Online Supplement to "Ad Blockers and Ad Quality"

The online supplement contains two parts: Section A presents the technical details pertaining to the main model, while Section B elaborates on the details pertaining to the extensions.

A. Technical Details

This section provides technical details pertaining to the main model and is divided into two parts: Section A.1. covers the threshold details and win-or-lose outcomes omitted from the presentation of the main model. Section A.2. presents results when the satiation rate k is general (which for the sake of expositional clarity is simplified to 1 in the main text).

A.1. Main Model Details

In Propositions 4 and 5, there are two thresholds. The specific expressions for these thresholds are as follows:

$$\underline{\mathfrak{n}} = \begin{cases} \min\left\{\frac{1-\lambda-\lambda^2+r\lambda^2}{1-\lambda}, \max\left\{1-\lambda+\lambda\mathfrak{i}, \frac{r-\lambda-\lambda\mathfrak{i}(1-r)}{r-\lambda}\right\}\right\} & \text{if} \quad \lambda \leq \min\left\{r, \frac{1}{3}\right\} \\ \max\left\{\frac{r-\lambda-\lambda\mathfrak{i}(1-r)}{r-\lambda}, 1-\lambda+\lambda\mathfrak{i}\right\} & \text{if } \frac{1}{3} < \lambda \leq r, \mathfrak{i} \leq \frac{1-2\lambda+r\lambda}{1-\lambda} \\ \frac{1-\lambda-\lambda^2+r\lambda^2}{1-\lambda} & \text{if } \frac{1}{3} < \lambda \leq r, \mathfrak{i} > \frac{1-2\lambda+r\lambda}{1-\lambda} \end{cases}$$

$$\underline{\mathfrak{i}} = \begin{cases} 0 & \text{if} \quad \mathfrak{n} \leq \lambda(1-r) \\ \mathfrak{n} - \lambda(1-r) & \text{if } \lambda(1-r) < \mathfrak{n} \leq \frac{r-\lambda(1-\lambda)-2r\lambda^2+r^2\lambda^2}{r(1-\lambda)} \\ \frac{(r-\lambda)(1-\mathfrak{n})}{\lambda(1-r)} & \text{if} \quad \mathfrak{n} > \frac{r-\lambda(1-\lambda)-2r\lambda^2+r^2\lambda^2}{r(1-\lambda)} \end{cases}$$

Proposition 6 presents only conditions for the win-win-win outcome; next, we characterize conditions for all the other outcomes.

(1) The presence of ad blockers leads to a win-win-indifferent outcome for the advertiser, the platform, and consumers when $\lambda \leq r$ and $\mathfrak{i} + \lambda(1-r) < \mathfrak{n} \leq \min\{\mathfrak{i} + \sqrt{2\lambda(1-r)}, \frac{r-\lambda-\lambda\mathfrak{i}(1-r)}{r-\lambda}\}$.

(2) The presence of ad blockers leads to a win-lose-win outcome for the advertiser, the platform, and consumers when $\lambda > r$ and $\lambda - r < \mathfrak{n} \leq \min\{1+\lambda\mathfrak{i} - r, (1+\lambda)(1-r)\}$, or $\lambda \leq r$ and $\frac{r-\lambda-\lambda\mathfrak{i}(1-r)}{r-\lambda} < \mathfrak{n} \leq \underline{\mathfrak{n}}$.

(3) The presence of ad blockers leads to a win-lose-lose outcome for the advertiser, the platform, and consumers when $\lambda > r$ and $\lambda - r - \sqrt{2(1-\lambda)r} < \mathfrak{n} \leq \lambda - r$.

(4) The presence of ad blockers leads to a lose-win-win outcome for the advertiser, the platform, and consumers when $\lambda > r$ and $\lambda - r + \mathfrak{i} + \sqrt{2(1-\lambda)r(1-\mathfrak{i})} < \mathfrak{n} \leq \mathfrak{i} + \sqrt{2\lambda(1-r)}$, or $\lambda \leq r$ and $\lambda - r + \mathfrak{i} + \sqrt{\lambda^2 - 2\lambda r(2-\mathfrak{i}) + r(2+r-2\mathfrak{i})} < \mathfrak{n} \leq \mathfrak{i} + \sqrt{2\lambda(1-r)}$.

(5) The presence of ad blockers leads to a lose-lose-win outcome for the advertiser, the platform, and consumers when $\lambda > r$ and $\mathfrak{n} > \mathfrak{i} + \sqrt{2\lambda(1-r)}$, or $\lambda \leq r$ and $\mathfrak{n} > \max\{\frac{r-\lambda-\lambda\mathfrak{i}(1-r)}{r-\lambda}, \mathfrak{i} + \sqrt{2\lambda(1-r)}\}$.

(6) The presence of ad blockers leads to an indifferent-indifferent-indifferent outcome for the advertiser, the platform, and consumers when $\lambda > r$ and $\mathfrak{n} \leq \lambda - r - \sqrt{2(1-\lambda)r}$, or $\lambda \leq r$ and $\mathfrak{i} + \sqrt{2\lambda(1-r)} < \mathfrak{n} \leq \frac{r-\lambda-\lambda\mathfrak{i}(1-r)}{r-\lambda}$.

A.2. Complete Equilibrium Outcomes with a General Satiation Rate

In the main text, to facilitate crisper exposition, a satiation rate of 1 for consumer content consumption is assumed. We now present the equilibrium analytical results given a general satiation rate k.

Lemma A.1 *In the scenario without ad blockers, the equilibrium outcomes are as summarized in the table below:*

Region	Range	Ad quality
I	$\lambda > r$	$\frac{\lambda-r}{k}$
II	$\lambda \leq r$, $\mathfrak{n} > \frac{r-\lambda-\lambda\mathfrak{i}(1-r)}{r-\lambda}$	0
III	otherwise	advertiser exits

Region	Advertiser profit	Platform profit	Consumer welfare
I	$\frac{(\lambda-r)^2+2k[\lambda(1+\mathfrak{i}-\mathfrak{n})-r(1+\lambda\mathfrak{i}-\mathfrak{n})]}{2k^2}$	$\frac{r(\lambda+\lambda k\mathfrak{i}+k-r-k\mathfrak{n})}{k^2}$	$\frac{(\lambda-r)^2+2k(\lambda-r)(1+\lambda\mathfrak{i}-\mathfrak{n})+k^2[(1-\mathfrak{n})^2+\lambda\mathfrak{i}(2+\mathfrak{i}-2\mathfrak{n})]}{2k^3}$
II	$\frac{\lambda(1+\mathfrak{i}-\mathfrak{n})-r(1+\lambda\mathfrak{i}-\mathfrak{n})}{k}$	$\frac{r(1+\lambda\mathfrak{i}-\mathfrak{n})}{k}$	$\frac{(1-\mathfrak{n})^2+\lambda\mathfrak{i}(2+\mathfrak{i}-2\mathfrak{n})}{2k}$
III	0	0	$\frac{1}{2k}$

Lemma A.2 *In the scenario with ad blockers, the equilibrium outcomes are summarized in the table below:*

Region	Range	Consumer choice	Ad Quality
I	$\mathfrak{n} \leq \frac{\lambda-r}{k} - \sqrt{\frac{2r(1-\lambda)}{k}}$	all consumers N	$\frac{\lambda-r}{k}$
II	$\frac{\lambda-r}{k} - \sqrt{\frac{2r(1-\lambda)}{k}} < \mathfrak{n} \leq \frac{\lambda(1-r)}{k}$	E-consumers N, I-consumers Y	$\mathfrak{n}$
III	$\frac{\lambda(1-r)}{k} < \mathfrak{n} \leq \frac{\lambda(1-r)+k\mathfrak{i}}{k}$	E-consumers N, I-consumers Y	$\frac{\lambda(1-r)}{k}$
IV	$\frac{\lambda(1-r)+k\mathfrak{i}}{k} < \mathfrak{n} \leq \mathfrak{i} + \sqrt{\frac{2\lambda(1-r)}{k}}$	E-consumers N, I-consumers Y	$\mathfrak{n}-\mathfrak{i}$
V	otherwise	all consumers indifferent	advertiser exits

Region	Advertiser profit	Platform profit	Consumer welfare
I	$\frac{(\lambda-r)^2+2k[\lambda(1+\mathfrak{i}-\mathfrak{n})-r(1+\lambda\mathfrak{i}-\mathfrak{n})]}{2k^2}$	$\frac{r(\lambda+\lambda k\mathfrak{i}+k-k\mathfrak{n}-r)}{k^2}$	$\frac{(\lambda-r)^2+2k(\lambda-r)(1+\lambda\mathfrak{i}-\mathfrak{n})+k^2[1+\mathfrak{n}^2+2\lambda\mathfrak{i}+\lambda\mathfrak{i}^2-2\mathfrak{n}(1+\lambda\mathfrak{i})]}{2k^3}$
II	$\frac{2\lambda(1-r)(1+\mathfrak{i})-k\mathfrak{n}^2}{2k}$	$\frac{\lambda r(1+\mathfrak{i})}{k}$	$\frac{(1+2\lambda\mathfrak{i}+\lambda\mathfrak{i}^2)}{2k}$
III	$\frac{\lambda(1-r)[\lambda(1-r)+2k(1+\mathfrak{i}-\mathfrak{n})]}{2k^2}$	$\frac{\lambda r[\lambda(1-r)+k(1+\mathfrak{i}-\mathfrak{n})]}{k^2}$	$\frac{k^2[1+\mathfrak{i}^2\lambda+2\mathfrak{i}(1-\mathfrak{n})\lambda-2\mathfrak{n}\lambda+\mathfrak{n}^2\lambda]+2k(1+\mathfrak{i}-\mathfrak{n})(1-r)\lambda^2+(1-r)^2\lambda^3}{2k^3}$
IV	$\frac{2(1-r)\lambda-k(\mathfrak{i}-\mathfrak{n})^2}{2k}$	$\frac{\lambda r}{k}$	$\frac{1}{2k}$
V	0	0	$\frac{1}{2k}$

Analytical win-or-lose analysis for each party, however, cannot be algebraically simplified to clean expressions. We then graphically present the win-or-lose outcomes for two satiation rates (0.5 and 1.5, and we have tested many others) in Figure A.2.1. It can be observed that the patterns characterized under the 1-satiation rate case carry over, as the model dynamics do not change.

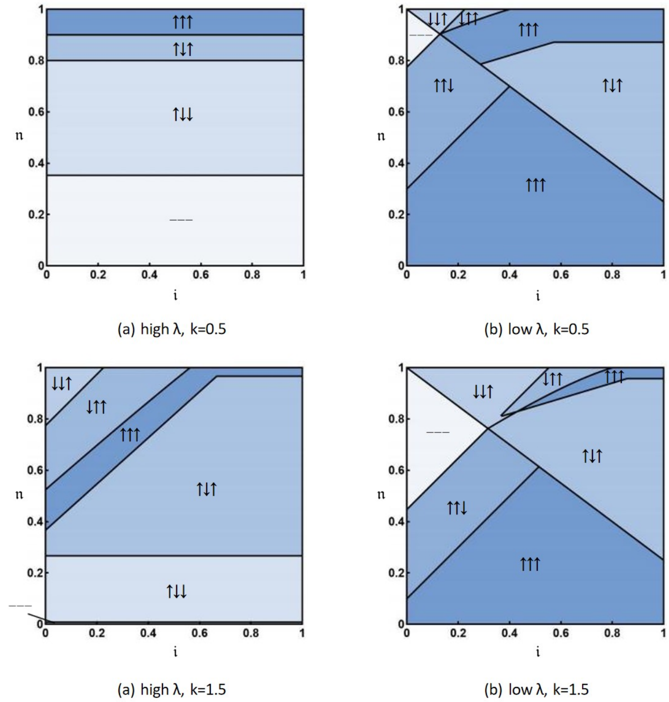
B. Extension Details

In this section, we present the main results and analyses of six extensions.

B.1. Competing Advertisers

In this section we examine a scenario where two advertisers (advertiser 1 and advertiser 2) compete on a single platform to promote substitutable, competing products. These advertisers differ in the efficiency with which they invest in ad quality, with advertiser 1 better at creating high-quality ads than advertiser 2. Specifically, if both advertisers produce an ad of quality $\mathfrak{e}$, advertiser 1 incurs a cost of $\eta_1\mathfrak{e}^2/2$ while advertiser 2 incurs a cost of $\eta_2\mathfrak{e}^2/2$, where $\eta_1 < \eta_2$. To capture the competitive dynamics, it is assumed that the effective

Figure A.2.1 Impacts of Ad Blockers on the Advertiser, Platform, and Consumers in the General Saturation Rate Setting



Note. $r = 0.5$, $\lambda = 0.9$ in the high-λ case, and $\lambda = 0.3$ in the low-λ case.

view of one advertiser not only contributes to its own revenue but also reduces its competitor's revenue. Let l denote the revenue lost by a competitor for each view of an advertiser's ad. For instance, if an effective consumer views an ad from advertiser 1, advertiser 2 incurs a negative payoff of $-l$.

Following the procedure of the main model, the scenario is analyzed first without ad blockers and then with ad blockers. In each scenario, four distinct cases are considered: only advertiser 1 joins the platform, only advertiser 2 joins the platform, both advertisers join the platform, and neither advertiser joins the platform. Specifically, if both advertisers advertise on the platform, it is assumed that the platform will rotate the displays of their ads, consistent with common practice.

In the case where both advertisers join the platform, a consumer's total utility from consuming x pieces of content is given by: $u_{\mathsf{C}} = \left[1 + \left(\mathfrak{i} \cdot \mathbb{1}_{\{\mathsf{C}=\mathsf{E}\}} + \frac{\mathfrak{e}_1+\mathfrak{e}_2}{2} - \mathfrak{n}\right) \cdot \mathbb{1}_{\{\mathsf{B}=\mathsf{N}\}}\right] \cdot x - \frac{x^2}{2}$. The optimal volume of content consumed by a consumer is then: $x^*_{\mathsf{C}} = 1 + \left(\mathfrak{i} \cdot \mathbb{1}_{\{\mathsf{C}=\mathsf{E}\}} + \frac{\mathfrak{e}_1+\mathfrak{e}_2}{2} - \mathfrak{n}\right) \cdot \mathbb{1}_{\{\mathsf{B}=\mathsf{N}\}}$. Based on these consumption levels, the advertiser's profit, the platform's profit, and consumer welfare in the scenario without ad blockers can be formulated as follows:

$$\pi_{\mathsf{a1}} = (1-r) \cdot \lambda \cdot \frac{x^*_{\mathsf{E}}}{2} - l \cdot \lambda \cdot \frac{x^*_{\mathsf{E}}}{2} - r \cdot (1-\lambda) \cdot \frac{x^*_{\mathsf{I}}}{2} - \frac{\eta_1 \mathfrak{e}_1^2}{2}$$

and

$$\pi_{\mathsf{a2}} = (1-r) \cdot \lambda \cdot \frac{x^*_{\mathsf{E}}}{2} - l \cdot \lambda \cdot \frac{x^*_{\mathsf{E}}}{2} - r \cdot (1-\lambda) \cdot \frac{x^*_{\mathsf{I}}}{2} - \frac{\eta_2 \mathfrak{e}_2^2}{2}$$

and

$$\pi_{\mathsf{p}} = r \cdot \left[\lambda \cdot x^*_{\mathsf{E}} + (1-\lambda) \cdot x^*_{\mathsf{I}}\right]$$

and

$$\pi_{\mathsf{c}} = \lambda \cdot \int_0^{x^*_{\mathsf{E}}} 1 + \left(\mathfrak{i} + \frac{\mathfrak{e}_1 + \mathfrak{e}_2}{2} - \mathfrak{n}\right) - y \; \mathsf{d}y + (1-\lambda) \cdot \int_0^{x^*_{\mathsf{I}}} 1 + \left(\frac{\mathfrak{e}_1 + \mathfrak{e}_2}{2} - \mathfrak{n}\right) - y \; \mathsf{d}y.$$

In the scenario with ad blockers, we substitute the optimal volume of content x^*_{C} into the consumer's utility function to obtain the optimal consumer utility u^*_{C}. When we compare the values of $u^*_{\{\mathsf{C}=\mathsf{N}\}}$ and $u^*_{\{\mathsf{C}=\mathsf{Y}\}}$, it is determined that all consumers refrain from using ad blockers when $\mathfrak{e}_1 + \mathfrak{e}_2 > 2\mathfrak{n}$ and only effective consumers refrain from using ad blockers when $2\mathfrak{n} - 2\mathfrak{i} \leq \mathfrak{e}_1 + \mathfrak{e}_2 \leq 2\mathfrak{n}$. The advertiser's profit, the platform's profit, and consumer welfare in this scenario are then formulated as follows:

$$\pi_{\mathsf{a1}} = (1-r) \cdot \lambda \cdot \frac{x^*_{\mathsf{E}}}{2} \cdot \mathbb{1}_{\{\mathfrak{e}_1+\mathfrak{e}_2 \geq 2\mathfrak{n}-2\mathfrak{i}\}} - l \cdot \lambda \cdot \frac{x^*_{\mathsf{E}}}{2} \cdot \mathbb{1}_{\{\mathfrak{e}_1+\mathfrak{e}_2 \geq 2\mathfrak{n}-2\mathfrak{i}\}} - r \cdot (1-\lambda) \cdot \frac{x^*_{\mathsf{I}}}{2} \cdot \mathbb{1}_{\{\mathfrak{e}_1+\mathfrak{e}_2 > 2\mathfrak{n}\}} - \frac{\eta_1 \mathfrak{e}_1^2}{2}$$

and

$$\pi_{\mathsf{a2}} = (1-r) \cdot \lambda \cdot \frac{x^*_{\mathsf{E}}}{2} \cdot \mathbb{1}_{\{\mathfrak{e}_1+\mathfrak{e}_2 \geq 2\mathfrak{n}-2\mathfrak{i}\}} - l \cdot \lambda \cdot \frac{x^*_{\mathsf{E}}}{2} \cdot \mathbb{1}_{\{\mathfrak{e}_1+\mathfrak{e}_2 \geq 2\mathfrak{n}-2\mathfrak{i}\}} - r \cdot (1-\lambda) \cdot \frac{x^*_{\mathsf{I}}}{2} \cdot \mathbb{1}_{\{\mathfrak{e}_1+\mathfrak{e}_2 > 2\mathfrak{n}\}} - \frac{\eta_2 \mathfrak{e}_2^2}{2}$$

and

$$\pi_{\mathsf{p}} = r \cdot \left[\lambda \cdot x^*_{\mathsf{E}} \cdot \mathbb{1}_{\{\mathfrak{e}_1+\mathfrak{e}_2 \geq 2\mathfrak{n}-2\mathfrak{i}\}} + (1-\lambda) \cdot x^*_{\mathsf{I}} \cdot \mathbb{1}_{\{\mathfrak{e}_1+\mathfrak{e}_2 > 2\mathfrak{n}\}}\right]$$

and

$$\pi_{\mathsf{c}} = \lambda \cdot \int_0^{x^*_{\mathsf{E}}} 1 + \left(\mathfrak{i} + \frac{\mathfrak{e}_1 + \mathfrak{e}_2}{2} - \mathfrak{n}\right)^+ - y \; \mathsf{d}y + (1-\lambda) \cdot \int_0^{x^*_{\mathsf{I}}} 1 + \left(\frac{\mathfrak{e}_1 + \mathfrak{e}_2}{2} - \mathfrak{n}\right)^+ - y \; \mathsf{d}y.$$

In the case where only advertiser 1 joins the platform, a consumer's total utility from consuming x pieces of content is given by: $u_{\mathsf{C}} = \left[1 + \left(\mathfrak{i} \cdot \mathbb{1}_{\{\mathsf{C}=\mathsf{E}\}} + \mathfrak{e}_1 - \mathfrak{n}\right) \cdot \mathbb{1}_{\{\mathsf{B}=\mathsf{N}\}}\right] \cdot x - \frac{x^2}{2}$. The optimal volume of content consumed by a consumer is then: $x^*_{\mathsf{C}} = 1 + \left(\mathfrak{i} \cdot \mathbb{1}_{\{\mathsf{C}=\mathsf{E}\}} + \mathfrak{e}_1 - \mathfrak{n}\right) \cdot \mathbb{1}_{\{\mathsf{B}=\mathsf{N}\}}$. Based on these consumption levels, we first formulate the advertiser's profit, the platform's profit, and consumer welfare in the scenario without ad blockers:

$$\pi_{\mathsf{a1}} = (1-r) \cdot \lambda \cdot x^*_{\mathsf{E}} - r \cdot (1-\lambda) \cdot \frac{x^*_{\mathsf{I}}}{2} - \frac{\eta_1 \mathfrak{e}_1^2}{2}$$

and

$$\pi_{\mathsf{a2}} = -l \cdot \lambda \cdot x^*_{\mathsf{E}}$$

and

$$\pi_{\mathsf{p}} = r \cdot \left[\lambda \cdot x^*_{\mathsf{E}} + (1-\lambda) \cdot x^*_{\mathsf{I}}\right]$$

and

$$\pi_{\mathsf{c}} = \lambda \cdot \int_0^{x^*_{\mathsf{E}}} 1 + \left(\mathfrak{i} + \mathfrak{e}_1 - \mathfrak{n}\right) - y \; \mathsf{d}y + (1-\lambda) \cdot \int_0^{x^*_{\mathsf{I}}} 1 + \left(\mathfrak{e}_1 - \mathfrak{n}\right) - y \; \mathsf{d}y.$$

In the scenario with ad blockers, when we substitute the optimal volume of content x^*_{C} into the consumer's utility function, we obtain the optimal consumer utility u^*_{C}. When comparing the values of $u^*_{\{\mathsf{C}=\mathsf{N}\}}$ and $u^*_{\{\mathsf{C}=\mathsf{Y}\}}$, we find that all consumers refrain from using ad blockers when $\mathfrak{e}_1 > \mathfrak{n}$, and only effective consumers refrain from using ad blockers when $\mathfrak{n} - \mathfrak{i} \le \mathfrak{e}_1 \le \mathfrak{n}$. The advertiser's profit, the platform's profit, and consumer welfare are then formulated as follows:

$$\pi_{\mathsf{a}1} = (1-r)\cdot\lambda\cdot x_{\mathsf{E}}^{*}\cdot\mathbb{1}_{\{\mathfrak{e}_1\ge\mathfrak{n}-\mathfrak{i}\}} - r\cdot(1-\lambda)\cdot x_{\mathsf{I}}^{*}\cdot\mathbb{1}_{\{\mathfrak{e}_1>\mathfrak{n}\}} - \frac{\eta_1\mathfrak{e}_1^2}{2}$$

and

$$\pi_{\mathsf{a}2} = -l\cdot\lambda\cdot x_{\mathsf{E}}^{*}\cdot\mathbb{1}_{\{\mathfrak{e}_1\ge\mathfrak{n}-\mathfrak{i}\}}$$

and

$$\pi_{\mathsf{p}} = r\cdot\left[\lambda\cdot x_{\mathsf{E}}^{*}\cdot\mathbb{1}_{\{\mathfrak{e}_1\ge\mathfrak{n}-\mathfrak{i}\}} + (1-\lambda)\cdot x_{\mathsf{I}}^{*}\cdot\mathbb{1}_{\{\mathfrak{e}_1>\mathfrak{n}\}}\right]$$

and

$$\pi_{\mathsf{c}} = \lambda\cdot\int_0^{x_{\mathsf{E}}^{*}} 1 + \left(\mathfrak{i}+\mathfrak{e}_1-\mathfrak{n}\right)^{+} - y\ \mathsf{d}y + (1-\lambda)\cdot\int_0^{x_{\mathsf{I}}^{*}} 1 + \left(\mathfrak{e}_1-\mathfrak{n}\right)^{+} - y\ \mathsf{d}y.$$

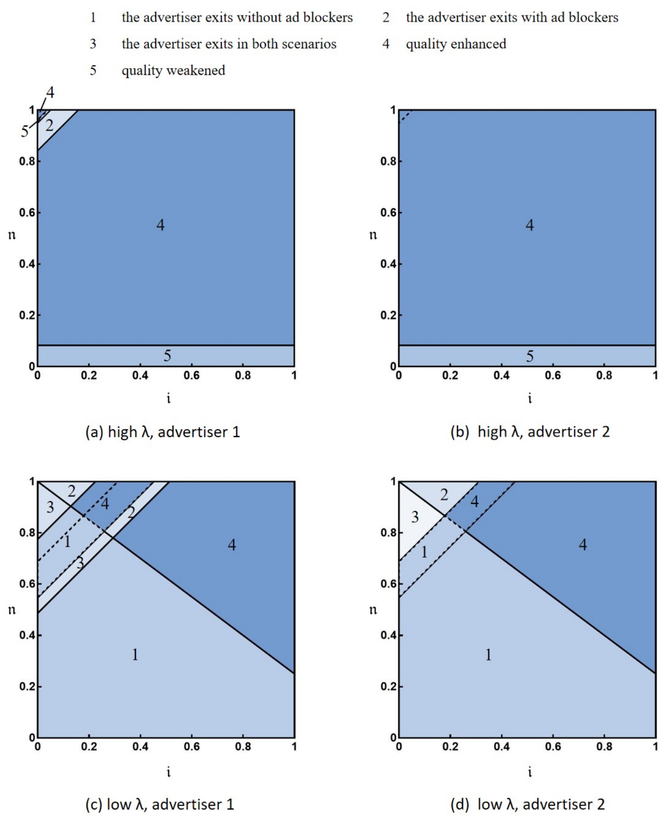
In the case where only advertiser 2 joins the platform, the results can be derived symmetrically.

We can determine the equilibrium results for each case using backward induction. Through numerical analysis, the following findings are derived. As is the case with the main model, here the parameter space is segmented based on the value of λ, and the pairs $(\mathfrak{i}, \mathfrak{n})$ are analyzed under varying λ values. The outcomes of advertisers' exit and ad-quality decisions are depicted in Figure B.1.1. Figure B.1.2 illustrates the win-or-lose outcomes for each party. In this setting, a mixed-strategy equilibrium exists, represented by the areas enclosed by dashed lines in Figure B.1.1 (specifically, the region where λ is high, $\mathfrak{i}$ is low, and $\mathfrak{n}$ is high, as well as the region where λ is low, $\mathfrak{i}$ is moderately low, and $\mathfrak{n}$ is moderately high). In these areas, the two advertisers mix their decisions between joining the platform and opting out. To facilitate analysis and comparison, we use the expected ad quality and expected profit within these regions to evaluate the equilibrium outcomes.

When the proportion of effective consumers is low, in the scenario without ad blockers, both advertisers are likely to join the platform when nuisance disvalue is high, while both exit the platform when nuisance disvalue is low (in Figure B.1.1 (c) and (d), regions 1 and 3 represent the case where the advertiser exits the market without ad blockers, while the other regions represent the case where the advertiser joins the market without ad blockers). In the presence of ad blockers, however, the situation changes significantly. A pure strategy equilibrium where only one advertiser joins the platform may now arise, along with a mixed strategy equilibrium where both advertisers make probabilistic decisions about joining or leaving the platform. This mixed strategy may result in four possible equilibrium outcomes: both join, only advertiser 1 joins, only advertiser 2 joins, or neither joins. These outcomes reflect the fact that the presence of ad blockers gives consumers the ability to block ads from all advertisers simultaneously. This can alleviate advertisers' concerns about competitors capturing consumers' attention, thereby reducing competition between advertisers and helping them avoid falling into the vicious cycle of a prisoner's dilemma.

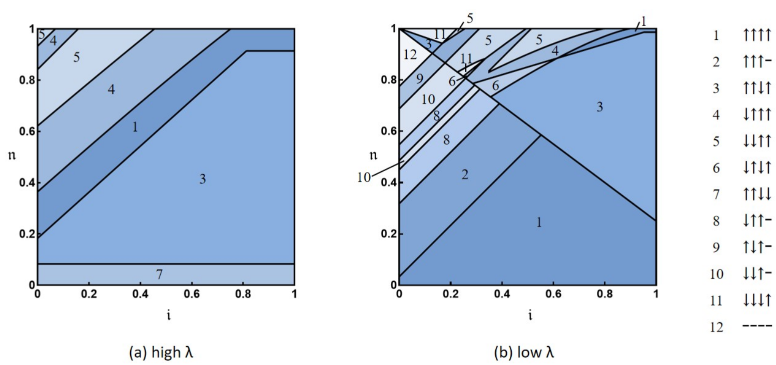
When comparing the equilibrium ad quality, we observe that the presence of ad blockers can actually result in better ad quality for both advertisers. This result is consistent with the principles that underlie our main model. Interestingly, as shown in Figure B.1.2, we find that advertiser 1 (the more efficient advertiser) is more likely to be negatively affected by the presence of ad blockers than advertiser 2 (the less efficient advertiser).

Figure B.1.1 Impacts of Ad Blockers on Advertiser Entry and Ad Quality in the Competing-Advertisers Extension



Note. $r = 0.5$, $l = 0.2$, $\eta_1 = 0.5$, $\eta_2 = 1$, $\lambda = 0.9$ in the high-λ case, and $\lambda = 0.3$ in the low-λ case.

Figure B.1.2 Impacts of Ad Blockers in the Competing-Advertisers Extension



Note. $r = 0.5$, $l = 0.2$, $\eta_1 = 0.5$, $\eta_2 = 1$, $\lambda = 0.9$ in the high-λ case, and $\lambda = 0.3$ in the low-λ case. The four arrows represent advertiser 1, advertiser 2, the platform, and consumers, respectively.

This occurs because, in the presence of ad blockers, advertiser 1, which is more efficient in its investments, will significantly improve ad quality. At the same time, because ad blockers block all ads simultaneously, advertiser 2 will choose to free-ride on the quality improvements of advertiser 1 without investing heavily in ad quality. For advertiser 1, the increase in ad consumption driven by effective consumers is not sufficient to offset the costs associated with a higher ad-quality investment, resulting in a net loss for advertiser 1. However, advertiser 2 can benefit from the lower investment costs.

We find that the all-win (↑↑↑↑) outcome still holds. This occurs when nuisance disvalue is high and information value falls within an intermediate range, or when the fraction of effective consumers is low and nuisance disvalue is low. This outcome is similar to what happens with the main model: either ad blockers act as a deal-saver or the advertiser benefits from screening out ineffective views, thereby avoiding unnecessary payments. The platform can gain from improved ad quality, resulting in an increase in effective views, and effective consumers can enjoy higher-quality ads, while ineffective consumers are spared irrelevant ones.

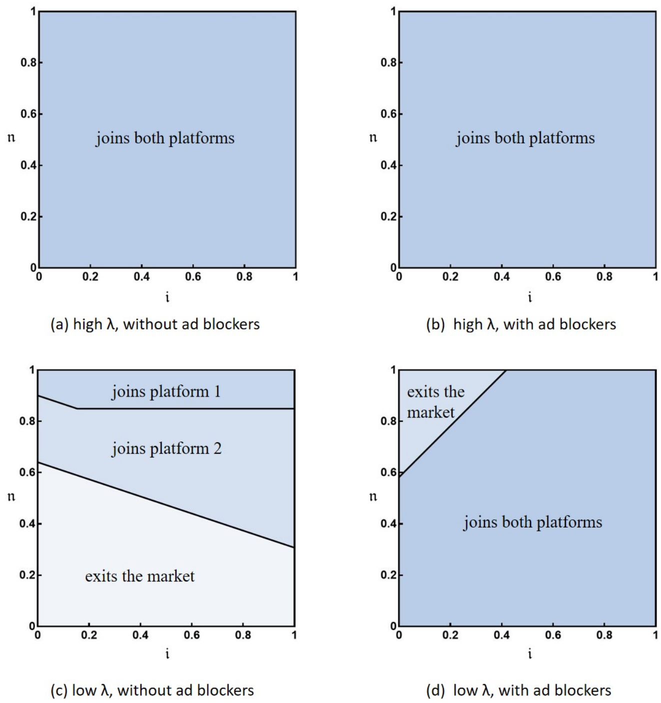
B.2. Competing Platforms

In this section we examine a setting involving one advertiser and two competing platforms to explore how ad blockers influence the advertiser's decision to join multiple platforms as well as how the quality of platform content and consumer behavior affect these decisions. To capture the differences between platforms, we assume that content quality varies, with one platform offering higher content quality than the other. Without loss of generality, let platform 1 have content quality q_1 and platform 2 have content quality q_2, where $q_1 > q_2$. The advertiser has four options: join only platform 1, join only platform 2, join both platforms, or exit the market. If the advertiser chooses to join both platforms, the same ad is placed on each. In this case, we follow Singh and Vives (1984) to capture consumers' multi-units content consumption, which is consistent with the main model. The utility for consumers is given by: $u_{\mathsf{C}} = (q_1 + \mathfrak{i} \cdot \mathbb{1}_{\{\mathsf{C}=\mathsf{E}\}} + \mathfrak{e} - \mathfrak{n})x_{\mathsf{C}1} + (q_2 + \mathfrak{i} \cdot \mathbb{1}_{\{\mathsf{C}=\mathsf{E}\}} + \mathfrak{e} - \mathfrak{n})x_{\mathsf{C}2} - (x_{\mathsf{C}1}^2 + x_{\mathsf{C}2}^2 + 2\gamma x_{\mathsf{C}1}x_{\mathsf{C}2})/2$. If the advertiser chooses to join only platform 1, the utility for consumers is: $u_{\mathsf{C}} = (q_1 + \mathfrak{i} \cdot \mathbb{1}_{\{\mathsf{C}=\mathsf{E}\}} + \mathfrak{e} - \mathfrak{n})x_{\mathsf{C}1} + q_2 x_{\mathsf{C}2} - (x_{\mathsf{C}1}^2 + x_{\mathsf{C}2}^2 + 2\gamma x_{\mathsf{C}1}x_{\mathsf{C}2})/2$. If the advertiser chooses to join only platform 2, the results can be derived symmetrically. If the advertiser chooses to exit the market, the utility for consumers is: $u_{\mathsf{C}} = q_1 x_{\mathsf{C}1} + q_2 x_{\mathsf{C}2} - (x_{\mathsf{C}1}^2 + x_{\mathsf{C}2}^2 + 2\gamma x_{\mathsf{C}1}x_{\mathsf{C}2})/2$. The parameter γ represents competition intensity between the two platforms, with $0 < \gamma \leq 1$.

Using backward induction, we can derive the equilibrium results for each case. Through numerical analysis, we obtain the following results. As is the case with the main model, here we segment the parameter space based on the magnitude of λ and then examine the values of $(\mathfrak{i}, \mathfrak{n})$ under varying values of λ. The advertiser's joining decisions are illustrated in Figure B.2.1. The results of advertiser exits and ad-quality decisions are depicted in Figure B.2.2. The impacts of ad blockers on the advertiser, platform 1, platform 2, and consumers are shown in Figure B.2.3.

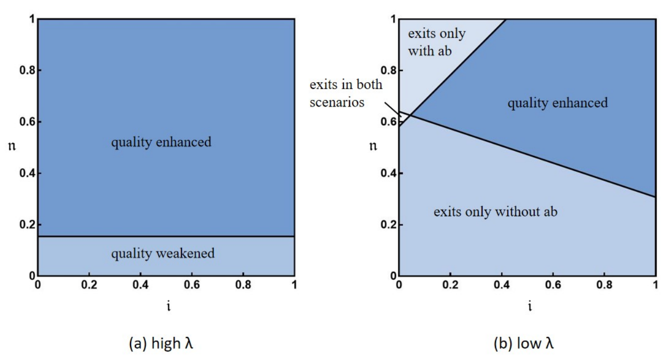
When comparing Figures B.2.1(c) and B.2.1(d), we find that the presence of ad blockers may result in the convergence of the advertiser's decisions regarding advertising on both platforms. In the absence of ad blockers, the advertiser is likely to advertise on both platforms only when the proportion of effective consumers is high. If the proportion of effective consumers is low, the advertiser will choose at most one platform for advertising. When consumers' ad nuisance disvalue is moderate, the advertiser will opt for the platform that offers lower-quality content (platform 2) because, in this condition, the lower content quality

Figure B.2.1 The Advertiser Joining Decision in the Competing-Platforms Extension



Note. $r = 0.5$, $\gamma = 0.3$, $q_1 = 1.2$, $q_2 = 1$, $\lambda = 0.6$ in the high-λ case, and $\lambda = 0.2$ in the low-λ case.

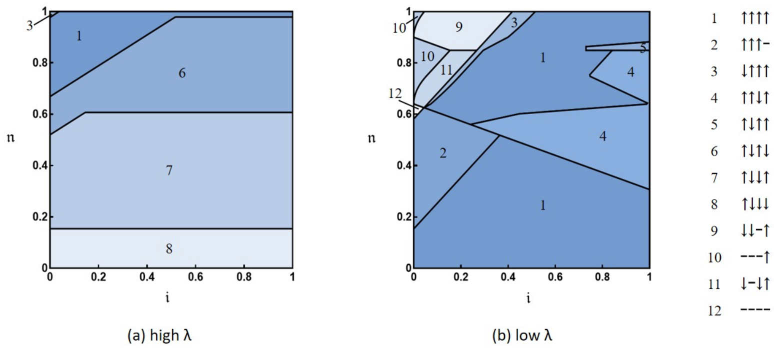
Figure B.2.2 Impacts of Ad Blockers on Advertiser Entry and Ad Quality in the Competing-Platforms Extension



Note. $r = 0.5$, $\gamma = 0.3$, $q_1 = 1.2$, $q_2 = 1$, $\lambda = 0.6$ in the high-λ case, and $\lambda = 0.2$ in the low-λ case.

on platform 2 will cause ineffective consumers to leave platform 2 and consume content only on platform 1. Therefore, the advertiser can benefit from the reduced ineffective advertising costs. Conversely, when nuisance disvalue is high, the advertiser will prefer the high-quality content platform (platform 1) because the superior content quality helps mitigate consumers' aversion to ads, leading to higher ad consumption by effective consumers. In the presence of ad blockers, however, the advertiser can adjust the ad quality in such a way that all effective consumers refrain from using ad blockers, while ineffective consumers continue to use

Figure B.2.3 Impacts of Ad Blockers in the Competing-Platforms Extension



Note. $r = 0.5$, $\gamma = 0.3$, $q_1 = 1.2$, $q_2 = 1$, $\lambda = 0.6$ in the high-λ case, and $\lambda = 0.2$ in the low-λ case; The four arrows represent the advertiser, platform 1, platform 2, and consumers, respectively.

them. As a result, the advertiser is more likely either to choose to join both platforms simultaneously or opt to leave both platforms simultaneously.

We find that the all-win outcome occurs when nuisance disvalue is high and information value falls within an intermediate range, or when the fraction of effective consumers is low and nuisance disvalue is low. In the first scenario (high nuisance disvalue and intermediate information value), the advertiser improves ad quality significantly to retain effective consumers, as a result of which the quality-enhancement effect outweighs the consumer screening effect for the platform. This also benefits both the advertiser and consumers: the advertiser avoids making ineffective payments to both platforms by filtering out ineffective impressions, while effective consumers enjoy higher-quality ads and ineffective consumers are spared from seeing irrelevant ads. In the second scenario (low fraction of effective consumers and low nuisance disvalue), the consumer screening effect of ad blockers encourages the advertiser to replace the ad on both platforms again, thereby increasing profits for both platforms and the advertiser, from zero to positive. Consumers also benefit, as the ad become sufficiently entertaining in this setting, enhancing the surplus they obtain from content consumption.

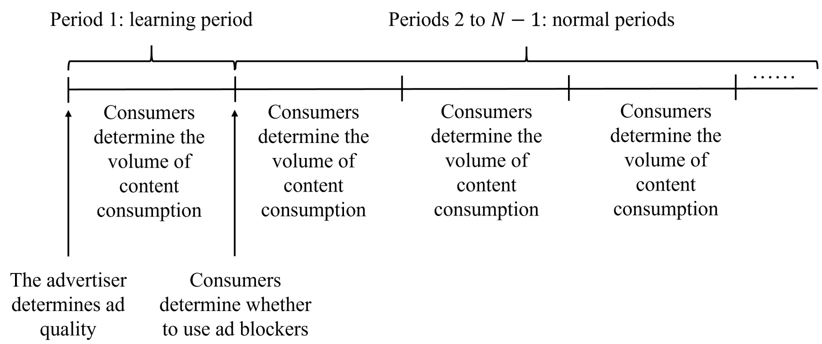
Interestingly, we find that ad blockers harm the low-quality content platform (platform 2) when the proportion of effective consumers is low and the consumer nuisance disvalue is moderate (region 4: ↑↑↓↑), even though ad quality improves under these conditions. This outcome occurs because ad blockers encourage the advertiser to re-enter platform 1, making platform 1 more competitive and capturing more consumer views from platform 2. As a result, platform 2 loses more ad views and is harmed.

We also observe that, when the proportion of effective consumers is high, the low-quality platform (platform 2) is more likely to benefit from ad blockers than the high-quality platform (platform 1), especially when consumers' nuisance disvalue is moderately high (region 6). This outcome occurs because the presence of ad blockers encourages ineffective consumers to use them, thereby reducing the revenue that platforms derive from ineffective consumers. In the absence of ad blockers, because of platform 2's lower content quality, ineffective consumers consume less content, reducing the significance of the revenue loss from these consumers when ad blockers are introduced. In other words, the consumer screening effect plays a less important role for platform 2 under these conditions. Therefore, the quality-enhancement effect continues to dominate the consumer screening effect for platform 2 in this scenario.

B.3. Gradual Ad-Quality Learning

In this section we formalize the process through which consumers learn about ad quality using an N-period model. The initial period serves as a learning period, during which consumers are required to view the ad even in the presence of ad blockers. In the subsequent $N-1$ periods, consumers can decide whether to use ad blockers. Content consumption in each period is independent, which means that the volume of content consumed in one period does not influence consumption in the following periods.

Figure B.3.1 Timeline in the Gradual Ad-Quality Learning Extension



In the scenario without ad blockers, consumers are required to view the ad in all periods, but in the scenario with ad blockers, consumers learn about ad quality during period 1 and then decide whether to use ad blockers in subsequent periods. Given the long-term nature of ad-quality investments, we assume that the advertiser sets the ad quality at the beginning of period 1, after which consumers engage in content consumption in each period. In the absence of ad blockers, the N-period problem becomes a repeated game. In each period, consumers consume $x^*_{\mathsf{C}} = 1 + \mathfrak{i} \cdot \mathbb{1}_{\{\mathsf{C}=\mathsf{E}\}} + \mathfrak{e} - \mathfrak{n}$ units of content. To ensure consistency in scale with the main model, we normalize the results for the N-period case. In this scenario, as N approaches infinity, the outcomes converge on those generated by the main model. The advertiser's profit, the platform's profit, and consumer welfare are formulated as follows:

$$\pi_{\mathsf{a}} = \frac{N \cdot (1-r) \cdot \lambda \cdot x^*_{\mathsf{E}} - N \cdot r \cdot (1-\lambda) \cdot x^*_{\mathsf{I}}}{N} - \frac{\mathfrak{e}^2}{2} = (1-r) \cdot \lambda \cdot x^*_{\mathsf{E}} - r \cdot (1-\lambda) \cdot x^*_{\mathsf{I}} - \frac{\mathfrak{e}^2}{2} \tag{B.1}$$

and

$$\pi_{\mathsf{p}} = \frac{N \cdot r \cdot \left[\lambda \cdot x^*_{\mathsf{E}} + (1-\lambda) \cdot x^*_{\mathsf{I}}\right]}{N} \tag{B.2}$$

and

$$\pi_{\mathsf{c}} = \frac{N \cdot \lambda \cdot \int_0^{x^*_{\mathsf{E}}} 1 + \left(\mathfrak{i} + \mathfrak{e} - \mathfrak{n}\right) - y \; \mathsf{d}y + N \cdot (1-\lambda) \cdot \int_0^{x^*_{\mathsf{I}}} 1 + \left(\mathfrak{e} - \mathfrak{n}\right) - y \; \mathsf{d}y}{N}. \tag{B.3}$$

In the scenario with ad blockers, from periods 2 to N, no consumers use ad blockers if $\mathfrak{e} > \mathfrak{n}$, and only effective consumers refrain from using ad blockers if $\mathfrak{n} - \mathfrak{i} \le \mathfrak{e} \le \mathfrak{n}$. The advertiser's profit, the platform's profit, and consumer welfare are formulated as follows:

$$\pi_{\mathsf{a}} = \frac{(1-r) \cdot \lambda \cdot x^*_{\mathsf{E}} - r \cdot (1-\lambda) \cdot x^*_{\mathsf{I}} + (N-1) \cdot (1-r) \cdot \lambda \cdot x^*_{\mathsf{E}} \cdot \mathbb{1}_{\{\mathfrak{e} \ge \mathfrak{n}-\mathfrak{i}\}} - (N-1) \cdot r \cdot (1-\lambda) \cdot x^*_{\mathsf{I}} \cdot \mathbb{1}_{\{\mathfrak{e} > \mathfrak{n}\}}}{N} - \frac{\mathfrak{e}^2}{2} \tag{B.4}$$

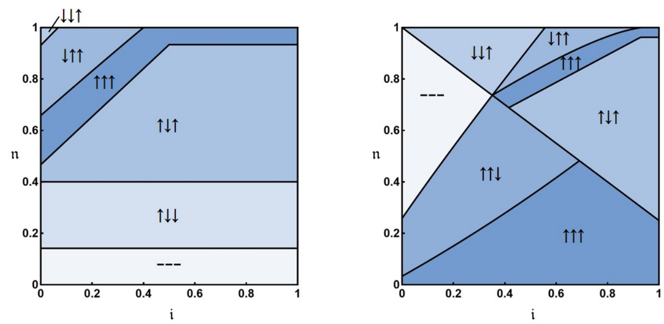
and

$$\pi_{\mathsf{p}} = \frac{r \cdot \left[\lambda \cdot x_{\mathsf{E}}^{*} + (1-\lambda)\cdot x_{\mathsf{I}}^{*} + (N-1)\cdot\lambda\cdot x_{\mathsf{E}}^{*}\cdot \mathbb{1}_{\{\mathfrak{e}\geq \mathfrak{n}-\mathfrak{i}\}} + (N-1)\cdot(1-\lambda)\cdot x_{\mathsf{I}}^{*}\cdot \mathbb{1}_{\{\mathfrak{e}>\mathfrak{n}\}}\right]}{N} \tag{B.5}$$

and

$$\pi_{\mathsf{c}} = \frac{\begin{array}{c}\lambda\cdot\int_0^{x_{\mathsf{E}}^{*}} 1+\left(\mathfrak{i}+\mathfrak{e}-\mathfrak{n}\right)-y\,\mathsf{d}y + (1-\lambda)\cdot\int_0^{x_{\mathsf{I}}^{*}} 1+\left(\mathfrak{e}-\mathfrak{n}\right)-y\,\mathsf{d}y \\ +(N-1)\cdot\lambda\cdot\int_0^{x_{\mathsf{E}}^{*}} 1+\left(\mathfrak{i}+\mathfrak{e}-\mathfrak{n}\right)^{+}-y\,\mathsf{d}y + (N-1)\cdot(1-\lambda)\cdot\int_0^{x_{\mathsf{I}}^{*}} 1+\left(\mathfrak{e}-\mathfrak{n}\right)^{+}-y\,\mathsf{d}y\end{array}}{N}. \tag{B.6}$$

Figure B.3.2 Impacts of Ad Blockers in the Gradual Ad-Quality Learning Extension



(a) high λ (b) low λ

Note. $r = 0.5$, $N = 3$, $\lambda = 0.9$ in the high-λ case, and $\lambda = 0.3$ in the low-λ case.

Using backward induction, we can obtain the equilibrium results in each scenario. The impacts of ad blockers on all parties' outcomes are shown in Figure B.3.2. The advertiser entry and ad-quality comparison outcomes are similar to those obtained with the main model. Regarding the profit comparison across all parties, we offer the following observations.

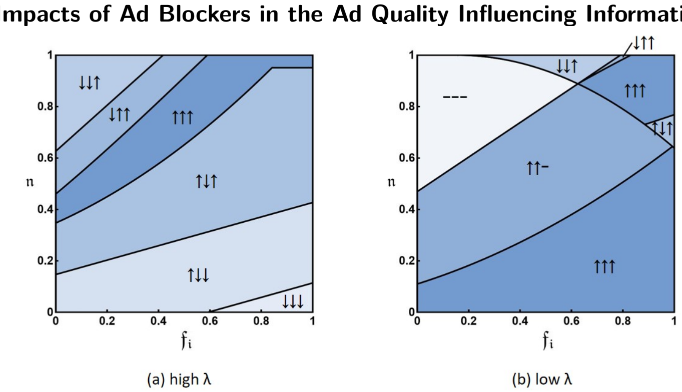
When the proportion of effective consumers is low, the comparison results are similar to those generated by the main model, with the exception of the consumer-welfare comparison outcomes. When ad information value is low and consumer nuisance disvalue is moderate, consumers may still be harmed even if ad blockers entice the advertiser to return to the market, despite the benefit that consumers might obtain from the information and entertainment value of the ad. This reflects the long-term comparison. In the scenario without ad blockers, the advertiser always exits the market because of cost inefficiency, with the result that no consumers view the ad on the platform. In the scenario with ad blockers, although effective consumers' welfare improves in the final $N-1$ period as a result of the higher ad quality, in the first period ineffective consumers are forced to view the ad. This results in a welfare loss for ineffective consumers in the first period that outweighs the welfare gain for effective consumers in the final $N-1$ periods, leading to an overall drop in consumer welfare. Certainly, as N increases, the final outcome will align with the results generated by the main model. When the proportion of effective consumers is high, the comparison results align with those generated by the main model, and therefore we will not reiterate them here.

B.4. Ad Quality Influencing both Entertainment and Information Values

In this section we examine the setting where ad quality influences ad information value. Specifically, as ad quality improves, information value that consumers obtain can increase correspondingly. To facilitate the analysis, we use $\mathfrak{f}_\mathfrak{e}$ and $\mathfrak{f}_\mathfrak{i}$ to represent the entertainment- and information-value factors. Here, we denote ad quality by $\mathfrak{q}$, so that $\mathfrak{e} = \mathfrak{f}_\mathfrak{e}\mathfrak{q}$ and $\mathfrak{i} = \mathfrak{f}_\mathfrak{i}\mathfrak{q}$ continue to represent the ad entertainment value and information value. The consumer's utility function with content consumption can therefore be formulated as: $u_\mathsf{C} = \left[1 + \mathfrak{q}(\mathfrak{f}_\mathfrak{e} + \mathfrak{f}_\mathfrak{i} \cdot \mathbb{1}_{\{\mathsf{C}=\mathsf{E}\}}) - \mathfrak{n}\right] x - x^2/2$, $(\mathsf{C} \in \{\mathsf{E}, \mathsf{I}\})$.

Using backward induction, we derive the equilibrium outcomes. When comparing the equilibrium results, we obtain the impacts of ad blockers as shown in Figure B.4.1. The outcomes for advertiser entry and ad-quality comparisons are similar to those generated by the main model. Regarding the profit comparison for all parties, the all-win outcome still occurs under two conditions: when nuisance disvalue is high and information value falls within an intermediate range, or when the proportion of effective consumers is low and nuisance disvalue is low.

Figure B.4.1 Impacts of Ad Blockers in the Ad Quality Influencing Information Value Extension



Note. $r = 0.5$, $\mathfrak{f}_\mathfrak{e} = 0.7$, $\lambda = 0.8$ in the high-λ case, and $\lambda = 0.45$ in the low-λ case.
The first three arrows represent the advertiser, the platform, and consumers.

In this setting, improvements in ad quality not only enhance entertainment value of the ad, but also further increase their information value. In the main model without ad blockers, when the proportion of effective consumers is low and nuisance disvalue is high, the advertiser can choose to set ad quality to zero, relying only on the exogenous information value to attract effective consumers and generate a profit. In the current model setup, however, when ad quality is zero, the advertiser is unable to attract effective consumers, making market exit more likely. It is more likely that the advertiser will exit the market in the absence of ad blockers. As is the case with the main model, here, in the presence of ad blockers, the advertiser also is more likely to exit the market. This occurs also because, when an advertiser invests few resources in ad quality, information value of the ad remains relatively low, making it difficult for the advertiser to retain effective consumers. If the advertiser seeks to retain and attract effective consumers to engage with the ad more often, he must significantly improve ad quality, but this inevitably also leads to the retention of ineffective consumers at a higher rate. Consequently, it becomes clear that, when ad quality simultaneously influences information value of the ad, the consumer screening effect of ad blockers is diminished, making them less effective at screening consumer types in a way that discourages ineffective consumers from viewing the ad, making the advertiser more likely to exit the market.

When the proportion of effective consumers is low and nuisance disvalue is small, in the main model where ad quality affects only entertainment value of the ad, the platform transitions from benefiting to incurring losses as information value increases (see the second arrow in Figure 8(b) associated with the main model). When ad quality also influences information value of the ad, however, it is less likely that the platform incurs losses as the information-value factor increases (see the second arrow in Figure B.4.1(b) above). Specifically, with the main model, the upper boundary of the ↑↑↑ region first increases and then decreases with rising information value, whereas in this setting the upper boundary of the ↑↑↑ region consistently increases. This outcome occurs because improvements in ad quality, by simultaneously enhancing information value of the ad, lead to a sufficient increase in the consumption of effective consumers, which offsets the revenue losses from ineffective consumers. As a result, it is more likely that the platform benefits.

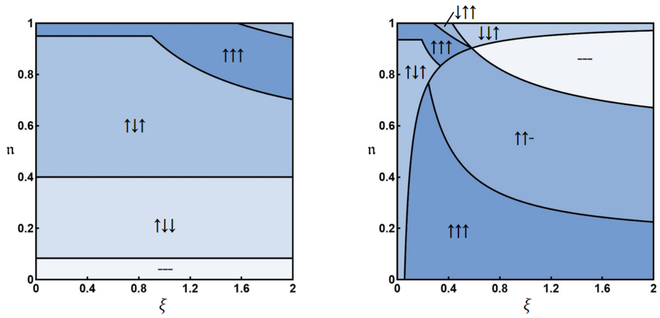
When the proportion of effective consumers is high, although ad quality simultaneously affects the ad information value, the large share of effective consumers reduces this impact. As a result, we can see from Figure B.4.1(a) that the overall structure of the outcomes remains fundamentally unchanged. Overall, this finding demonstrates that whether ad quality affects ad information value does not alter the main results of this paper.

B.5. Advertiser Controls Entertainment and Information Values Separately

In this section, we analyze the setting where the advertiser may control the entertainment value and the information value separately. That is, the information value $\mathfrak{i}$ can be considered as endogenous with a cost of $\xi\mathfrak{i}^2/2$, where ξ is the information value investment efficiency. The timeline remains the same as in the main model, except that the advertiser now simultaneously determines both ad quality and ad information value. Using backward induction, we derive the equilibrium outcomes. In this setting, we use ξ and $\mathfrak{n}$ as the two axes to illustrate the results.

When comparing the equilibrium results, we obtain the impacts of ad blockers as shown in Figure B.5.1. We find that the presence of ad blockers may simultaneously enhance both ad quality and ad information value. This occurs under two conditions: (1) when the proportion of effective consumers and the ad nuisance disvalue are both high while the information value investment efficiency is low; or (2) when the proportion of effective consumers is low, ad nuisance disvalue is high, and information value investment efficiency is moderate. This is because when λ is high and the nuisance disvalue is also high, the consumer-screening effect of the ad blocker helps the advertiser screen out ineffective consumers, thereby saving a substantial amount of ineffective advertising expenditure. As a result, the advertiser can invest more in both ad quality and ad information value. Specifically, this only occurs when information value investment efficiency is low. This is because when the information value investment efficiency is high (i.e., ξ is small), the high proportion of effective consumers in the market makes the advertiser inclined to invest heavily in ad information value, even in the absence of ad blockers, to capture the attention of those consumers. However, when λ is low, This happens only when the information value investment efficiency is moderate. This is because when the information value investment efficiency is too low (i.e., ξ is large), the presence of ad blockers may force the advertiser to exit the market due to excessively high investment costs. On the other hand, when the investment efficiency is too high, the advertiser already chooses to invest heavily in ad information value even without ad blockers, so the introduction of ad blockers does not significantly enhance the information value of ads.

Figure B.5.1 Impacts of Ad Blockers in the Endogenous-Ad-Information-Value Setting



(a) high λ (b) low λ

Note. $r = 0.5$, $\lambda = 0.9$ in high-λ case, $\lambda = 0.3$ in low-λ case.

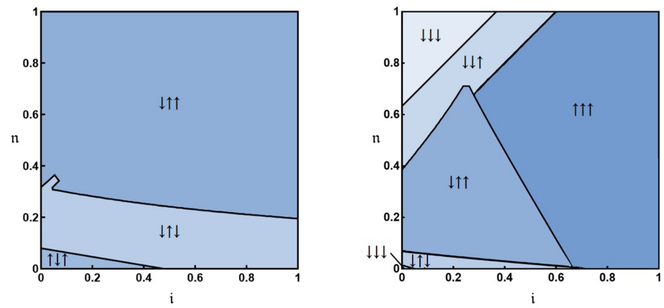
Regarding the profit comparison for all parties, we find that the results in this setting (as shown in Figure B.5.1) are approximately a mirror image of those in the main model. This is because the base model uses ad information value as the horizontal axis, whereas here the horizontal axis represents the investment efficiency of ad information value. A higher investment efficiency corresponds to a lower ξ, which in turn implies a relatively higher obtained information value. Therefore, the results appear approximately mirrored and the all-win outcome occurs when nuisance disvalue is high and ad information value investment efficiency falls within an intermediate range, or when the fraction of effective consumers is low and nuisance disvalue is low.

B.6. Endogenous Ad Fee

In this section we analyze the setting where the advertiser and the platform engage in a Nash bargaining game to determine the ad fee r. We derive the equilibrium outcomes for both scenarios—with and without ad blockers—and compare them to identify the impact of ad blockers. Following the Nash bargaining framework, and without loss of generality, we assume that the advertiser's bargaining power is β, while the platform's bargaining power is $1-\beta$. All the formulations of consumer utilities and firm profits remain unchanged (see Sections 3, 4.1, and 4.2 in the main text). In this case, however, the advertiser and the platform must bargain to determine r, such that the joint objective of maximizing $(\pi_{\mathsf{a}})^{\beta} \cdot (\pi_{\mathsf{p}})^{(1-\beta)}$ is achieved at the beginning of the game.

Figure B.6.1 presents the impact of ad blockers on all parties' profits. We can show that the all-win outcome occurs only when the advertiser's bargaining power falls into the intermediate range, the proportion

Figure B.6.1 Impacts of Ad Blockers in the Endogenous-Ad-Fee Extension



(a) high λ (b) low λ

Note. $\beta = 0.3$, $\lambda = 0.7$ in high-λ case, $\lambda = 0.2$ in low-λ case.
The first three arrows represent the advertiser, the platform, and consumers.

of effective consumers is small, and information value is high. In the following analysis, we first examine the condition where the proportion of effective consumers is low and then proceed to the condition where this proportion is high.

Given the low proportion of effective consumers, the presence of ad blockers results in an increase in the ad fee when nuisance disvalue is low, but it drops when this disvalue is high. This outcome occurs because, when consumers' ad nuisance disvalue is low, the advertiser does not face a significant investment burden when improving ad quality. Simultaneously, the consumer screening effect of ad blockers significantly reduces the advertiser's ineffective costs, although it also results in lower platform revenue. As a result, the bargaining outcome between the two parties is an increase in the ad fee to compensate for the platform's loss of income. Conversely, when consumers experience a high nuisance disvalue from the ad, the advertiser must invest heavily in ad quality to retain effective consumers. In this condition, the bargaining outcome favors a lower ad fee to support the advertiser's investment. Regarding ad quality, we observe that, when nuisance disvalue is moderate, ad quality increases. This reflects the dual effects of ad blockers: both the pressure they exert and the encouragements they create. When both information value and nuisance disvalue are low, however, the advertiser opts to reduce ad quality. This outcome stems from two factors: first, the increase in the equilibrium ad fee means that a larger share of the revenue from each unit of advertising goes to the platform, reducing the advertiser's incentive to invest in ad quality; second, the advertiser must reduce ad quality to discourage ineffective consumers from viewing the ad, thus achieving a screening effect. We find that the advertiser benefits only when information value is high (as indicated by the first upward arrow in Figure B.6.1(b)). In such a case, the advertiser can leverage information value to retain effective consumers without making significant investments in ad quality. In other words, high information value allows the advertiser to use ad blockers more effectively to screen out ineffective consumers. The platform benefits when nuisance disvalue is moderate (as shown by the second upward arrow in Figure B.6.1(b)). Unlike the trade-offs associated with the main model, in this condition the platform benefits from higher ad fees and improved ad quality but suffers from the consumer screening effect. With moderate ad nuisance disvalue, however, the positive impacts outweigh the negative impacts. When nuisance disvalue is either too high or too low, the platform suffers because the advertiser exits the market or ad quality declines. For consumers, ad blockers can be detrimental when information value is low and nuisance disvalue is either low or high (as indicated by the third downward arrow in Figure B.6.1(b)). When nuisance disvalue is low, the drop in ad quality means that the benefit of avoiding ads for consumers who use ad blockers is offset by the negative impact of reduced ad quality on the ad consumption experience of effective consumers, ultimately diminishing consumer welfare. Conversely, when nuisance disvalue is high, the presence of ad blockers can drive the advertiser out of the market, reducing information value that effective consumers would otherwise enjoy, thereby also harming consumers.

Given a high proportion of effective consumers, we find that the equilibrium ad fee may drop in the presence of ad blockers when nuisance disvalue is either too high or too low. This outcome occurs because, when nuisance disvalue is low, no consumers use ad blockers, allowing the advertiser to maintain a consistent level of investment in ad quality at $\lambda - r$. In this case, the platform is willing to reduce the ad fee moderately to encourage the advertiser to invest more robustly in ad quality, thereby attracting more consumers to view the ads. When nuisance disvalue is excessively high, the advertiser must invest heavily to retain effective consumers in the market, which results in a bargaining outcome that drives the equilibrium ad fee down. Regarding equilibrium ad quality, we find that ad quality may rise when nuisance disvalue is either low or high, either because the lower ad fee provides the advertiser with greater capacity for investment or because the pressure and encouragements from ad blockers prompt the advertiser to improve ad quality. In contrast, we find that there are no all-win regions when the proportion of effective consumers is high, mainly because the advertiser finds it difficult to benefit from this situation. We observe that the advertiser benefits from ad blockers only when both nuisance disvalue and information value are low (as indicated by the first arrow in Figure B.6.1(a)). In this small region, the reduced ad fees reduce expenditures and the improved ad quality attracts effective consumers in greater numbers. This compensates for the loss of ad views from ineffective consumers and the increased investment costs, benefiting the advertiser. For the platform, however, the increase in ad views is insufficient to offset the decline in ad fee revenue, resulting in a loss. The higher ad quality enhances the experience for consumers, enabling them to benefit from the use of ad blockers. On the other hand, when nuisance disvalue is high, the advertiser is harmed by the high proportion of ineffective consumers and the increased ad fees. Therefore, there are no all-win regions in this case.

References

Singh, N., X. Vives. 1984. Price and quantity competition in a differentiated duopoly. *The Rand Journal of Economics* 546–554.