

Web Appendix: Targeted Promotions on an E-Book Platform: Crowding Out, Heterogeneity, and Opportunity Costs

Appendix A: Additional Robustness Checks

Randomization Checks

We first report detailed randomization checks by examining whether pre-treatment variables are correlated with experimental conditions. Table A1 presents the results of a randomization check comparing the pre-treatment activity for each group in Study 1, which found no significant difference across conditions out of 12 comparisons.

Table A1: Randomization Checks for Study 1

Variable (Pre-test)	Holdout vs. A	Holdout vs. B	Holdout vs. C	Genre A vs. B	Genre A vs. C	Genre B vs. C
Paid Chapters	-9.418 (-1.23)	-12.166 (-1.56)	-9.516 (-1.23)	-2.748 (-0.66)	-0.098 (-0.02)	2.65 (0.64)
Books Read	-0.31 (-0.82)	-0.448 (-1.06)	-0.402 (-1.07)	-0.138 (-0.66)	-0.091 (-0.48)	0.046 (0.23)
N	7,451	7,204	7,757	12,679	13,232	12,985

Note: T-test for difference in means in pre-test measures, between indicated groups for each column. † Different from zero, $p < 0.10$; * different from zero, $p < 0.05$; ** different from zero, $p < 0.01$. T-statistics in parentheses.

Table A2 presents the results of a randomization check comparing the pre-treatment activity for each group. We detected a few significant differences in pre-treatment activity between the holdout group and the genre framing group. These differences did not affect our analysis in the main text, as our primary comparisons did not involve the framing manipulation.

Table A2: Randomization Checks for Study 2

Panel A						
Variable (Pre-test)	Holdout vs. A	Holdout vs. B	Holdout vs. C	Genre A vs. B	Genre A vs. C	Genre B vs. C
Paid Chapters	-36.386 (-0.73)	48.771 (0.98)	12.456 (0.25)	85.157 [†] (1.77)	48.841 (0.99)	-36.316 (-0.74)
Books Read	-1.548 (-1.43)	-1.003 (-0.89)	-1.458 (-1.29)	0.544 (0.45)	0.09 (0.07)	-0.455 (-0.36)
Unique Books Searched	-1.541 [†] (-1.92)	-1.364 (-1.61)	-1.504 [†] (-1.80)	0.177 (0.19)	0.037 (0.04)	-0.14 (-0.15)
N	9,783	9,714	9,695	9,827	9,808	9,739
Panel B						
Variable (Pre-test)	Holdout vs. Basic	Holdout vs. Title	Holdout vs. Cat.	Basic vs. Title	Basic vs. Cat.	Title vs. Cat.
Paid Chapters	-7.316 (-0.15)	43.764 (0.90)	-12.627 (-0.24)	51.08 (1.09)	-5.311 (-0.11)	-56.391 (-1.15)
Books Read	-1.144 (-1.07)	-0.514 (-0.48)	-2.357* (-1.97)	0.63 (0.55)	-1.213 (-0.96)	-1.843 (-1.46)
Unique Books Searched	-1.369 [†] (-1.71)	-0.838 (-1.06)	-2.206* (-2.48)	0.532 (0.61)	-0.836 (-0.87)	-1.368 (-1.43)
N	9,691	9,767	9,734	9,788	9,755	9,831

Note: T-test for difference in means in pre-test measures, between indicated groups for each column. [†] Different from zero, $p < 0.10$; * different from zero, $p < 0.05$; ** different from zero, $p < 0.01$. T-statistics in parentheses.

As a final check we regressed holdout status on pre-treatment variables, to ensure there were no sample selection artifacts that account for the differences reported in Table A1 and Table A2. These regressions did not detect any “effects” that would indicate sample balance issues affecting our subsequent analysis.

Table A3: Regressions to Check for Sample Selection

DV = Holdout			
	(1)	(2)	(3)
Study 1			
Paid Chapters	-0.000009 (0.000006)	-0.000008 (0.000007)	-0.000012 (0.000008)
Books Read		-0.000042 (0.000144)	-0.000214 (0.000184)
Free Chapters			0.000082 (0.000055)
Constant	0.048850*** (0.001546)	0.048927*** (0.001569)	0.048840*** (0.001570)
R-sq	0.0001	0.0001	0.0002
N	20,436	20,436	20,436
Study 2			
Paid Chapters	0.0000003 (0.000001)	0.0000005 (0.000002)	0.0000274 (0.000031)
Books Read		-0.0000428 (0.000144)	0.0002443 (0.000357)
Free Chapters			-0.0000265 (0.000030)
Constant	0.2472967** (0.003631)	0.2475306** (0.003697)	0.2466593** (0.003829)
R-sq	0.000002	0.000006	0.000065
N	19,522	19,522	19,522

Note: The dependent variable is an indicator variable that is equal to 1 if the individual is in the holdout group.

Effect of Message Framing

The experiment for Study 2 included an additional factor, which varied the creative used in the push notification. The objective of this manipulation was to test whether making the promoted title vs. the promoted genre more salient would moderate the spillover effects from targeting. Each of the three promoted books was presented with one of three different types of message framing. The first, which we label “Basic Framing,” used the phrasing, “Read on for a free sample from [promoted book] or to see our [promoted genre] listings!” The second, which we label “Title Framing,” emphasized the book named in the promotion: “In [promoted book], [synopsis of book premise]! What happens next? Read on to find out!” The third, which we label “Genre Framing,” emphasized the promoted genre, using the phrasing, “What hot new releases are there in [promoted genre]? Check out [promoted book] and our latest listings and find out!”

We expected that title framing would inhibit search, increasing the negative spillovers from targeting, whereas the category framing would encourage search, increasing the positive spillovers from targeting. While we did not observe strong targeting spillover effects, the results have tactical implications that we report for completeness. Table A5 presents regressions that test whether message framing moderates the spillover effects. The model specification adds dummy variables for title framing and category framing (with the basic framing as the baseline), and interacts the message framing dummies with the targeted treatment dummy and an untargeted treatment dummy (which is treated minus targeted). Coded in this way, the untargeted by title and category coefficients represent the incremental effect of message framing relative to the basic framing for untargeted promotions. The targeted by title and category coefficients represent the incremental effect of message framing relative to the basic framing for untargeted promotions.

The first column of Table A5 shows an effect of message framing on the direct response to a targeted promotion. Intuitively, by drawing more attention to the specific book featured in the promotion, title framing increases the effectiveness of the targeted promotion. However, the title framing did not affect the targeting spillovers as hypothesized. Surprisingly, we found that the title framing had a negative effect (relative to the basic framing) on cross-category purchasing for the untargeted promotions. A possible explanation is that the title framing is a turn-off for customers who have low fit with the promotion, causing them to be less active. Finally, we find that the category framing has no effect on purchasing relative to the basic framing – most likely, the creatives were too similar. Taken together, these findings suggest that message framing can moderate the effectiveness of targeted promotions, and the same creative can help or hurt depending on the target and objective.

Table A4: Summary Statistics by Framing Condition for Study 2

Group	N	Paid Chapters	Books Read	Unique Search
Holdout	4,835	1,483.3 (2,525.9)	27.9 (48.6)	16.1 (34.6)
Basic Framing	4,856	1,490.6 (2,367.5)	29.1 (56.4)	17.5 (43.7)
Title Framing	4,932	1,439.6 (2,264.3)	28.5 (56.7)	17.0 (43.1)
Genre Framing	4,899	1,495.9 (2,594.6)	30.3 (67.6)	18.3 (51.4)

Table A5: Message Framing Effects

	Promo Purchase Incidence	# Same Category Purchases	# Cross Category Purchases	Total # of Purchase
Targeted	0.0048 [†] (0.0025)	3.1307** (0.2350)	-3.4860** (0.1845)	-0.3505* (0.1732)
Targeted × Title	0.0108** (0.0041)	-0.0851 (0.3180)	0.0969 (0.2238)	0.0226 (0.1881)
Targeted × Category	0.0049 (0.0036)	0.2867 (0.3289)	-0.1857 (0.2391)	0.1058 (0.1873)
Treated	0.0010 (0.0013)	-1.5909** (0.0666)	1.7778** (0.1078)	0.1879 (0.1307)
Untargeted × Title	0.0026 (0.0017)	-0.0298 (0.0440)	-0.2995* (0.1312)	-0.3266* (0.1358)
Untargeted × Category	0.0012 (0.0016)	-0.0298 (0.0421)	-0.0496 (0.1435)	-0.0782 (0.1487)
Constant	0.0027** (0.0007)	1.9272** (0.0561)	1.1129** (0.0395)	3.0428** (0.0814)
R-sq	0.0035	0.0640	0.0658	0.0005
N	19,522	19,522	19,522	19,522

Note: Targeted indicates the group that received a promotion for a high-fit genre. Treated indicates that a user received one of the promotions. Untargeted indicates the group that received one of the two low-fit promotions. The baseline group did not receive any promotion. [†] Different from zero, $p < 0.10$; * different from zero, $p < 0.05$; ** different from zero, $p < 0.01$. Robust standard errors in parentheses.

Alternative Targeting Cutoffs for Main Analysis

The *Targeting* coefficient for the main analysis under a variety of alternative targeting rules is reported in the main text. Table A6 reports the *Treatment* coefficient for these regressions. The most notable pattern is that, at high levels of targeting precision, the direct promotional response for the non-targeted users falls (as the incremental response for users who are most likely to respond is attributed to targeting).

Table A6: Cutoff Sensitivity Analysis, Treatment Coefficient

Fit	Promo Purchase Incidence	# Same Genre Purchases	# Cross Genre Purchases	Total # of Purchase	N
$\geq 2/3$	0.0023*	-1.6109**	1.6597**	0.0511	19,522
= 1	0.0007	-0.7508**	0.7094**	-0.0407	4,539
≥ 0.9	0.0016	-1.6327**	1.5462**	-0.0849	12,978
≥ 0.8	0.0017	-1.6861**	1.5980**	-0.0864	15,881
≥ 0.7	0.0025*	-1.6350**	1.6508**	0.0184	18,384
≥ 0.6	0.0027**	-1.5587**	1.5839**	0.028	21,116
≥ 0.5	0.0028**	-1.4387**	1.5446**	0.1087	24,145
≥ 0.3	0.0025**	-1.3501**	1.4218**	0.0742	29,364
≥ 0.1	0.0030**	-1.2807**	1.1721**	-0.1057	35,518
> 0 (Any Purchase)	0.0030**	-0.6920**	-0.1159	-0.8049**	50,349
= Most Purchased Genre	0.0054**	-0.7740**	0.7588**	-0.0152	50,349
Finished Book in Genre	0.0061**	-1.5690**	1.9333**	0.3703	10,514
Broader Categories	-0.0014**	-2.6643**	2.7400**	0.0744	37,219
$\geq 2/3$ Multi Pre-test Purch.	0.0026*	-1.6781**	1.7449**	0.0693	18,480
$\geq 2/3$ Excluding Top 1%	0.0023*	-1.5960**	1.6011**	0.0074	19,487
≥ 0.5 Multi Pre-test Purch.	0.0030**	-1.4840**	1.6091**	0.1281	23,103
≥ 0.5 Excluding Top 1%	0.0030**	-1.4335**	1.4645**	0.034	24,064
Continuous Fit	0.0067**	0.3700**	0.1574	0.1486†	77,731

Note: Each estimate reflects the coefficient on the Treatment variable, which indicates the group that received a promotion, contrasted with the holdout group (for models with high-fit genre defined by the first column). † Different from zero, $p < 0.10$; *, * different from zero, $p < 0.05$; ** different from zero, $p < 0.01$.

Alternative Functional Form for Main Analysis

Our primary analysis employs a series of linear regressions because they estimate marginal effects directly, providing average treatment effects of the promotions and the incremental effect of targeting. Also, in our main analyses the regressors are dummy variables that result in estimates that simply provide differences in the conditional means for discrete groups. As an alternative, here we report the parameter estimates for the corresponding nonlinear models that would be appropriate for each outcome variable.

Table A7: Study 1 Logit/Poisson Regression Results

	Promo Purchase Incidence	# of Same Genre Purchase	# of Cross Genre Purchase	Total # of Purchase
Model	Logit	Poisson	Poisson	Poisson
Targeted	0.9898** (0.2312)	0.3120* (0.0338)	-0.1693** (0.0507)	-0.1131* (0.0526)
Treated		0.9705** (0.0732)	1.8481** (0.2499)	1.7054** (0.2334)
Constant	-6.017** (0.1717)	-2.3739** (0.2031)	-1.1623** (0.2483)	-0.9017** (0.2318)
Pseudo R-sq	0.0182	0.0070	0.0162	0.0142
N	20,436	20,436	20,436	20,435

Note: Targeted indicates the group that received a promotion for a high-fit genre. Treated indicates that a user received one of the promotions. The baseline group did not receive any promotion. In the logit model (first column), we combine users that received a promotion for a non-high-fit genre with the baseline group because there were no purchase observations for the baseline group. We also separately estimate a model comparing the targeted and non-targeted group. The coefficient on targeted for this model is significant and positive: 0.9898** (0.2312).

† different from zero, $p < 0.10$; * different from zero, $p < 0.05$; ** different from zero, $p < 0.01$. Robust standard errors in parentheses.

Table A8: Study 2 Logit/Poisson Regression Results

	Promo Purchase Incidence	# of Same Genre Purchase	# of Cross Genre Purchase	Total # of Purchase
Model	Logit	Poisson	Poisson	Poisson
Targeted	1.0193** (0.1888)	2.4138** (0.0637)	-1.4641** (0.0462)	-0.0568† (0.0318)
Treated	0.6221* (0.3125)	-1.8070** (0.0593)	0.9320** (0.0403)	0.0167 (0.0326)
Constant	-5.9160** (0.2777)	0.6561** (0.0291)	0.1077** (0.0355)	1.1128** (0.0268)
Pseudo R-sq	0.0306	0.1921	0.0913	0.0002
N	19,522	19,522	19,522	19,522

Note: Targeted indicates the group that received a promotion for a high-fit genre.

Treated indicates that a user received one of the promotions.

† different from zero, $p < 0.10$; * different from zero, $p < 0.05$; ** different from zero, $p < 0.01$. Robust standard errors in parentheses.

Regressions with Genre-Specific Effects

As an alternative to the analyses where we pool across three promoted genres, we also reported regressions with the three promotions as separate treatments, interacted with consumer preferences with those treatments. As an alternative to the results reported in the main text (Table 6), in Table A9 we report the same regression run on the full sample (instead of the $\geq 2/3$ fit sample).

Table A9: Regression with Genre-Specific Effects (Full Sample)

	Promo Purchase Incidence	# Same Genre Purchases	# Cross Genre Purchases	Total # of Purchase
Genre D Promo. × Genre D Pref.	0.0107** (0.0033)	2.1772** (0.1852)	-2.3068** (0.1673)	-0.1189 (0.1594)
Genre D Promo.	0.0072** (0.0007)	0.2333** (0.0332)	-0.2017* (0.0976)	0.0388 (0.1016)
Genre D Pref.	-0.001 (0.0009)	0.3014** (0.0350)	-2.4890** (0.0786)	-2.1886** (0.0847)
Genre E Promo. × Genre E Pref.	0.0041+ (0.0021)	2.4140** (0.1979)	-2.6510** (0.1727)	-0.233 (0.1523)
Genre E Promo.	0.0062** (0.0007)	0.5934** (0.0424)	-0.5764** (0.1010)	0.0232 (0.1059)
Genre E Pref.	-0.0015+ (0.0008)	0.5957** (0.0344)	-2.4067** (0.0720)	-1.8125** (0.0819)
Genre F Promo. × Genre F Pref.	0.0253+ (0.0146)	1.4608** (0.3481)	-1.3834** (0.2511)	0.1027 (0.4000)
Genre F Promo.	0.0064** (0.0006)	-0.3286** (0.0163)	0.2879** (0.0950)	-0.0343 (0.0970)
Genre F Pref.	0.0024 (0.0039)	-0.2827** (0.0569)	-3.0518** (0.1483)	-3.3321** (0.1650)
Constant	0.0010** (0.0002)	0.3669** (0.0110)	4.7146** (0.0734)	5.0824** (0.0744)
R-sq	0.0024	0.0403	0.0264	0.0090
N	77,516	77,516	77,516	77,516

Note: Targeted indicates the group that received a promotion for a high-fit genre. Treated indicates that a user received one of the promotions. The baseline group did not receive any promotion. † Different from zero, $p < 0.10$; * different from zero, $p < 0.05$; ** different from zero, $p < 0.01$. Robust standard errors in parentheses.

Appendix B: Detailed Regressions on the Role of Search

In this section we report the regressions on search activity described in the main text (with Table B2 reporting the regression for Figure 1 in the main text).

Table B1: Effects of Targeted Promotion on Search Activity

	Same Genre Search (Books)	Cross Genre Search (Books)	Total # Unique Books Searched	Same Genre Search (Incidence)	Other Genres Search	Total # Unique Genres Searched
Targeted	1.8694** (0.0910)	-1.9990** (0.1578)	-0.1295 (0.2093)	0.2679** (0.0076)	-0.3502** (0.0381)	-0.0822 [†] (0.0418)
Treated	-0.6481** (0.0395)	0.8923** (0.1666)	0.2442 (0.1949)	-0.0938*** (0.0049)	0.1273** (0.0402)	0.0335 (0.0432)
Constant	0.9040** (0.0367)	2.4085** (0.1233)	3.3125** (0.1556)	0.2002** (0.0037)	1.3400** (0.0324)	1.5402** (0.0351)
R-sq	0.0274	0.0099	0.0001	0.0887	0.0040	0.0002
N	19,522	19,522	19,522	19,522	19,522	19,522

Note: Targeted indicates the group that received a promotion for a high-fit genre. Treated indicates that a user received one of the promotions. Untargeted indicates the group that received one of the two low-fit promotions. The baseline group did not receive any promotion. [†] Different from zero, $p < 0.10$; * different from zero, $p < 0.05$; ** different from zero, $p < 0.01$. Robust standard errors in parentheses.

Table B2: Effect of Search on Purchasing

	# of Same Genre Purchases	# of Cross Genre Purchases	Total # of Purchase
Same Genre Books Searched	1.1131** (0.0311)	-0.8006** (0.0516)	0.3133** (0.0480)
Cross Genre Books Searched	-0.0143 (0.0237)	-0.0006 (0.0285)	-0.015 (0.0260)
Same Genre Search Incidence	0.1516 (0.1049)	0.8862** (0.1928)	1.0674** (0.1875)
# Other Genres Searched	0.0495 (0.0482)	1.1434** (0.0697)	1.1925** (0.0672)
Pre-test Same Genre Books Searched	0.0669** (0.0115)	-0.0736** (0.0172)	-0.0068 (0.0098)
Pre-test Cross Genre Books Searched	-0.0017 (0.0030)	0.0171** (0.0058)	0.0154* (0.0060)
Pre-test Same Genre Search Incidence	-0.1433** (0.0396)	0.4825** (0.1013)	0.3385** (0.0961)
Pre-test # Other Genres Searched	-0.0142 (0.0264)	0.2319** (0.0475)	0.2181** (0.0340)
Pre-test Dispersion	0.1105 (0.1372)	-1.1901** (0.2351)	-1.0793** (0.1613)
Targeted	0.1602 (0.1137)	-0.5284** (0.1947)	-0.3682* (0.1521)
Treated	-0.5628** (0.0608)	0.6445** (0.0868)	0.0871 (0.0828)
Constant	0.4899** (0.0557)	0.1465 [†] (0.0851)	0.6312** (0.0733)
R-sq	0.8706	0.6399	0.4971
N	19,522	19,522	19,522

Note: Targeted indicates the group that received a promotion for a high-fit genre. Treated indicates that a user received one of the promotions. The baseline group did not receive any promotion. Each model also includes controls for all four pre-treatment search variables and dispersion. [†] Different from zero, $p < 0.10$; * different from zero, $p < 0.05$; ** different from zero, $p < 0.01$. Robust standard errors in parentheses.

Controlling for User Characteristics

Although the preceding analysis provides evidence that targeting reduces search activity, it is possible that certain consumers self-select into responding to targeted vs. untargeted promotions. That is, consumers who tend not to search could be more likely to respond to targeted promotions (i.e. I do not like to search, so a targeted promotion is attractive because it provides me with a good recommendation without the need for search). These same customers may be less likely to make cross-genre purchases. While this does not affect our average treatment effects reported earlier, this would change our interpretation of the results: the targeted promotion may not cause a decrease in search but rather cause certain low-searching individuals to respond at higher rates. To investigate this possibility, we use pre-treatment search activity, measured as the number of unique books visited during the five months before the experimental promotion, to quantify a user's propensity to search. We then use several different approaches to account for pre-treatment search. First, we include it as a covariate in a regression for post-treatment outcomes. Separately, we test related measures that indicate a propensity to search or a preference for variety: a measure of genre dispersion in a user's pre-test purchases.¹ Finally, we use a difference-in-differences specification to account for any time-invariant unobservable characteristics, which would include a general propensity to search.

Table B3 presents the results for regressions including pre-treatment search. We report the same dependent measures as used in our main analysis. First, the interactions between propensity to search and the targeting variable suggest that the spillover effects are slightly larger in magnitude for customers who searched more in the past. Also, since the search variables are

¹ We specify genre dispersion as an entropy measure: $-\sum_{i=1}^N [p(g_i) \cdot \log p(g_i)]$, where $p(g_i)$ is the proportion of books categorized as the i^{th} genre. A larger value indicates greater dispersion in genres purchased from.

not mean-centered, the main effects for Treated and Targeted are predictions for customers with low levels of pre-treatment search, and there remained a negative targeting effect on cross-genre sales for these customers.

Table B4 presents the results for regressions including pre-treatment genre dispersion. Genre dispersion was positively associated with higher levels of spillover effects, both same-genre and cross-genre. Again, there remained a negative effect of targeted promotions on cross-genre purchases, even for low dispersion individuals.

Table B5 presents the results for difference-in-differences regressions. These regressions are equivalent to models with data aggregated to pre- and post-treatment periods estimated with customer fixed effects, relying on within-unit variation in treatments and outcomes. Thus, this approach controls for time invariant unobserved characteristics, providing a very general robustness check. The pattern of estimates is consistent with our main results.

Table B3: Regressions Accounting for Pre-Treatment Search Depth

	Promo Purchase Incidence	# Same Genre Purchases	# Cross Genre Purchases	Total # of Purchase
Targeted	0.0078** (0.0020)	0.8093** (0.1802)	-1.0375** (0.1798)	-0.2205 (0.1570)
Targeted × Same Genre Search	-0.0006 (0.0005)	0.0420 [†] (0.0233)	0.0072 (0.0295)	0.0485 (0.0328)
Targeted × Cross Genre Search	0.0002 (0.0002)	0.026 (0.0255)	-0.1155** (0.0267)	-0.0893** (0.0159)
Treated	0.0021 [†] (0.0012)	-0.7521** (0.0990)	1.1789** (0.0976)	0.4289** (0.1576)
Treated × Same Genre Search	0.0004 (0.0006)	-0.1224** (0.0342)	-0.1473** (0.0313)	-0.2693** (0.0521)
Treated × Cross Genre Search	0.0002 (0.0001)	0.0495** (0.0125)	0.0567** (0.0093)	0.1064** (0.0188)
Pre-treatment Same Genre Search	0.0004 (0.0003)	0.2406** (0.0284)	0.0463** (0.0157)	0.2872** (0.0415)
Pre-treatment Cross Genre Search	-0.0002 (0.0001)	-0.0482** (0.0124)	0.0021 (0.0075)	-0.0462* (0.0180)
Constant	0.0018 [†] (0.0007)	0.8571** (0.0561)	0.7959** (0.0395)	1.6548** (0.0814)
R-sq	0.0059	0.4434	0.2876	0.2054
N	19,522	19,522	19,522	19,522

Note: Targeted indicates the group that received a promotion for a high-fit genre. Treated indicates that a user received one of the promotions. The baseline group did not receive any promotion. Mean same-genre search was 6.46 and mean cross-genre search was 10.77. [†] Different from zero, $p < 0.10$; * different from zero, $p < 0.05$; ** different from zero, $p < 0.01$. Robust standard errors in parentheses.

Table B4. Regressions Accounting for Pre-Treatment Dispersion

	Promo Purchase Incidence	# of Same Genre Purchase	# of Cross Genre Purchase	Total # of Purchase
Targeted	0.0087** (0.0031)	2.3271** (0.1804)	-2.4840** (0.1631)	-0.1482 (0.1421)
Targeted × Dispersion	0.0000 (0.0030)	0.8393** (0.1559)	-0.8613** (0.1535)	-0.022 (0.1444)
Treated	-0.0049* (0.0020)	-1.2623** (0.0830)	1.2239** (0.1065)	-0.0433 (0.1447)
Treated × Dispersion	0.0067** (0.0019)	-0.3170** (0.0762)	0.4078** (0.1145)	0.0975 (0.1498)
Dispersion	-0.0003 (0.0011)	0.5895** (0.0722)	1.0634** (0.0796)	1.6525** (0.1231)
Constant	0.0030* (0.0015)	1.2915** (0.0810)	-0.0339 (0.0682)	1.2607** (0.1172)
R-sq	0.0046	0.0699	0.0850	0.0382
N	19,522	19,522	19,522	19,522

Note: Targeted indicates the group that received a promotion for a high-fit genre. Treated indicates that a user received one of the promotions. The baseline group did not receive any promotion. Dispersion calculates the dispersion of purchased books as an entropy measure across genres. Mean dispersion was 1.07. † Different from zero, $p < 0.10$; * different from zero, $p < 0.05$; ** different from zero, $p < 0.01$. Robust standard errors in parentheses.

Table B5: Difference-in-Differences Regressions to Account for Unobservable Characteristics

	Change in Promoted Book Purchases (Post – Pre)	Change in # of Same Genre Purchases (Post – Pre)	Change in # of Cross Genre Purchases (Post – Pre)	Change in Total # of Purchases (Post – Pre)
Targeted	0.0064** (0.0018)	1.3196** (0.1012)	-1.4051** (0.0933)	-0.0791 (0.0821)
Treated	0.0031** (0.0010)	-0.6682** (0.0484)	0.6798** (0.0584)	0.0147 (0.0832)
Constant	0.0017* (0.0007)	0.7758** (0.0461)	0.4391** (0.0363)	1.2167** (0.0687)
R-sq	0.0019	0.0186	0.0167	0.0001
N	19,522	19,522	19,522	19,522

Note: DV is the difference in response normalized to 3 weeks. Targeted indicates the group that received a promotion for a high-fit genre. Treated indicates users that received any promotion. The baseline group did not receive any promotion. † Different from zero, $p < 0.10$; * different from zero, $p < 0.05$; ** different from zero, $p < 0.01$. Robust standard errors in parentheses.

Appendix C: Ticket Exchange Study

Replication Study with an Online Ticket Exchange Platform

This section demonstrates the generalizability of our findings with a study on an online ticket exchange platform, which generally sells high-priced items in contrast to the inexpensive mobile e-books. The firm sends emails promoting different genres of events (such as NFL games and concerts) to buyers targeted by their purchasing histories. Recipients included customers who had previously purchased from a genre, who we classify as targeted, and customers who had not previously purchased from the genre, who we classify as untargeted. Compared to randomized holdout groups (i.e. consumers who did not receive any promotion), both groups of customers were more likely to purchase the promoted genre. However, compared to holdout, the targeted customers were no more likely to subsequently purchase tickets from a new genre (a category not purchased before), whereas the untargeted customers were twice as likely to purchase from a new genre (excluding the promoted genre). These results are robust to controls for other customer characteristics. The event ticket study complements our e-book studies, taking place in a different market with a more expensive product, also using a different communication channel.

The dataset tracks a sample of nearly 96,000 customers over time, including information on their transactions, genre preferences, offer history, and email history. The genre preferences are a series of flags that are either inferred when a customer makes a purchase from a particular genre, or are explicitly set by the customer in their user profile page (about 1% of the recorded genre preferences were explicitly set). The offer history includes information on a series of promotional email campaigns, including randomly assigned holdout groups. The email history tracks all email traffic to the customer, including newsletters outside the scope of the offer

program. In Studies 1 and 2, each purchase is valued at a few cents; in contrast, the ticket purchases in this study average several hundred dollars per transaction, which allowed us to examine a comparatively high-stakes outcome.

The focus of this analysis is on a series of large-scale campaigns that, in addition to small discounts, targeted specific genre categories by tailoring the content of the emails. A genre is defined by the sports league for athletic events (e.g. NFL football or college football are separate genres), and are split into concerts and theater for cultural events. The data reports the exact incentives for only two subgroups, a 5% discount and a free shipping offer; the remaining offers were described as “Instant Discount.” Thus, we were not able to estimate the effects of specific promotional incentives, but this does not constrain our ability to estimate the effects of targeting.

Table C1 provides information on these campaigns. They were conducted within a few months of each other and were implemented using similar procedures, with very similar database descriptions.

Table C1: Ticket Exchange Email Campaigns

Campaign	Duration (Days)	Genre	N	Offer	Holdout
A	14	NFL	6,598	5,934	664
B	11	College Football	6,823	6,131	692
C	15	NFL	4,616	4,168	448
D	15	Concerts	7,127	6,391	736

Randomization checks, comparing several pre-test measures for the customers assigned to the holdout group and customers receiving the offer, found no statistically significant differences between the groups. However, since the campaigns tested a single genre at a time, targeting for these promotions was not randomized. We do find significant differences in pre-test measures for targeted and untargeted groups, reported in Table C2. Since targeting depends on

customer purchasing histories, there remains a possibility that the untargeted and targeted groups differ on key unobserved characteristics, such as overall likelihood of purchasing. We address these concerns through a series of robustness checks.

Table C2: Pre-treatment Covariates Before and After Matching

	Unmatched Data			Matched Data		
	Untargeted	Targeted	Difference	Untargeted	Targeted	Difference
Previous Orders	3.41	2.27	1.14** (0.05)	3.29	3.30	-0.01 (0.09)
Previous Quantity	9.39	6.10	3.29** (0.16)	9.09	9.07	0.03 (0.25)
Amount Per Order	334.7	341.6	-6.9 (5.38)	334.6	330.3	4.3 (6.31)
Days Since Last Order	305.8	418.6	-112.8** (3.85)	307.3	297.6	9.7* (4.51)
# of Genre Preferences	1.25	1.28	-0.04** (0.01)	1.25	1.28	-0.04** (0.01)
Offer Condition	0.90	0.90	0.00 (0.00)	0.90	0.90	0.00 (0.01)
N	7,093	18,071		7,088	18,071	

* Different from zero, $p < 0.05$; ** different from zero, $p < 0.01$. Standard errors in parentheses.

Note: Targeted group consisted of customers who previously made a purchase in the genre targeted by a campaign for which the customer was eligible. Matched data is reweighted using kernel matching on propensity scores. Propensity scores were estimated using a probit regression on previous orders, quantity, days since last order, and number of genre preferences indicated for each customer as of the offer start date. Matching used an Epanechnikov kernel with bandwidth of 0.025, on common support (other kernels, bandwidths, and nearest-neighbor matching produced similar results).

The retailer used different selection rules for campaign eligibility, depending on whether a customer's genre preferences matched the offer. The marketers providing the data confirmed that they imposed higher past purchasing thresholds for untargeted customers when building the campaign user lists, to focus cross-selling efforts on stronger prospects. These customers may

also have had higher responsiveness to promotions, or higher likelihoods of purchasing in the future, which could complicate comparisons with the targeted group.

While exact criteria for selection were unavailable, the marketers confirmed that the pre-test measures in Table C2 (or very similar metrics that were easily accessible to the marketers), which include industry standard recency, frequency, and monetary value variables, were used as a basis for targeting decisions. Thus, a matching procedure based on these variables should provide a strong indication of whether differences in customers accounts for our results. To supplement the conventional (OLS) estimates of the targeting effect, an alternative analysis was performed using propensity score matching to reweight the data, using the listed pre-test measures as covariates.

The outcome of interest is whether the customer made a purchase from a new genre, from which the customer has not previously purchased, during a period of 28 days. This variable also excludes the target genre itself, so we do not classify the target genre as a new genre for either the targeted or the untargeted customers. The purchase rate is regressed on indicators for whether the customer was targeted, whether they received an offer, and an interaction that estimates the effect of targeting an offer.

Table C3, Panel A reports the regression results. When not receiving an offer, the two groups were equally likely to purchase tickets to a genre they had not previously purchased. The untargeted group is more likely to buy from a new genre when receiving the offer, while the targeted group is not. This result is consistent with our previous findings that less targeted offers can facilitate the diversification of purchasing patterns. If a retailer considers it important to diversify across categories at the customer level, targeted offers that evoke the customer's preferred category come at the cost of less diversification. One reason this is particularly

important for the ticket exchange is that the genres tend to be very seasonal, and allowing customers to remain inactive for large parts of the year could hurt retention.

Table C3: Regression Results

	Purchased Target Genre	Purchased Preferred Genre	Purchased New Genre	Any Purchase
Panel A: OLS				
Offer × Targeted	-0.0051 (0.0032)	0.0043 (0.0063)	-0.0105* (0.0028)	-0.0096 (0.0069)
Offer	0.0091 [†] (0.0032)	-0.0056 (0.0045)	0.0114** (0.0015)	0.0135 (0.0070)
Targeted	0.0061 (0.0054)	-0.0254** (0.0010)	-0.0032 (0.0041)	-0.0228 [†] (0.0093)
R-sq	0.0150	0.0186	0.0162	0.0426
Panel B: Matching				
Offer × Targeted	-0.0016 (0.0069)	0.0052 (0.0113)	-0.0135* (0.0040)	-0.0087 (0.0096)
Offer	0.0091** (0.0024)	-0.0038 (0.0038)	0.0109** (0.0014)	0.0148 [†] (0.0052)
Targeted	0.0152* (0.0061)	-0.0173 (0.0092)	0.0088 [†] (0.0034)	0.0051 (0.0082)
R-sq	0.0249	0.0228	0.0232	0.0610

[†] Different from zero, $p < 0.10$; * different from zero, $p < 0.05$; ** different from zero, $p < 0.01$. Robust standard errors in parentheses.

Note: Sample includes all active customers in the four genre-targeted campaigns (N = 25,164). Targeted group consisted of customers who previously made a purchase in the genre targeted by a campaign for which the customer was eligible. Matched data is reweighted using kernel matching on propensity scores. Propensity scores were estimated using a probit regression on previous orders, quantity, days since last order, and number of genre preferences indicated for each customer as of the offer start date. Matching used an Epanechnikov kernel with bandwidth of 0.025, on common support (other kernels, bandwidths, and nearest-neighbor matching produced similar results).

Purchasing of a new genre, in the third column of Table C3, is analogous to cross-category purchasing in our e-book experiments. Three other sets of purchasing are also considered. The first column indicates whether the customer purchased tickets within the genre specified in the offer – equivalent to the same-category purchases in our e-book experiments. The second indicates whether the customer purchased tickets for a preferred genre (having made a previous purchase or set an explicit preference) other than the genre specific to the offer. The last column indicates whether the customer made any purchase.

As previously noted, the targeting of promotions was not randomized, as it was in Studies 1 and 2. The concern is that there could also be unobservable differences that affect our results. We employed a matching procedure to help attribute the differences in behavior to differences in genre preference. First, each customer's membership in the untargeted group was predicted using a probit regression on recency, frequency, monetary value, and the number of genre preferences contemporaneously reported for each customer. Assignment to the untargeted group is independent of the covariates conditional on this predicted probability, or propensity score (Rosenbaum and Rubin 1983). The estimated propensity scores suggest that the support for the targeted customers provides adequate coverage to form a comparison group for the untargeted customers, while the converse would not be true. This is also consistent with the aforementioned conversations with the marketers providing the data, who confirmed that high-value customers who had not purchased specific genres were included as prospects in targeted campaigns. For each untargeted customer, weights were then assigned to targeted customers based on the similarity of their propensity scores using a kernel matching method. The right half of Table C2 reports the differences in weighted averages for the pre-test measures. While statistically significant differences between the two groups remain, the magnitude of these differences after

the weighting process is relatively small.

Table C3, Panel B reports the matching estimates. The results confirm the initial analysis: the targeted group is less likely to purchase from a new genre. As expected, the baseline purchasing for the targeted customers was higher after matching. In contrast to the unmatched results, baseline purchasing was very similar using the matched estimates. The matched targeted group also had a stronger purchasing response, more in line with expectations for a targeted offer. This suggests that the matching procedure was effective in forming groups with similar promotional responsiveness. The results show that customers receiving targeted offers were less likely to go on to purchase tickets in unpromoted genres that they had not previously purchased. This study generalizes our findings from Study 1 to a different market, both in terms of product and geography. In addition, Study 1 took place in a mobile setting, and information search is more cumbersome on mobile devices. Promotions in this study were sent by email, which may be more likely to be read on a device (such as a PC) that facilitates organic information search, yet we still found negative spillovers.

Thus, we are able to generalize the main results to an online ticket exchange. This is a different product market, with much more expensive products, but as with e-books, consumers may be variety seeking. The study takes place in North America, using targeted email promotions. Together, these studies provide convergent evidence that the negative spillovers from targeted promotions occur across different markets and communication channels.

REFERENCES

- Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika*, 70(1), 41–55.