Online Program Engagement and Audience Size during Television Ads

= Web Appendices =

Web Appendix 1: Interviews with Experts from the Advertising Industry

We conducted interviews with five professionals in the television media buying and advertising industries to gain insights on how advertisers obtain information on audience size. We began our interviews via email with the question: "how long does it typically take you to know how many viewers saw a specific television ad?" Our conversations validate claims from industry citations (e.g., Crupi 2019; Friedman 2012; Lafayette 2018b; Schwarz 2019; Story 2007) that (1) data on audience size during individual ads is very rare for firms to obtain as it is almost always aggregated to either the ad break or program level, and (2) aggregate data on audience size is not available in real-time but rather takes several days for firms to obtain in the best-case scenarios. We showcase representative quotes from our interviews, alongside relevant expertise of the five professionals below (identifying information is masked to preserve anonymity).

> **Professional 1, television media planner and broadcast traffic manager (5 years):** *It will often take 90 days (one quarter) to get the full Post (post-buy analysis) based on Nielsen ratings. This likely won't be specific to certain ad slots themselves, but rather by program. So, then the buyer can review planned versus delivered GRPs for an entire schedule across multiple networks and say, we delivered 110% against our planned levels. Although, I do know in certain cases buyers can obtain an overnight rating for more premium placements (they'll know the next day or two after the Oscars what the rating was) upon request.*

> **Professional 2, national television ad buyer (5 years) and media planner at MediaCom (4 years):** *With TV, you typically get Nielsen ratings 3-4 weeks after air. You can get overnight ratings, but they are not final and will not reflect C3 (Commercial Live + 3 days) or C7 (Commercial Live +7 days) - which is how majority of the ratings are purchased/measured. It's typically not specific ad slot though. Depends on the network/program, but most program ratings from what I've been told historically are within certain time periods. I think for broadcast, it is quarter hour/half hour- 15-30 min increments.*

Professional 3, executive director of research at ABC Television (8 years): *Advertisers get viewership data from third party companies, mostly Nielsen. Nielsen has a quick one-day turnaround for program ratings (not commercial ratings though). However, given that viewers watch programs delayed with DVRs and given that multiple stakeholders in the industry have an incentive to count all of the viewing, advertisers can't get final viewing numbers for C3 and C7 until about 8 days after airing. Even then, you can't get a rating for your specific commercial; you get a rating for where your commercial lived. The most granular data is typically viewership numbers for a 60 second block, so it does not give you viewership for a specific ad.*

Professional 4, media manager of television ad buys (1 year) and brand manager (1 year): *I believe actual live viewership is confirmed at the spot level within 7 days (although usually less) since many agencies individually confirm that each spot has run with the networks. Also depends on which viewership metrics you want - I've heard of Nielsen C3 (live + 3 days digital recorder playback) & C7 (live + 7 days).*

Professional 5, media associate at ad agency Starcom (3 year): *It takes about 2-3 days for advertisers to know how many viewers saw their ad. We use a program called Lake5 that congregates the information for us to pull from. Networks aggregate program ratings for viewership for ads within a show.*

We conducted a follow-up interview with Professional 1 who has experience with programmatic television ad buys to improve our understanding of what information advertisers have available in such ad buys. This interview provided further support of claims from industry reports that audience size data is not typically leveraged in programmatic ad buys (e.g., Chordia 2018; Peterson 2019). Specifically, Professional 1 noted that audience size data is not used as ad buys typically do not occur at the program-level. Rather, programmatic ad buys are "based on audience segments and television genres but not specific shows." This interview provided additional support to our claim that, even in a programmatic ad buying world, advertisers could benefit from real-time insights on audience size as gained through readily available online program engagement (OPE) data.

Web Appendix 2: Additional Descriptive Statistics

Web Appendix Table 2.1 shows the correlations among the variables in our model. Web Appendix Table 2.2 illustrates the variation of our two measures of OPE both within and across programs.

Web Appendix Table 2.1: Correlation table

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	*AudienceSizeBeg* $_i$	1.0000																				
2	*AudienceSizeEnd* $_i$	.9995	1.0000																			
3	*LogProgram WOMVolume* $_i$	-.3006	-.3007	1.0000																		
4	*LogProgram WOMDeviation* $_i$	-.0428	-.0374	-.0011	1.0000																	
5	Ad position	-.0033	.0172	.0137	.1119	1.0000																
6	Break position	-.0121	-.0126	-.0840	.1378	-.0095	1.0000															
7	Ad length	.0128	.0047	.0170	-.0723	-.1930	.0128	1.0000														
8	Ads on other networks	-.0288	-.0291	.0399	.0003	-.0283	-.0129	.0574	1.0000													
9	Ad stock (same channel)	-.0893	-.0903	.0627	-.0804	-.0138	.0151	.0870	-.0407	1.0000												
10	Ad stock (different broadcast channel)	.0569	.0540	.0459	-.0425	-.0722	.1140	.1498	-.0323	.3034	1.0000											
11	Monday	.0644	.0640	-.0847	-.0028	.0044	-.0073	.0129	.0319	-.0175	.0274	1.0000										
12	Tuesday	.0200	.0198	.0534	.0348	-.0322	.0035	.0296	.0060	.0349	.0281	-.2379	1.0000									
13	Wednesday	.0221	.0227	-.0440	-.0570	.0404	-.0119	-.0158	-.0180	-.0251	-.0220	-.2206	-.2200	1.0000								
14	Thursday	-.0520	-.0518	.3007	-.0030	-.0252	-.0004	.0009	.0201	.0221	.1116	-.2395	-.2389	-.2215	1.0000							
15	Friday	-.1494	-.1495	-.1614	.0191	.0278	-.0032	-.0658	.0142	-.0577	-.0841	-.1995	-.1990	-.1845	-.2004	1.0000						
16	Saturday	.0109	.0110	-.0178	.0068	-.0085	-.0044	-.0012	-.0236	-.0134	-.0177	-.0151	-.0150	-.0139	-.0151	-.0126	1.0000					
17	Sunday	.0997	.0996	-.1060	.0099	-.0120	.0237	.0384	-.0657	.0466	-.0893	-.1702	-.1698	-.1574	-.1710	-.1424	-.0108	1.0000				
18	Viewer episode ratings	-.2140	-.2136	.1553	-.0200	-.0154	-.0259	.0286	-.0460	.1454	.0793	.0532	.0461	-.1349	-.0164	-.0693	-.0490	.1407	1.0000			
19	Half-hour break	.0939	.0942	-.0394	.0686	.0078	.1715	-.0007	.0110	-.0192	.0276	-.0129	.0092	-.0110	.0027	.0097	-.0120	.0048	-.0291	1.0000		
20	Season premiere	.0288	.0271	.1523	-.1235	-.0320	.0091	.0587	.0209	.1034	.0407	.0063	-.0447	.0211	.0288	-.0134	-.0100	.0026	.0877	-.0085	1.0000	
21	Fall finale	-.0486	-.0476	.0099	.0543	.0095	-.0110	-.0020	-.0133	-.0101	-.0448	-.0729	.0043	-.0420	.0258	.0317	-.0106	.0703	.0843	-.0043	-.1110	1.0000

Notes: See Table 2 in the main manuscript for variable definitions. The model also includes fixed effects for the ad creative and the program in which the ad airs.

Web Appendix Table 2.2: Descriptive statistics for OPE measures across programs

Program	$ProgramWOMVolume_i$				$ProgramWOMDeviation_i$			
	Min	Mean	(SD)	Max	Min	Mean	(SD)	Max
2 BROKE GIRLS	21.61	50.36	(47.25)	231.67	-75.63	-2.99	(17.73)	60.33
48 HOURS	7.00	9.22	(1.49)	10.73	-4.65	1.53	(5.81)	13.52
ALMOST HUMAN	77.89	137.09	(47.26)	231.00	-90.33	-25.28	(24.18)	70.45
AMAZING RACE	31.50	53.35	(25.51)	138.34	-39.70	10.07	(24.77)	104.06
AMERICAN DAD	18.50	51.71	(46.97)	187.29	-109.56	-4.83	(44.15)	249.50
AMERICA'S NEXT TOP MODEL	32.37	71.72	(30.88)	201.57	-44.27	8.78	(26.42)	132.09
ARROW	53.10	191.27	(50.80)	345.23	-159.23	7.47	(78.50)	253.80
BACK IN THE GAME	8.11	25.62	(13.82)	65.38	-22.57	-2.54	(7.92)	13.89
BEAUTY AND THE BEAST	99.88	130.85	(18.43)	198.00	-55.10	5.70	(26.42)	96.17
BETRAYAL	27.17	61.10	(21.76)	120.60	-44.00	-8.42	(16.88)	41.04
BIG BANG THEORY	47.50	158.14	(156.51)	793.50	-174.46	-4.53	(45.09)	194.33
BIGGEST LOSER	29.20	47.00	(26.84)	173.25	-77.25	-.42	(17.90)	86.08
BLACKLIST	102.74	184.49	(41.51)	284.28	-145.33	8.72	(114.37)	504.40
BLUE BLOODS	22.68	61.16	(39.55)	285.50	-113.60	-12.85	(23.57)	46.07
BOB'S BURGERS	33.14	59.31	(23.86)	161.86	-75.86	-14.89	(15.51)	3.96
BONES	51.25	136.24	(58.85)	343.43	-96.86	-4.57	(44.79)	187.52
BROOKLYN NINE-NINE	29.88	69.26	(44.20)	231.10	-75.44	-10.96	(20.44)	44.85
CARRIE DIARIES	25.48	42.25	(18.98)	103.17	-47.52	1.45	(19.76)	85.12
CASTLE	160.58	273.49	(121.33)	770.08	-321.29	-41.19	(81.57)	266.14
CHICAGO FIRE	169.89	299.96	(90.69)	602.21	-361.94	12.17	(142.36)	630.02
CRAZY ONES	15.93	30.71	(23.17)	121.75	-40.75	-4.09	(9.25)	15.27
CRIMINAL MINDS	70.82	201.87	(175.83)	1169.14	-449.14	-8.67	(83.06)	280.77
CSI	14.21	39.21	(30.42)	187.75	-59.83	-6.41	(20.84)	153.09
DADS	39.69	62.25	(22.18)	144.78	-19.72	-1.97	(9.01)	23.13
DANCING WITH THE STARS	127.98	235.88	(182.68)	1075.77	-307.49	49.17	(185.87)	1273.82
DATELINE	15.69	21.40	(3.67)	32.50	-10.81	-.66	(4.97)	11.81
DRACULA	69.14	121.84	(57.75)	273.59	-82.59	-16.06	(28.71)	79.35
ELEMENTARY	32.02	51.26	(21.76)	145.29	-52.64	-6.41	(14.22)	39.00
FAMILY GUY	56.00	189.36	(152.67)	777.89	-153.00	62.08	(501.21)	3507.11
GLEE	379.02	1409.34	(1396.89)	5885.69	-2271.52	-215.73	(572.38)	2846.53
GOLDBERGS	25.48	55.69	(34.56)	176.91	-43.06	-6.02	(15.47)	24.41
GOOD WIFE	.00	36.31	(20.65)	114.00	-58.00	9.74	(25.59)	144.45
GREY'S ANATOMY	127.17	368.95	(314.46)	1758.67	-803.83	-34.85	(175.69)	739.19
GRIMM	57.44	101.65	(48.44)	271.55	-77.50	-13.62	(21.39)	34.75
HART OF DIXIE	12.26	23.37	(10.76)	64.44	-27.48	-2.66	(9.72)	47.00
HAWAII FIVE-0	13.34	29.20	(23.71)	135.67	-28.88	-4.32	(9.58)	28.40
HOSTAGES	23.62	53.65	(35.82)	164.30	-100.07	-6.05	(26.66)	88.88
HOW I MET YOUR MOTHER	73.04	208.36	(262.77)	1255.25	-400.58	29.68	(163.75)	659.50
IRONSIDE	16.68	54.88	(33.91)	126.11	-60.11	-15.86	(12.89)	5.70
LAST MAN STANDING	4.71	13.34	(7.31)	31.57	-13.18	-1.86	(4.38)	15.14
LAW & ORDER: SVU	120.23	373.16	(288.81)	1616.00	-603.94	-8.88	(165.98)	587.95
LUCKY 7	16.15	21.89	(2.42)	25.18	-12.18	-1.68	(6.13)	8.53

Web Appendix Table 2.2: Descriptive statistics for OPE measures across programs (continued)

Program	$ProgramWOMVolume_i$				$ProgramWOMDeviation_i$			
	Min	Mean	(SD)	Max	Min	Mean	(SD)	Max
MARVEL'S AGENTS OF S.H.I.E.L.D.	112.89	294.25	(266.21)	1557.18	-415.54	-8.42	(103.66)	259.65
MASTERCHEF JUNIOR	20.03	36.25	(18.53)	89.00	-25.26	3.35	(11.03)	32.38
MENTALIST	17.21	55.53	(33.35)	135.75	-30.09	4.69	(27.05)	136.34
MICHAEL J. FOX SHOW	10.00	36.10	(36.23)	153.60	-57.60	-7.79	(12.78)	19.50
MIDDLE	53.50	74.21	(15.89)	129.29	-39.55	-1.53	(13.17)	18.82
MILLERS	6.78	17.08	(13.50)	61.00	-15.14	-1.61	(6.01)	11.82
MINDY PROJECT	39.63	96.22	(48.00)	280.50	-73.50	-2.34	(51.37)	222.22
MODERN FAMILY	57.83	143.72	(76.31)	391.87	-136.93	-33.24	(40.16)	68.28
MOM	.00	2.52	(2.61)	10.50	-5.54	.04	(2.07)	6.60
NASHVILLE	93.68	159.44	(83.90)	518.09	-207.05	-4.48	(60.88)	175.30
NCIS: LOS ANGELES	18.36	47.77	(48.20)	237.93	-94.00	3.62	(42.36)	261.07
NCIS	43.19	116.03	(134.74)	824.00	-65.29	3.91	(59.40)	350.52
NEIGHBORS	17.79	24.18	(4.94)	38.74	-12.38	-2.31	(5.80)	11.59
NEW GIRL	74.53	230.86	(166.72)	904.00	-397.50	-39.04	(77.05)	65.00
ONCE UPON A TIME IN WONDERLAND	30.75	77.33	(56.73)	218.93	-58.31	-6.77	(16.68)	28.66
ONCE UPON A TIME	283.19	419.71	(102.32)	766.00	-196.00	38.18	(175.51)	972.68
ORIGINALS	206.03	359.15	(225.33)	1290.58	-645.58	13.61	(167.77)	631.73
PARENTHOOD	26.65	52.29	(28.96)	152.00	-86.00	-3.11	(22.69)	61.88
PARKS AND RECREATION	55.03	103.39	(44.74)	273.00	-105.00	-11.86	(32.15)	36.05
PERSON OF INTEREST	27.87	59.66	(30.78)	212.00	-86.00	2.70	(46.26)	307.83
RAISING HOPE	7.21	13.27	(4.71)	27.20	-11.07	-.60	(4.23)	10.80
REIGN	68.83	160.38	(59.15)	297.43	-87.59	10.55	(57.56)	305.44
REVENGE	165.18	291.03	(159.78)	1098.44	-433.95	-14.84	(98.43)	303.06
REVOLUTION	32.50	100.85	(38.06)	237.50	-78.75	-1.57	(33.97)	129.51
SCANDAL	1366.00	3104.47	(1510.19)	8778.50	-2212.50	185.85	(1191.36)	6502.92
SEAN SAVES THE WORLD	15.05	27.94	(11.88)	67.83	-21.08	-2.44	(6.79)	8.48
SHARK TANK	66.69	87.87	(14.80)	151.80	-54.80	.41	(22.98)	91.05
SIMPSONS	35.54	122.23	(82.40)	358.75	-119.22	-17.72	(44.45)	152.67
SLEEPY HOLLOW	214.42	382.51	(118.32)	754.50	-245.38	-49.21	(97.99)	261.89
SUPER FUN NIGHT	18.04	55.71	(48.99)	199.64	-73.65	-4.91	(22.63)	59.95
SUPERNATURAL	348.38	568.25	(194.75)	1116.44	-508.85	73.93	(293.36)	1359.64
SURVIVOR	21.43	167.92	(100.67)	575.60	-212.11	17.98	(92.65)	412.27
TOMORROW PEOPLE	45.89	92.68	(39.08)	226.17	-76.00	-8.67	(42.28)	297.97
TROPHY WIFE	24.00	34.74	(7.13)	54.82	-17.82	-1.89	(9.43)	32.54
TWO AND A HALF MEN	5.39	10.30	(4.81)	31.80	-7.40	-.56	(3.21)	6.60
UNDERCOVER BOSS	5.00	12.95	(5.20)	32.25	-15.25	9.37	(18.31)	82.47
VAMPIRE DIARIES	250.74	502.48	(369.48)	2014.00	-821.22	56.92	(251.96)	1070.25
VOICE	200.28	589.38	(329.25)	2722.63	-558.87	356.50	(2563.71)	32690.37
WE ARE MEN	15.26	42.37	(19.79)	65.60	-21.00	-2.37	(15.16)	17.96
WELCOME TO THE FAMILY	16.04	23.41	(4.18)	29.83	-8.57	-2.22	(3.97)	6.17
X FACTOR	66.90	669.40	(345.01)	2369.00	-447.50	15.19	(233.08)	1342.40
Total	.00	266.56	(510.46)	8778.50	-2271.52	23.91	(667.86)	32690.37

Notes: See Table 2 in the main manuscript for variable definitions.

Web Appendix 3: Supplementary Analyses

Web Appendix 3.1: Alternative audience size measures

As discussed in the main manuscript, the 30-second intervals of the audience size data do not always line up with an ad's beginning and end. As a remedy, we determine audience size at the beginning and end of ad instance *i* using three approaches. For our primary approach in the main analysis, we treat the audience size data as constant such that the audience size for a given program recorded at 8:00:00 PM would be used to represent the number of households tuned into that program from 8:00:00 PM–8:00:29 PM (Constant Audience Size Measure). We also estimate two alternative approaches. First, we consider an operationalization that uses the audience size estimate recorded closest to a given ad's start or end time (Closest Audience Size Measure). For example, if an ad began airing at 8:00:16 PM, then the audience size recorded at 8:00:30 PM, instead of 8:00:00 PM, would be used to represent the number of households tuned in at the start of that ad. Second, we consider an approach that measures audience size using the last audience size estimate recorded before the start of ad *i* and the first estimate recorded after its end (First/Last Audience Size Measure). In Web Appendix Table 3.1.1, we provide examples of how audience size at the start and end of a given ad varies across these three approaches for three different ad start times and two different ad lengths. We estimate our model with these two alternative approaches to measuring audience size and the key results, shown in Web Appendix Table 3.1.2, are consistent with those of our proposed approach.

Web Appendix Table 3.1.1: Examples of different approaches to measuring audience size at beginning and end of ads

Ad begins	***Ad length***	***Constant Audience Size Measure***		***Closest Audience Size Measure***		***First/Last Audience Size Measure***	
		Measurement window for *AudienceSize* Beg_i	Measurement window for *AudienceSize* End_i	Measurement window for *AudienceSize* Beg_i	Measurement window for *AudienceSize* End_i	Measurement window for *AudienceSize* Beg_i	Measurement window for *AudienceSize* End_i
8:00:14	15 secs	8:00:00 -8:00:29	8:00:00 -8:00:29	8:00:00 -8:00:29	8:00:30 -8:00:59	8:00:00 -8:00:29	8:00:30 -8:00:59
8:00:14	30 secs	8:00:00 -8:00:29	8:00:30 -8:00:59	8:00:00 -8:00:29	8:00:30 -8:00:59	8:00:00 -8:00:29	8:01:00 -8:01:29
8:00:16	15 secs	8:00:00 -8:00:29	8:00:30 -8:00:59	8:00:30 -8:00:59	8:00:30 -8:00:59	8:00:00 -8:00:29	8:01:00 -8:01:29
8:00:16	30 secs	8:00:00 -8:00:29	8:00:30 -8:00:59	8:00:30 -8:00:59	8:01:00 -8:01:29	8:00:00 -8:00:29	8:01:00 -8:01:29
8:00:30	15 secs	8:00:30 -8:00:59	8:00:30 -8:00:59	8:00:30 -8:00:59	8:01:00 -8:01:29	8:00:30 -8:00:59	8:01:00 -8:01:29
8:00:30	30 secs	8:00:30 -8:00:59	8:01:00 -8:01:29	8:00:30 -8:00:59	8:01:00 -8:01:29	8:00:30 -8:00:59	8:01:00 -8:01:29

Web Appendix Table 3.1.2: Key results from alternative audience size measure analyses

Variable	*Closest Audience Size measure*			*First/Last Audience Size measure*		
	Estimate (SE)			Estimate (SE)		
Ad position	.005	(.000)	**	.010	(.000)	**
OPE						
$LogProgramWOMVolume_i$	9.323	(2.461)	**	14.660	(3.863)	**
$LogProgramWOMDeviation_i$	.000	(.000)	**	.001	(.000)	**
Interaction with ad position						
LogProgramWOMVolumei × *Ad position*	-.192	(.625)		-1.253	(.981)	
LogProgramWOMDeviationi × *Ad position*	-.000	(.000)	**	.000	(.000)	**
Adjusted R-squared	.9997			.9992		

Notes: Measures for OPE and ad position are mean-centered for ease of interpretation.
* $p < .10$, ** $p < .05$

Web Appendix 3.2: Alternative operationalizations of the dependent variable

For robustness, we test five alternative dependent variables: (1) our primary outcome without the log transformation: $AudienceSizeEnd_i$ (with $AudienceSizeBeg_i$ as a control variable); (2) percentage change in audience size ($AudienceSizePC_i$ = ($AudienceSizeEnd_i$ - $AudienceSizeBeg_i$)/ $AudienceSizeBeg_i$); (3) log of the percentage change in audience size ($LogAudienceSizePC_i$ = log ($AudienceSizePC_i$ + 1))[1]; (4) ratio of audience size from the end to the beginning of the ad ($AudienceSizeRatio_i$ = $AudienceSizeEnd_i$ /$AudienceSizeBeg_i$); and (5) log of the ratio of audience size from the end to the beginning of the ad ($LogAudienceSizeRatio_i$ = log ($AudienceSizeRatio_i$ + 1)). In models (2)-(5), audience size at the beginning of ad *i* is not included as a control since it is incorporated into the outcome measure. The key results, shown in Web Appendix Table 3.2, are consistent with our proposed approach.

[1] If the percentage change is negative, we take the log transformation of the absolute value of $AudienceSizePC_i$ plus 1 and then multiply this by -1.

Web Appendix Table 3.2: Key results from alternative operationalizations of the dependent variable

Variable	*AudienceSizeEnd*$_i$			*AudienceSizePC*$_i$			*LogAudienceSizePC*$_i$			*AudienceSize Ratio*$_i$			*LogAudience SizeRatio*$_i$		
	Estimate (SE)			Estimate (SE)			Estimate (SE)			Estimate (SE)			Estimate (SE)		
Ad position	3.4E+04	(6.4E+02)	**	.710	(.010)	**	.304	(.003)	**	.007	(.000)	**	.004	(.000)	**
OPE															
LogProgramWOMVolume$_i$	3.9E+07	(1.8E+07)	**	575.100	(285.700)	**	173.600	(98.270)	*	5.754	(2.857)	**	2.928	(1.452)	**
LogProgramWOMDeviation$_i$	1.9E+03	(3.4E+02)	**	.055	(.005)	**	.021	(.002)	**	.001	(.000)	**	.000	(.000)	**
Interaction with ad position															
LogProgramWOMVolume$_i$ × *Ad position*	-4.2E+07	(4.7E+06)	**	-82.350	(72.790)		-13.030	(25.040)		-.825	(.728)		-.422	(.370)	
LogProgramWOMDeviation$_i$ × *Ad position*	-8.5E+02	(1.7E+02)	**	-.018	(.003)	**	-.005	(.001)	**	-.000	(.000)	**	-.000	(.000)	**
Adjusted R-squared	.9986			.5143			.6162			.5143			.5117		

Notes: Measures for OPE and ad position are mean-centered for ease of interpretation.
* $p < .10$, ** $p < .05$

Web Appendix 3.3: Proposed mechanism

Web Appendix Table 3.3 shows the results from the proposed mechanism tests, as detailed in the main manuscript.

Web Appendix Table 3.3: Key results from tests of the proposed mechanism

Variable	*Higher-involvement condition*			*Lower-involvement condition*		
	Estimate (SE)			Estimate (SE)		
Peak primetime versus other times in primetime						
Ad position	.008	(.000)	**	.007	(.00)	**
OPE						
LogProgramWOMVolume$_i$	17.230	(5.245)	**	4.575	(4.36)	
LogProgramWOMDeviation$_i$	.001	(.000)	**	.000	(.00)	**
Interaction with ad position						
LogProgramWOMVolume$_i$ × *Ad position*	-.705	(1.316)		-1.658	(1.07)	
LogProgramWOMDeviation$_i$ × *Ad position*	-.000	(.000)	**	-.000	(.00)	**
Adjusted R-squared	.9995			.9995		
Second-half of episode versus first-half of episode						
Ad position	.008	(.000)	**	.006	(.000)	**
OPE						
LogProgramWOMVolume$_i$	13.140	(5.100)	**	10.490	(4.086)	**
LogProgramWOMDeviation$_i$	.001	(.000)	**	.001	(.000)	**
Interaction with ad position						
LogProgramWOMVolume$_i$ × *Ad position*	-1.140	(1.299)		.266	(1.035)	
LogProgramWOMDeviation$_i$ × *Ad position*	-.000	(.000)	**	.000	(.000)	**
Adjusted R-squared	.9994			.9996		
Older programs versus newer programs						
Ad position	.007	(.000)	**	.007	(.000)	**
OPE						
LogProgramWOMVolume$_i$	8.005	(3.496)	**	6.618	(13.010)	
LogProgramWOMDeviation$_i$	.001	(.000)	**	.000	(.000)	**
Interaction with ad position						
LogProgramWOMVolume$_i$ × *Ad position*	-.867	(.907)		.178	(2.095)	
LogProgramWOMDeviation$_i$ × *Ad position*	-.000	(.000)	**	-.000	(.000)	**
Adjusted R-squared	.9994			.9996		

Notes: Measures for OPE and ad position are mean-centered for ease of interpretation.
* $p < .10$, ** $p < .05$

Web Appendix 3.4: Ad WOM as a measure of attention paid to ads

To test whether ads aired in more social episodes or after more social moments see less attention, we use a measure of ad WOM: the change in the relative volume of brand-related WOM by audience size after its ad was aired compared to before it was aired. We obtain this data for the 248 brands in our data at the second-level from Crimson Hexagon. Akin to our approach for program-related WOM, we tally the brand-related Twitter mentions, capturing Tweets mentioning the brand, a hashtag featuring the brand name, a hashtag included in the brand's ad, or the brand's Twitter handle. We model ad WOM as per Equation (1), that is, as a function of OPE (volume and deviation), ad position, and the ad and program control variables from our main model. For ease of interpretation, we mean-center the measures for OPE and ad position.

In contrast to concerns that viewers of social episodes might pay less attention to ads even though they do not change the channel, the results in Web Appendix Table 3.4 reveal a marginally significant positive relationship between OPE volume and ad WOM ($\beta = .0006$, $p = .054$). This positive relationship is stronger for earlier ads in an ad break ($\beta = -.0003$, $p < .001$). We do not find a significant relationship between OPE deviation and ad WOM ($\beta = -.0000$, $p = .430$), and this relationship does also not depend on ad position ($\beta = .0000$, $p = .882$).

Web Appendix Table 3.4: Key results from analysis of ad WOM

Variable	Estimate (SE)	
Ad position	-.0000 (.0000)	
OPE		
$LogProgramWOMVolume_i$	.0006 (.0003)	*
$LogProgramWOMDeviation_i$	-.0000 (.0000)	
Interaction with ad position		
$LogProgramWOMVolume_i \times Ad\ position$	-.0003 (.0001)	**
$LogProgramWOMDeviation_i \times Ad\ position$	-.0000 (.0000)	
Adjusted R-squared	.14	

Notes: Measures for OPE and ad position are mean-centered for ease of interpretation.
* $p < .10$, ** $p < .05$

Web Appendix 3.5: Alternative operationalizations of OPE volume

For robustness, we test three alternative operationalizations of OPE volume: (1) main specification of OPE volume without the log transformation; (2) absolute measure of OPE volume, that is, our main specification but without dividing by the number of viewers at the beginning of the focal ad and without taking the log of this value; and (3) log transformation of absolute measure of OPE volume, that is, specification as per (2) but with a log transformation. The key results, shown in Web Appendix Table 3.5, are consistent with our main results and illustrate the robustness of our findings to alternative operationalizations of OPE volume.

Web Appendix Table 3.5: Key results from alternative operationalizations of OPE volume

Variable	*Main volume measure without log transformation*	*Absolute volume measure*	*Log of absolute volume measure*
	Estimate (SE)	Estimate (SE)	Estimate (SE)
Ad position	.007 (.000) **	.007 (.000) **	.007 (.000) **
OPE			
LogProgramWOMVolume$_i$	9.476 (2.988) **	.000 (.000) **	.002 (.001) **
LogProgramWOMDeviation$_i$	.001 (.000) **	.001 (.000) **	.001 (.000) **
Interaction with ad position			
LogProgramWOMVolume$_i$ × *Ad position*	-.358 (.759)	.000 (.000)	.000 (.000) **
LogProgramWOMDeviation$_i$ × *Ad position*	-.000 (.000) **	-.000 (.000) **	-.000 (.000) **
Adjusted R-squared	.9995	.9995	.9995

Notes: Measures for OPE and ad position are mean-centered for ease of interpretation.
* $p < .10$, ** $p < .05$

Web Appendix 3.6: Alternative operationalizations of OPE deviation

In our conceptual framework, we conjecture that OPE deviations just prior to an ad will have the most meaningful relationship with audience size during ads, and, in our main analysis, we operationalize this variable as the difference between the volume of program-related Tweets in the minute before a focal ad begins airing and the average number of per-minute program-related Tweets between the start of the episode and when the focal ad begins airing. We test nine alternative operationalizations of this measure where we vary the time window used pre-ad from 2 to 10 minutes. These analyses not only allow us to probe our conjecture that OPE deviations closer to the ad airing are more meaningful for ad audience size, but they also allow us to explore the dynamics of OPE and examine the robustness of our results. As shown in Web Appendix Table 3.6.1, we find that the positive relationship between positive OPE deviations and ad audience size remains significant using the 2-minute to 8-minute measurement windows but then becomes insignificant. Overall, these results support our argument that positive OPE deviations just prior to an ad will have the most meaningful relationship with ad audience size while also showing that our results regarding OPE deviation are robust to alternative operationalizations.

Web Appendix Table 3.6.1: Key results from alternative pre-ad time windows for OPE deviation

Operationalization of $LogProgramWOMDeviation_i$	Estimate (SE) of $LogProgram\ WOMDeviation_i$		
Using 2-minute window pre-ad	.00033	(.00006)	**
Using 3-minute window pre-ad	.00029	(.00006)	**
Using 4-minute window pre-ad	.00027	(.00007)	**
Using 5-minute window pre-ad	.00027	(.00007)	**
Using 6-minute window pre-ad	.00024	(.00007)	**
Using 7-minute window pre-ad	.00019	(.00008)	**
Using 8-minute window pre-ad	.00014	(.00008)	*
Using 9-minute window pre-ad	.00012	(.00008)	
Using 10-minute window pre-ad	.00006	(.00008)	

Notes: * $p < .10$, ** $p < .05$

As further robustness tests, we explore 11 alternative operationalizations of OPE deviation: (1) main specification with a more narrow baseline (i.e., log of the difference between the volume of program-related Tweets in the minute before ad *i* airs (window *p*) and the average number of per-minute program-related Tweets in the 5-minute window preceding window *p*); (2) dichotomous operationalization to capture a *spike* in OPE (variable equals 1 if the volume of program-related Tweets in the minute before ad *i* is greater than or equal to a 25% increase relative to the average number of per-minute program-related Tweets between the start of the episode and ad *i*; 0 otherwise); (3) dichotomous operationalization to capture a *spike* in OPE (variable equals 1 if the volume of program-related Tweets in the minute before ad *i* is greater than or equal to a 50% increase relative to the average number of per-minute program-related Tweets between the start of the episode and ad *i*; 0 otherwise); (4) $ProgramWOMDeviationRatio_i$, the volume of program-related Tweets in the minute before ad *i* airs divided by the average number of per-minute program-related Tweets between the start of the episode and ad *i*; (5) log of $ProgramWOMDeviationRatio_i$; (6) $ProgramWOMDeviationPC_i$, the percentage of program-related Tweets in the minute before ad *i* (operationalized as the volume of program-related Tweets in the minute before ad *i* divided by the volume of program-related Tweets between the start of the episode and ad *i*; (7) log of $ProgramWOMDeviationPC_i$; (8) $ProgramWOMDeviationPC_i$ using the 2-minute window before ad *i* (rather than the 1-minute window); (9) log of $ProgramWOMDeviationPC_i$ using the 2-minute window; (10) $ProgramWOMDeviationPC_i$ using the 5-minute window before ad *i*; and (11) log of $ProgramWOMDeviationPC_i$ using the 5-minute window.

The key results, shown in Web Appendix Table 3.6.2, are consistent with our main model and illustrate the robustness our findings to alternative operationalizations of OPE deviation.

Web Appendix Table 3.6.2: Key results from alternative operationalizations of OPE deviation

Variable	*LogProgramWOM Deviation* $_i$ with narrow baseline Estimate (SE)	*ProgramWOM DeviationSpike* $_i$ with 25% threshold Estimate (SE)	*ProgramWOM DeviationSpike* $_i$ with 50% threshold Estimate (SE)	*ProgramWOM DeviationRatio* $_i$ Estimate (SE)	*LogProgramWOM DeviationRatio* $_i$ Estimate (SE)
Ad position	.007 (.000) **	.007 (.000) **	.007 (.000) **	.007 (.000) **	.007 (.000) **
OPE					
LogProgramWOMVolume $_i$	8.383 (2.998) **	8.368 (3.003) **	8.094 (3.009) **	7.365 (3.002) **	8.367 (2.991) **
LogProgramWOMDeviation $_i$	.001 (.000) **	.004 (.000) **	.004 (.001) **	.003 (.000) **	.009 (.001) **
Interaction with ad position					
LogProgramWOMVolume $_i$ × *Ad position*	-.253 (.766)	.410 (.760)	.472 (.762)	.542 (.761)	.534 (.759)
LogProgramWOMDeviation $_i$ × *Ad position*	-.000 (.000) **	-.001 (.000) **	-.001 (.000) **	-.001 (.000) **	-.003 (.001) **
Adjusted R-squared	.9995	.9995	.9995	.9995	.9995

Variable	*ProgramWOM DeviationPC* $_i$ with 1-minute window Estimate (SE)	*LogProgramWOM DeviationPC* $_i$ with 1-minute window Estimate (SE)	*ProgramWOM DeviationPC* $_i$ with 2-minute window Estimate (SE)	*LogProgramWOM DeviationPC* $_i$ with 2-minute window Estimate (SE)	*ProgramWOM DeviationPC* $_i$ with 5-minute window Estimate (SE)	*LogProgramWOM DeviationPC* $_i$ with 5-minute window Estimate (SE)
Ad position	.007 (.000) **	.007 (.000) **	.007 (.000) **	.007 (.000) **	.007 (.000) **	.007 (.000) **
OPE						
LogProgramWOMVolume $_i$	8.292 (3.005) **	8.356 (2.977) **	8.354 (3.002) **	8.415 (2.988) **	8.228 (3.000) **	8.134 (2.995) **
LogProgramWOMDeviation $_i$	.015 (.004) **	.004 (.000) **	.005 (.003) *	.002 (.000) **	.004 (.002) **	.002 (.001) **
Interaction with ad position						
LogProgramWOMVolume $_i$ × *Ad position*	.199 (.762)	.013 (.754)	.111 (.761)	.037 (.757)	.088 (.761)	.124 (.759)
LogProgramWOMDeviation $_i$ × *Ad position*	-.008 (.002) **	-.001 (.000) **	-.007 (.001) **	-.001 (.000) **	-.004 (.000) **	-.001 (.000) **
Adjusted R-squared	.9995	.9995	.9995	.9995	.9995	.9995

Notes: Measures for OPE and ad position are mean-centered for ease of interpretation.
* $p < .10$, ** $p < .05$

Web Appendix 3.7: Program characteristics that associate with social moments

Our analyses show that positive OPE deviations – that is, social moments in an episode – associate with increased ad audience size. We conduct a follow up analysis in which we explore how episode characteristics associate with social moments. We present the results from this analysis, which we discuss in the main manuscript, below in Web Appendix Table 3.7.

Web Appendix Table 3.7: Relationship between program characteristics and OPE deviation

Variable	Estimate	(SE)	
Intercept	-3.13	(.45)	**
Fixed episode characteristics			
Day of the week (Baseline: Friday)			
Monday	-.03	(.13)	
Tuesday	.27	(.13)	**
Wednesday	-.32	(.14)	**
Thursday	.20	(.14)	
Saturday	.53	(1.28)	
Sunday	.05	(.15)	
Program genre (Baseline: Slice-of-life)			
Comedy	-.46	(.27)	*
Drama/adventure	-1.80	(.21)	**
News	.73	(1.01)	
Suspense/mystery	-2.01	(.45)	**
Special episode			
Fall finale	.43	(.12)	**
Season premiere	-1.33	(.13)	**
Viewer episode rating	.35	(.06)	**
Characteristics that vary within episodes			
$LogProgramWOMVolume_i$	285.36	(321.04)	
Ads on other networks	-.02	(.08)	
Break position	1.60	(.25)	**
Break position × comedy	-1.57	(.39)	**
Break position × drama/adventure	.68	(.30)	**
Break position × news	-1.77	(1.46)	
Break position × suspense/mystery	1.42	(.71)	**
Half-hour break	.51	(.11)	**
Adjusted R-squared	.0660		

Notes: * $p < .10$, ** $p < .05$

Web Appendix 3.8: Exclusion of final ad break

Television viewers may show different patterns of behavior for ad breaks that air after a program has ended. We therefore consider a robustness analysis in which we exclude ads that aired in the final ad break of a program, i.e., the only ad break that may occur after the program has ended. The key results from this alternative analysis, shown in Web Appendix Table 3.8, are consistent with those of our main analysis and provide evidence that ads that air in the final ad break of a program do not alter the results we observe.

Web Appendix Table 3.8: Key results from main model estimation excluding ads aired in a program's final ad break

Variable	Estimate (SE)		
Ad position	.007	(.000)	**
OPE			
$LogProgramWOMVolume_i$	10.100	(3.211)	**
$LogProgramWOMDeviation_i$	.001	(.000)	**
Interaction with ad position			
$LogProgramWOMVolume_i$ × *Ad position*	-.153	(.822)	
$LogProgramWOMDeviation_i$ × *Ad position*	-.000	(.000)	**
Adjusted R-squared	.9996		

Notes: Measures for OPE and ad position are mean-centered for ease of interpretation.
* $p < .10$, ** $p < .05$