on channel j in hour t in the total advertising cost of hour t

$\gamma_{ij} \Rightarrow$ price elasticities of advertising demand

$\kappa_{ij} \Rightarrow$ two-sided network externalities

Demand of advertisers (cont.)

Estimation

➤ Zellner's iterated seemingly unrelated regression method

➤ Any temporal shock to TV advertising market that might affect advertising pricing and demand is controlled for by estimating the system of advertising cost share equations simoutanously

➤ e_{jt}: white noise error that is orthogonal to the equilibrium advertising prices $p_{1t}, ..., p_{Jt}$ and audience sizes $y_{1t}, ..., y_{Jt}$

Demand of advertisers (cont.)

Result

– Advertisers' dde more elastic to the price of PT slots than to the price of non-PT slots

– Advertisers generally do not substitute an advert slot of private channel by an advert slot of public channel

– Per minute price of an advert slot is not linear to the associated audience size ($\frac{\partial p_{jt}}{\partial y_{it}} = \frac{\kappa_{ij} c_t^A}{y_i A_j}$, κ_{jj} is not always positive)

Supply

Two types of broadcasters

Public broadcasters:

– provide content as a public service instead of for profit

– do not make strategic decision in programming genres and advertising levels

Private broadcasters:

– take the content choices and advertising levels of public broadcasters as given

– their profits depend on the programming choices of public channels in equilibrium
because viewers can switch between public and private channels

Supply

Two-stage game played by private broadcasters

Stage 1: observe programming fixed cost $\Rightarrow$

select simultaneously the content

Stage 2: realize demand shocks $\Rightarrow$

determine simultaneously the advertising level, subject to the regulatory constraints

Solve the problem by working backward!

Stage 2: Supply of advertising slots

Model

Advert revenue: $R_{jt} = p_{jt}\left[A_t, y_{1t}, ..., y_{jt}, ..., y_{Jt}; \Gamma, K, e_{jt}\right] A_{jt}$

- $A_t = (A_{1t}, ..., A_{Jt})$
- $y_{jt} = s(A_t, \mathbf{G}_t, \mathbf{X}_t; \Theta, \xi_t) M_t$: number of viewers
- $\mathbf{G}_t$, $\mathbf{X}_t$: characteristics of content chosen in 1^{st} *stage*
- Θ: the set of parameters of viewers' taste
- Γ and K: vectors of parameters in the cost function of advertisers

Stage 2: Supply of advertising slots (cont.)

Model

TV channels solve constrained maximization problems:

$$\max_{A_{jt}} \{p_{jt}\left[A_t, y_t(A_t, \mathbf{G}_t, \mathbf{X}_t, \xi_t), e_{jt}\right] A_{jt}\}$$

$$\text{s.t. } A_{jt} \leq \bar{A}^g_{jt} \quad \forall j \in J_t$$

FOC:

$$p_j + \left[A_j\left(\frac{\partial p_j}{\partial A_j} + \sum_{i,\forall i} \frac{\partial p_j}{\partial y_i}\frac{\partial y_i}{\partial A_j}\right)\right] = \lambda_j$$

Stage 1: Selection of broadcasting content

Model

Channel selects the genre of content g which gives the highest expected profit:

$$\mathbb{E}\left[\Pi_{jt}\right] = \mathbb{E}_{(\Theta,\mathcal{F}_\xi,\Gamma,K,\mathcal{F}_e)}\left[R_{jt}(G^g_{j,t}, \mathbf{G}_{-j,t}, \mathbf{X}_t)\right] - C^g_j$$

- $\mathbb{E}_{(\Theta,\mathcal{F}_\xi,\Gamma,K,\mathcal{F}_e)}\left[R_{jt}(G^g_{j,t}, \mathbf{G}_{-j,t}, \mathbf{X}_t)\right]$: expected 2^{nd} stage revenue

- C^g_j: fixed cost of programming a content of genre g for channel j

- No new program is selected for hour t if the expected advertising revenue is below the cost of programming any genre of content

Programming Fixed Costs

Estimation

Assumption: the observed programming genre choice, advert quantity and prices support a SPNE

Simultaneous move $\Rightarrow$ need not consider an impact on rival's choice

Programming Fixed Costs

Estimation

- UB_j^g: Set of prime time hours t where channel j broadcasts genre g

$$C_j^g \leqslant \mathbb{E}_{(\Theta,\mathcal{F}_\xi,\Gamma,K,\mathcal{F}_e)}\left[R_{jt}(G_{j,t}^g, \mathbf{G}_{-j,t}, \mathbf{X}_t)\right] \equiv \widetilde{R}_{jt}^g, \quad \forall t \in UB_j^g$$

$$\overline{C}_j^g = \min_{t \in UB_j^g}\left\{\widetilde{R}_{jt}^g\right\}$$

- LB_j: Set of hours t' where channel j does not broadcast any new content

$$C_j^g \geqslant \mathbb{E}_{(\Theta,\mathcal{F}_\xi,\Gamma,K,\mathcal{F}_e)}\left[R_{jt'}(\widetilde{G}_{j,t'}^g, \mathbf{G}_{-j,t'}, \mathbf{X}_{t'})\right] \equiv \widetilde{R}_{jt'}^g, \quad \forall t' \in LB_j \text{ and } \forall g$$

$$\underline{C}_j^g = \max_{t' \in LB_j}\left\{\widetilde{R}_{jt'}^g\right\}$$

Programming Fixed Costs

Result

Genre	Mean Lower Bound	Mean Upper Bound
News	2.04	2.20
Education	0.60	0.70
Talk Show	0.90	1.02
Music Show	1.29	1.50
Audiovisual	0.92	1.07
Sports	7.77	8.80

Programming Fixed Costs

Result

Channel	Mean Lower Bound	Mean Upper Bound
Channel 1	4.76	5.30
Channel 4	2.52	2.84
Channel 6	0.55	0.66
Channel 7	0.23	0.28
Channel 9	0.36	0.42
Channel 10	0.42	0.53
Channel 11	0.14	0.19
Channel 12	0.37	0.51

Counterfactual

Context

Recall: advertising restriction

➤ General restriction on the number of advertising minutes per hour apply to all types of content

➤ Stricter regulation applies to educational and music programming

Counterfactual

Context

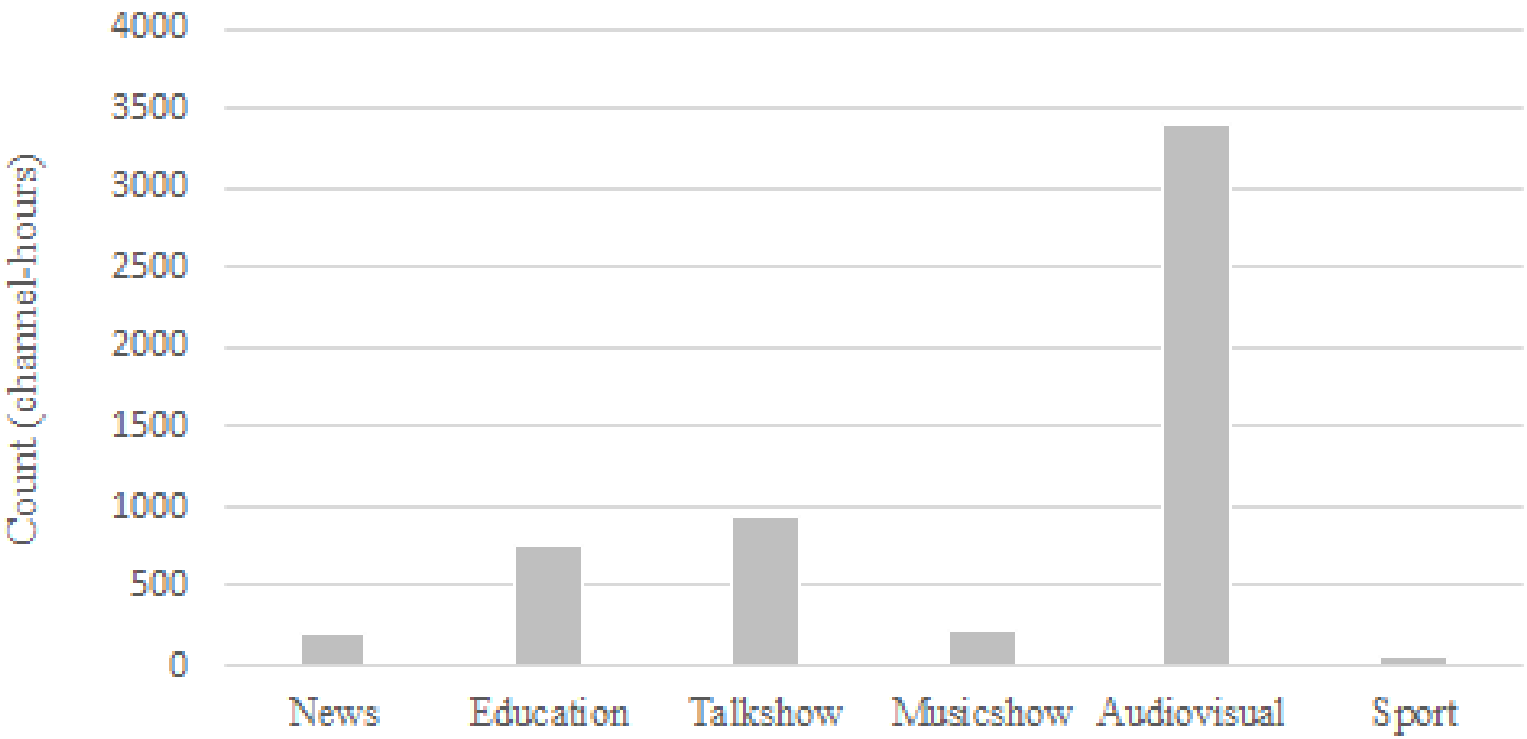


Figure: Private Content Offerings Under Advertising Restrictions

Counterfactual

Design

☞ Solve the two-stage game for each prime-time hour and each combination of programming offerings of different channels

☞ Focus on prime time hours

8 private stations, each with a choice set of 4-6 programming genres

$\Rightarrow$ *more than* 4^8 $(\equiv 65,536)$ candidates for equilibrium in each hour & in total 708 prime time hours

$\Rightarrow$ Learning process (Lee and Packs, 2009) $\rightarrow$ simultaneous move NE

Counterfactual (cont.)

Result

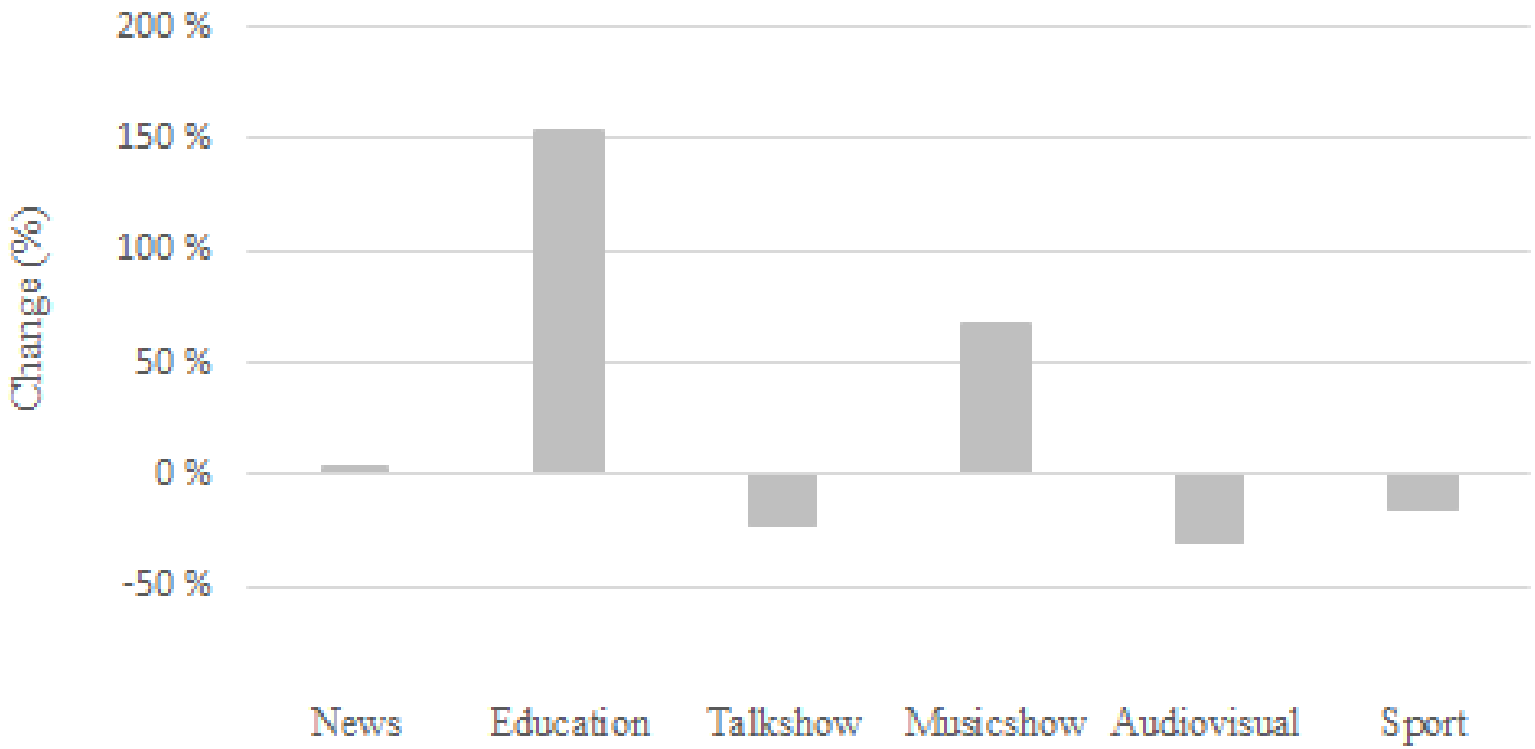


Figure: Counterfactual Effects of Deregulation on Content Offerings

Counterfactual (cont.)

Result

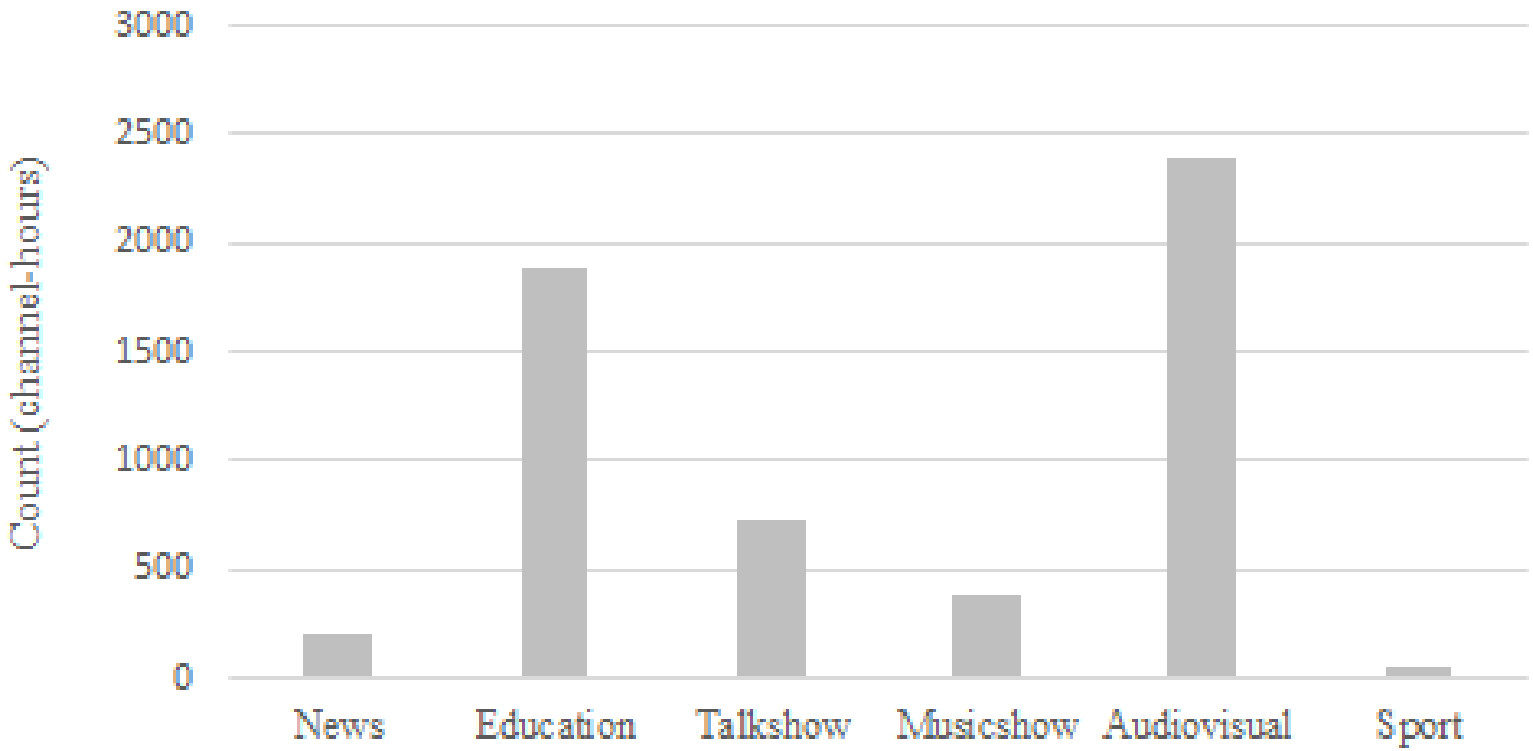


Figure: Private Content Offerings without Advertising Restrictions

Counterfactual (cont.)

Result

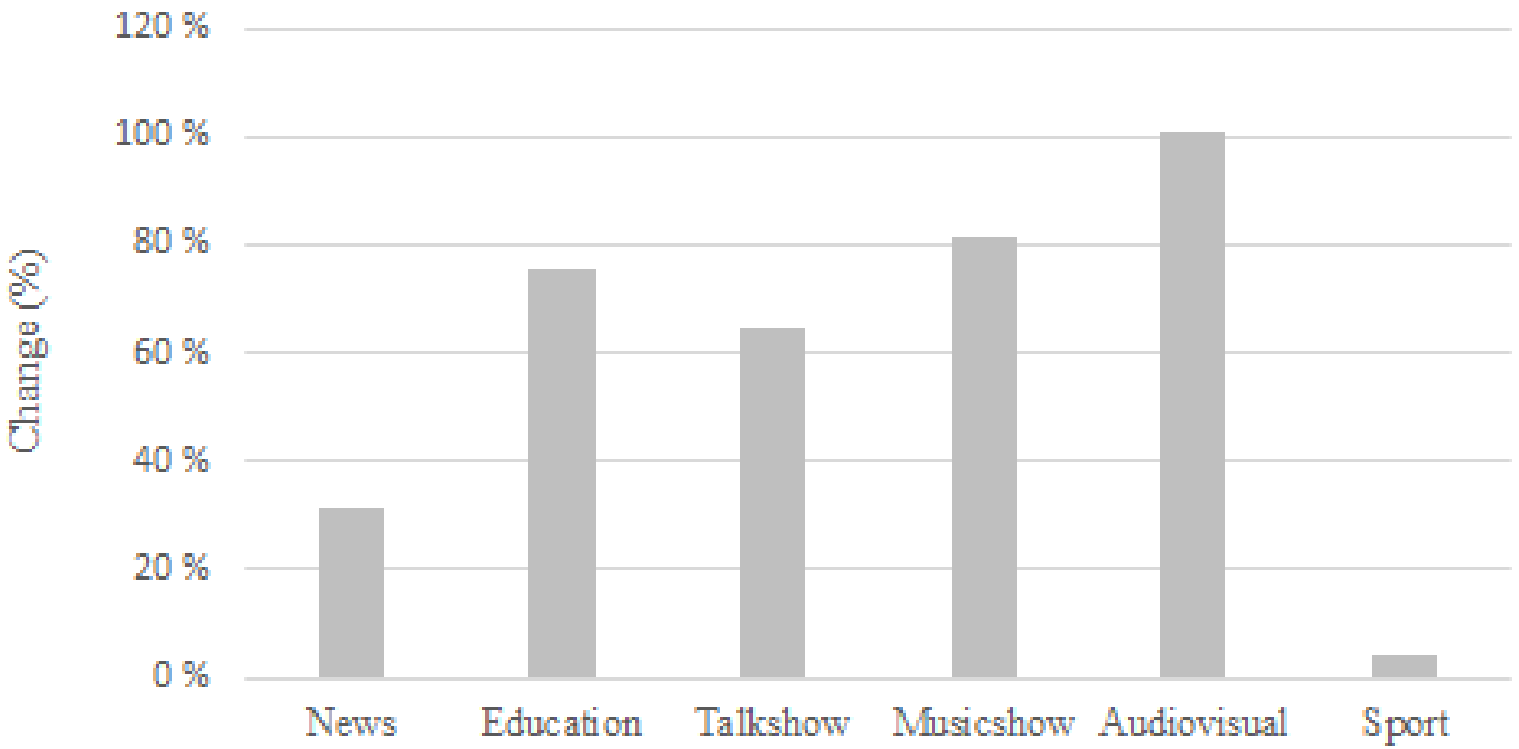


Figure: Counterfactual Effects of Deregulation on Advertising Levels

Counterfactual (cont.)

Result

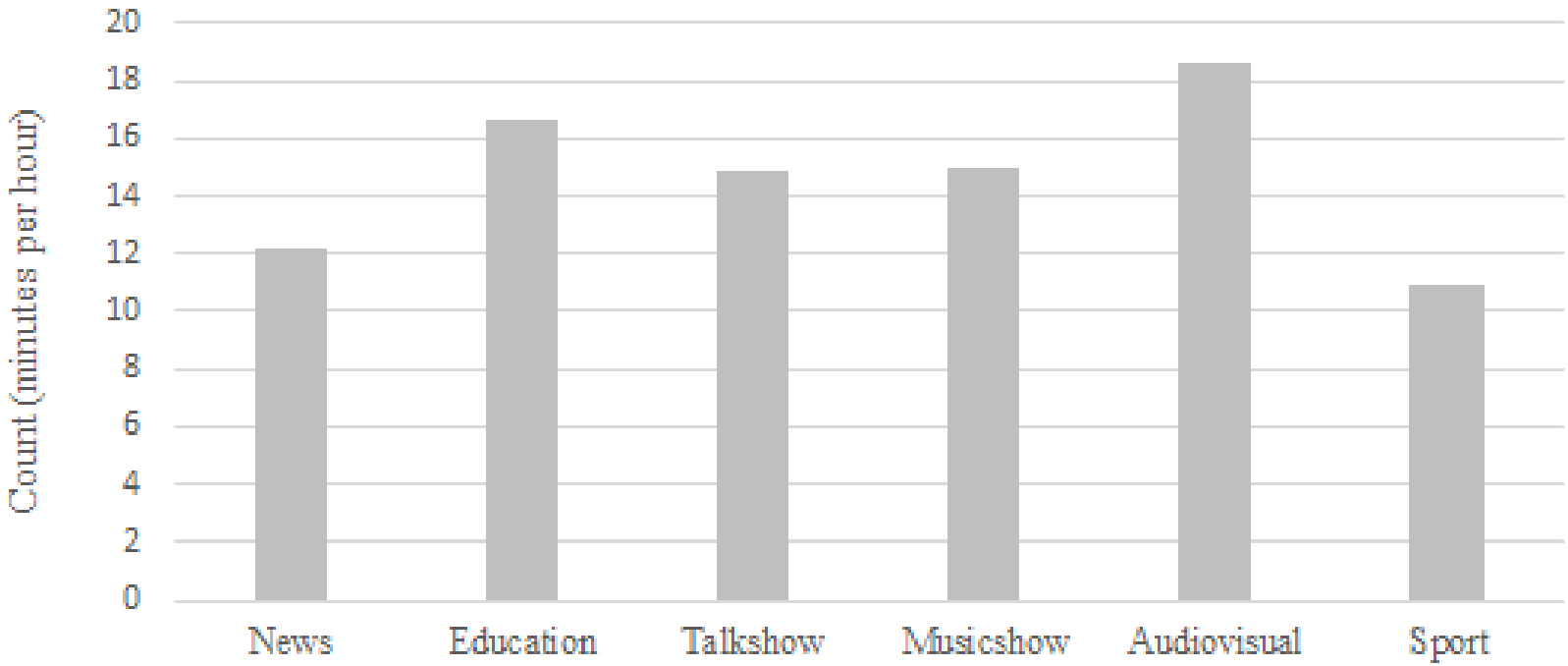


Figure: Prime Time Private Advertising Levels without Regulation

Counterfactual (cont.)

Result

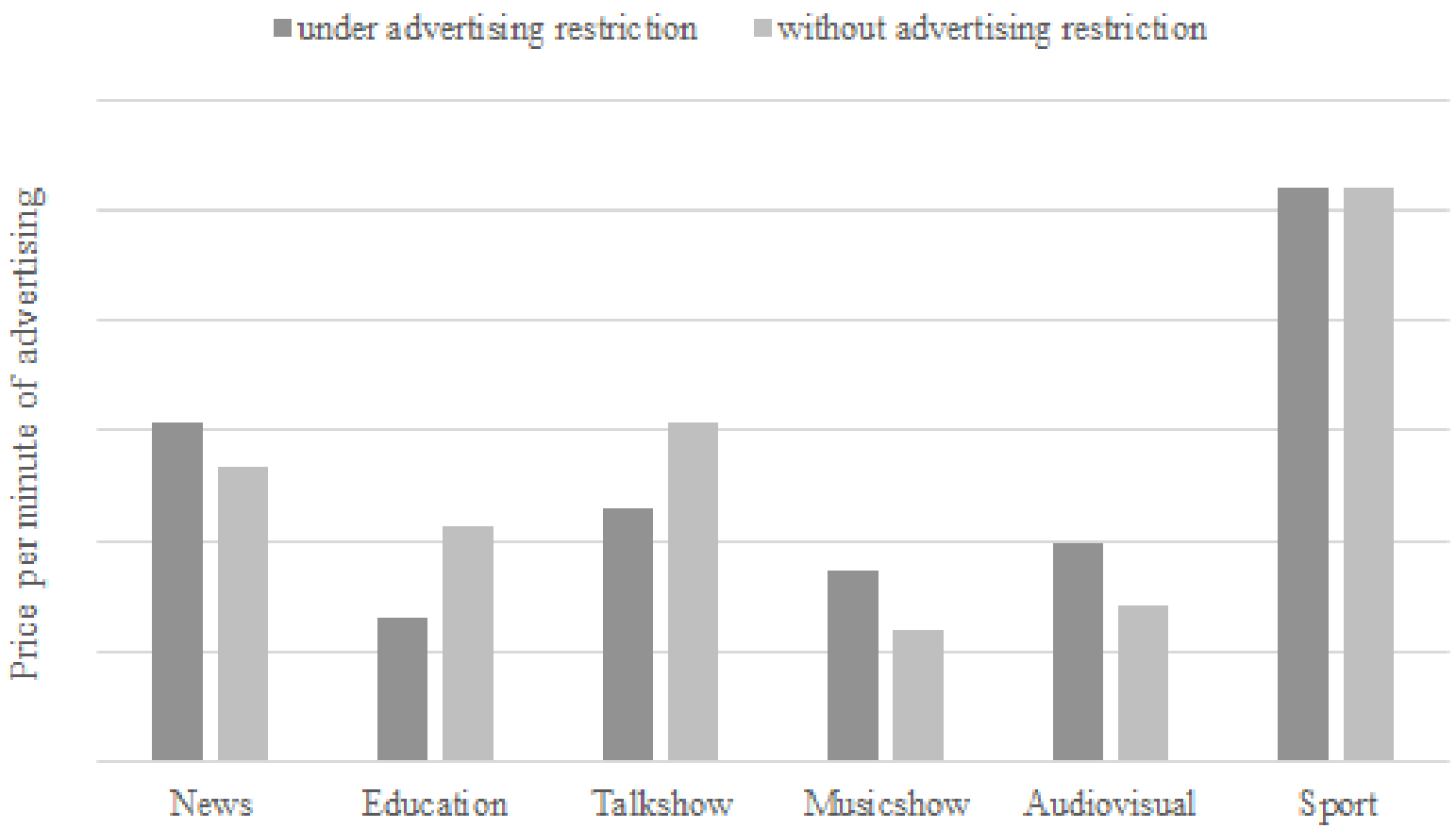


Figure: Prime Time Private Advertising Prices

Counterfactual (cont.)

Result

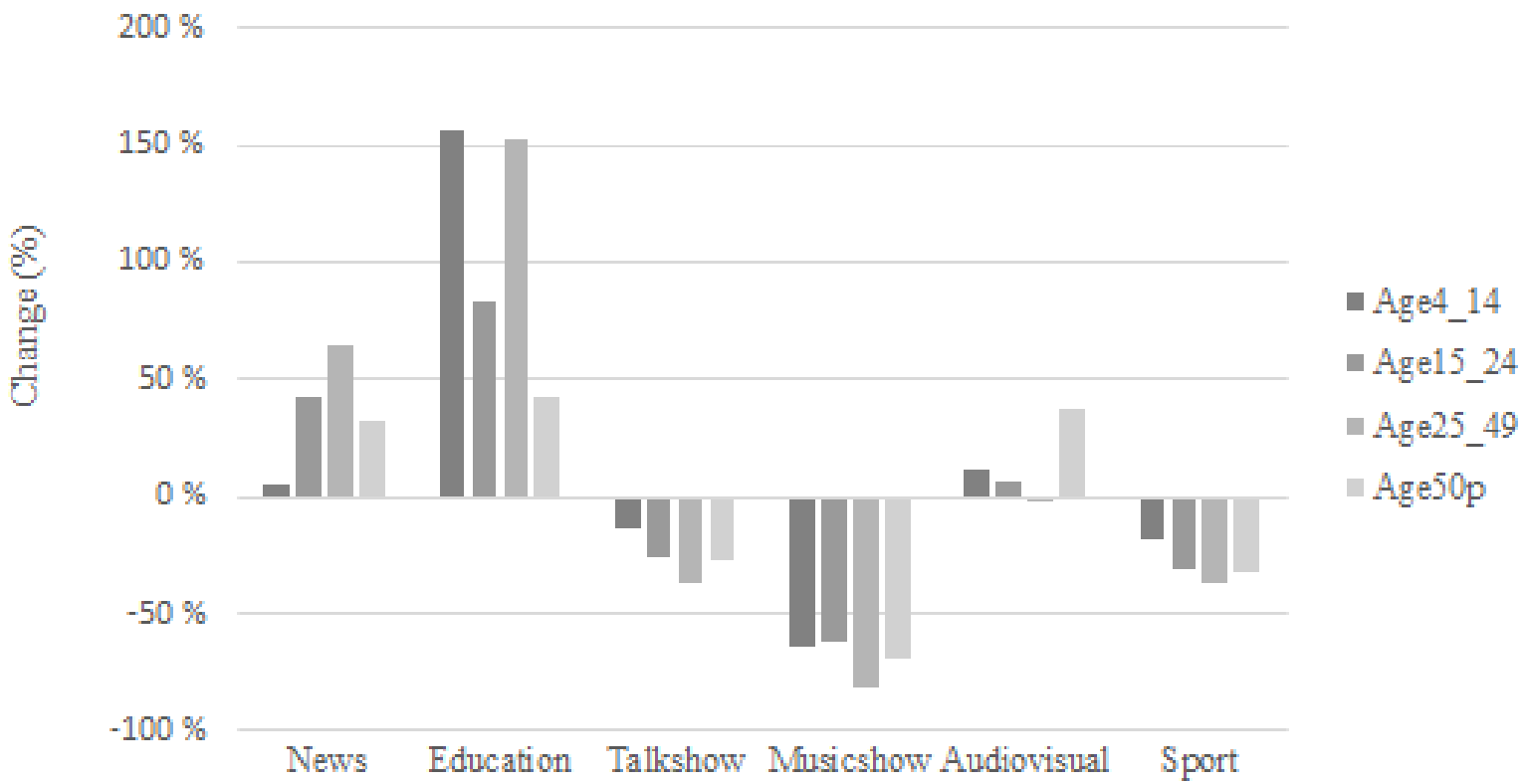


Figure: Percentage Changes in Audience after Advertising Deregulation

Counterfactual (cont.)

Consumer Surplus

Panel A. Percentage change in "utility units"	
%Δ in average expected utility per viewer	+38.68
%Δ in average expected utility per viewer in female audiences	+41.25
%Δ in average expected utility per viewer in male audiences	+21.89
%Δ in average expected utility per viewer aged between 4 and 14	+40.28
%Δ in average expected utility per viewer aged between 15 and 24	+36.97
%Δ in average expected utility per viewer aged between 25 and 49	+28.39
%Δ in average expected utility per viewer aged above 50	+58.41

Counterfactual (cont.)

Consumer Surplus

Panel B. Variation in minutes of advertising per hour with initial content offering

compensation variation per viewer	−3.18
compensation variation per viewer in female audiences	−5.47
compensation variation per viewer in male audiences	−0.45
compensation variation per viewer aged between 4 and 14	−2.93
compensation variation per viewer aged between 15 and 24	−3.95
compensation variation per viewer aged between 25 and 49	−4.34
compensation variation per viewer aged above 50	−2.40

Counterfactual (cont.)

Firms welfare

cost of the advertiser $\equiv$ revenue of the private broadcasters

➤ benefit of the advertiser:

– total audience size increases by 27%

– the advertiser losses some reach in audiences of 15-24 years old but gains more reach in audiences of the other age groups, particularly 25-49-year-olds

$\Rightarrow$ disadvantages firms whose target audience is primary the 15-24-year-olds but advantage firms whose target audience is primary in the other age groups

➤ total programming costs of private braodcasters decrease

Conclusion

➤ Deregulation implies more advertising, but its negative impact does not outweigh the benefit (more diversified programming)

➤ Lesson to the design of regulation for online media platforms:

– consider platforms' strategic adjustment in content offerings

– possible to influence the content offering (or generation) of media platforms by strategically designing the regulatory rules on advertising