The Beneficial Effects of Ad Blockers

Yu-Chieh Kuo[1]

[1]Department of Information Management, National Taiwan University

May 12, 2022

Background

- Online advertising is the lifeline of many internat content platforms, whose revenue highly depends on ad.
  - 59.6 B in the US in 2015.
  - Almost half of it accounted for by Big Techs.
- However, people do not want to see ads when surfing the web.
  - The ad blocking usage is ascending over years, especially on the mobile devices and softwares.
- Online platforms lost huge revenues due to the ad blocker.

Question

- It comes to some question:
  - Why do not the companies and platforms forbid the use of ad-blocking software even it is easy to erect a block wall?
  - What is the idea behind the platforms which allow the ad blocker?
  - What is the optimal response of platforms under different scenarios?

Ingredient

- What may be the important element to the analysis?

Competition: 74% of ad-block users say they leave websites when faced with an ad-block wall. This may be the key point why platforms do not adopt ad-block walls.

Ad. Intensity: 77% of ad-block users say they are willing to view some ad and are not totally against ads.

Ad. Sensitivity: People are heterogeneous of ad sensitivity across sites and devices.

Agenda

1. Model Setting

2. Beneficial Ad Blockers

3. Additional Strategies

4. Quality of Content

5. Assumption Relaxation

6. Conclusion

Platforms

- There are two platforms, platform 1 and platform 2, competing over a set of users. Platforms profit from ads.
- Each platform can choose one of three different strategies: $\mathcal{Ban}$, $\mathcal{Allow}$, or $\mathcal{Fee}$.
- The platform's decision variables for each strategy are ad intensity $a_i \geq 0$ and subscription fee $p_i \geq 0$.
- Their profits are

$$\Pi_i^{\mathcal{Ban}} = (\#\text{ users picking platform i}) \cdot a_i$$

$$\Pi_i^{\mathcal{Allow}} = (\#\text{ users picking platform i and seeing ads}) \cdot a_i$$

$$\Pi_i^{\mathcal{Fee}} = (\#\text{ users picking platform i}) \cdot p_i$$

Users

- We model users using a Hotelling line.
  - Assume that the two platforms are located on the endpoints of the interval $[0, 1]$.
  - Users are distributed uniformly from $[0, 1]$. For users at position x, they obtain $1 - x$ if they pick platform 1 and x if they pick platform 2.
- We use m to denote the independent exogeneity of users.
- Users are sensitive to ads. They get the disutility when seeing ads.
  - Assume there are two segment of users. The first consists of users without ad-blocks in a mass λ and ad sensitivity β. The second is in a mass μ and ad sensitivity γ.

Assumption

- There are two simplifying assumptions imposed in the model:
  - Users without an ad blocker always suffer a negative linear utility from advertising.
  - Users with an ad blocker are only those with high ad sensitivity.
- We will relax these two assumptions in the end.

Utility of the User

who is at position x and picks platform 1

- We can start the analysis from the utility of the users.

Users	*Ban*	*Allow*	*Fee*
(λ, β)	$m + (1 - x) - \beta \cdot a_1$	$m + (1 - x) - \beta \cdot a_1$	$m + (1 - x) - p_1$
(μ, γ)	$m + (1 - x) - \gamma \cdot a_1$	$m + (1 - x)$	$m + (1 - x) - p_1$

Benchmark

- To compare the performance of the model ad blockers, we consider a world without ad blockers as a benchmark.
- Since there is no ad blockers, the platform can profit by $\mathcal{A}ds$ or $\mathcal{F}ee$.
- There are two equilibriums: $(\mathcal{A}ds, \mathcal{A}ds)$ and $(\mathcal{F}ee, \mathcal{F}ee)$.

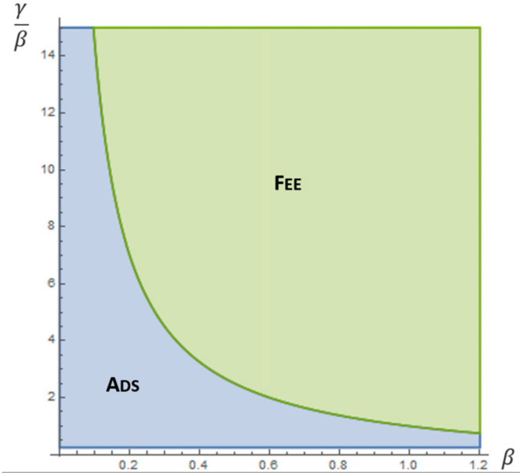
Benchmark

Payoff Matrix

	Platform 2	
Platform 1	ADS	FEE
ADS	$\frac{(\lambda+\mu)^2}{2(\beta\lambda+\gamma\mu)}, \frac{(\lambda+\mu)^2}{2(\beta\lambda+\gamma\mu)}$	$\frac{(\lambda+\mu)^2}{2(\beta\lambda+\gamma\mu)}, \frac{\lambda+\mu}{2}$
FEE	$\frac{\lambda+\mu}{2}, \frac{(\lambda+\mu)^2}{2(\beta\lambda+\gamma\mu)}$	$\frac{\lambda+\mu}{2}, \frac{\lambda+\mu}{2}$

Benchmark

Payoff Matrix



Platform Welfare

Proposition 1: There is an equilibrium where both platforms allow ad blockers. In this equilibrium, when β is sufficiently low and $\frac{\gamma}{\beta}$ is sufficiently high, platforms are better off than they would be if ad blockers did not exist.

Intuition:

- If platforms ban ad blockers, both segments of users see ads. However, due to the competition, platforms have no choice but to decrease the ad intensity a_i, which leads to low ad revenue.
- If platforms allow ad blockers, they do not need to compete the ad-block users although they do not bring any revenue. However, they can discriminate users and raise the ad intensity a_i to increase the profit.

Platform Welfare

Intuition

- Platforms want to be able to choose a different ad intensity for segments of users with different ad sensitivity.
- However, this is an ideal. They cannot perfectly do that.
- Ad blockers provide an exogenous mechanism to achieve a similar effect to help platforms discriminate users.
- Ad-sensitive users self-select out of the market by using ad blockers.

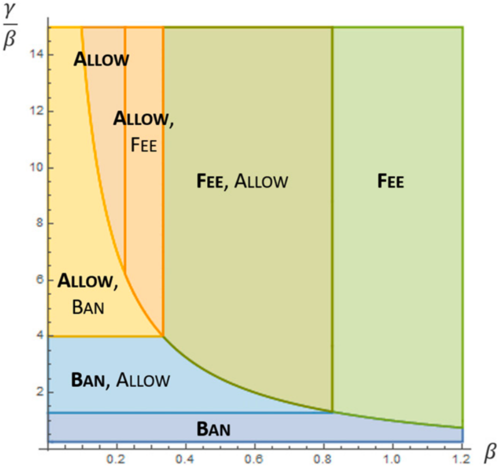
Platform Welfare

Summary

- Platforms incentive to allow ad blockers as if the ad sensitivity of non-ad-block users β is low and which of ad-block users γ is high.
- Three equilibria: $(\mathcal{Ban}, \mathcal{Ban})$, $(\mathcal{Allow}, \mathcal{Allow})$, and $(\mathcal{Fee}, \mathcal{Fee})$.
- There are regions in the parameter space with multi-equilibria, and we label better one in **bold** in the following figure.

	Ban	Allow	Fee
Ban	$\frac{(\lambda+\mu)^2}{2(\beta\lambda+\gamma\mu)}, \frac{(\lambda+\mu)^2}{2(\beta\lambda+\gamma\mu)}$	$\frac{(3\lambda+2\mu)^2(\beta\lambda+\gamma\mu)}{2(3\beta\lambda+4\gamma\mu)^2}, \frac{\lambda(3\beta\lambda+\beta\mu+2\gamma\mu)^2}{2\beta(3\beta\lambda+4\gamma\mu)^2}$	$\frac{(\lambda+\mu)^2}{2(\beta\lambda+\gamma\mu)}, \frac{\lambda+\mu}{2}$
Allow	$\frac{\lambda(3\beta\lambda+\beta\mu+2\gamma\mu)^2}{2\beta(3\beta\lambda+4\gamma\mu)^2}, \frac{(3\lambda+2\mu)^2(\beta\lambda+\gamma\mu)}{2(3\beta\lambda+4\gamma\mu)^2}$	$\frac{\lambda}{2\beta}, \frac{\lambda}{2\beta}$	$\frac{9\lambda(\lambda+\mu)^2}{2\beta(3\lambda+4\mu)^2}, \frac{(\lambda+\mu)(3\lambda+2\mu)^2}{2(3\lambda+4\mu)^2}$
Fee	$\frac{\lambda+\mu}{2}, \frac{(\lambda+\mu)^2}{2(\beta\lambda+\gamma\mu)}$	$\frac{(\lambda+\mu)(3\lambda+2\mu)^2}{2(3\lambda+4\mu)^2}, \frac{9\lambda(\lambda+\mu)^2}{2\beta(3\lambda+4\mu)^2}$	$\frac{\lambda+\mu}{2}, \frac{\lambda+\mu}{2}$

Platform Welfare



Note. When there are two equilibrium strategies in the same region, the first one (in bold) is better for platforms.

User Welfare

Proposition 2: Total user welfare is higher than in the other two equilibria when both platforms allow ad blockers. Moreover, some regions in the parameter space are better off by both users and platforms.

Intuition: Ad-block users get no disutility from ads because they block them, which improve the overall user utility even if non-ad-block users are sometimes worse off.
My explanation: as non-ad-block users are less sensitive, their disutilities affect lightly the overall user utility than ad-block users .

Proof of Proposition 2

Optimal ad intensity in the $\mathcal{B}an$ case

- The indifferent non-ad-block users are at position x_N satisfying $m + 1 - x_N - \beta a_1 = m + x_N - \beta a_2 \iff x_N = \frac{1+\beta(a_2-a_1)}{2}$.
- The indifferent ad-block users are at position x_A satisfying $m + 1 - x_A - \gamma a_1 = m + x_A - \gamma a_2 \iff x_A = \frac{1+\gamma(a_2-a_1)}{2}$.
- The expected market share of platform 1 and 2 is $(z_1, z_2) = (\lambda x_N + \mu x_A, \lambda(1 - x_N) + \mu(1 - x_A))$, then the profit for both platforms is $(\Pi_1, \Pi_2) = (z_1 a_1, z_2 a_2)$.
- The optimal ad intensity a_1 and a_2 are derived by FOC, i.e., $\frac{\partial \Pi_1}{\partial a_1} = \frac{\partial \Pi_2}{\partial a_2} = 0$, which gives $a_1 = a_2 = \frac{\lambda+\mu}{\beta\lambda+\gamma\mu}$.

Proof of Proposition 2

User utility in the $\mathcal{B}an$ case

- Given ad intensity, the user utility when both platforms choose $\mathcal{B}an$ is

$$
\begin{aligned}
& u^{\mathcal{B}an} \\
= & \lambda\left(\int_0^{\frac{1}{2}}\left(m+1-x-\beta\cdot\frac{\lambda+\mu}{\beta\lambda+\gamma\mu}\right)dx+\int_{\frac{1}{2}}^{1}\left(m+x-\beta\cdot\frac{\lambda+\mu}{\beta\lambda+\gamma\mu}\right)dx\right) \\
+ & \mu\left(\int_0^{\frac{1}{2}}\left(m+1-x-\gamma\cdot\frac{\lambda+\mu}{\beta\lambda+\gamma\mu}\right)dx+\int_{\frac{1}{2}}^{1}\left(m+x-\gamma\cdot\frac{\lambda+\mu}{\beta\lambda+\gamma\mu}\right)dx\right) \\
= & (\lambda+\mu)\left(m-\frac{1}{4}\right).
\end{aligned}
$$

Proof of Proposition 2

Optimal ad intensity in *Allow* and *Fee* cases

- Following the same steps above, we can derive the optimal ad intensity and the optimal subscription fee when both platforms select *Allow* and *Fee*, respectively.
- $a_1^{Allow} = a_2^{Allow} = \frac{1}{\beta}$ and $p_1 = p_2 = 1$.

Proof of Proposition 2

User utility in the $\mathcal{Fee}$ case

- The user utility when both platforms choose $\mathcal{Fee}$ is

$$
\begin{aligned}
& u^{\mathcal{Fee}} \\
= \ & \lambda \left(\int_0^{\frac{1}{2}} (m+1-x-1)\,dx + \int_{\frac{1}{2}}^{1} (m+x-1)\,dx \right) \\
+ \ & \mu \left(\int_0^{\frac{1}{2}} (m+1-x-1)\,dx + \int_{\frac{1}{2}}^{1} (m+x-1)\,dx \right) \\
= \ & (\lambda+\mu) \left(m - \frac{1}{4} \right).
\end{aligned}
$$

Proof of Proposition 2

User utility in the *Allow* case

- The user utility when both platforms choose *Allow* is

$$
\begin{aligned}
& u^{\mathcal{Allow}} \\
= \; & \lambda \left(\int_0^{\frac{1}{2}} \left(m + 1 - x - \beta \cdot \frac{1}{\beta} \right) dx + \int_{\frac{1}{2}}^{1} \left(m + x - \beta \cdot \frac{1}{\beta} \right) dx \right) \\
+ \; & \mu \left(\int_0^{\frac{1}{2}} (m + 1 - x) \, dx + \int_{\frac{1}{2}}^{1} (m + x) \, dx \right) \\
= \; & \lambda \left(m - \frac{1}{4} \right) + \mu \left(m + \frac{3}{4} \right).
\end{aligned}
$$

- We can easily observe that $u^{\mathcal{Allow}} > u^{\mathcal{Ban}} = u^{\mathcal{Fee}}$.

Benefits Summary

Platforms: Discriminate users with ad sensitivities and choose different ad intensity to maximize the profit.

Users: Users can see ads by their willingness.
Moreover, non-ad-block users are also better off since they obtain additional information, such as coupons, in ads.

- Everyone is strictly better off when allowing ad blockers.
- People have an incentive to stop ad blockers after learning it and obtain additional benefit.

New strategies

- We investigate the effect of adding two strategies to the platforms:

  ADs OR FEE: Let users choose between watching ads or paying for an ad-free plan.

  WHITE-LIST: Pay a fee to the ad blocker to white-list their ads among users employing the ad blocker.

Ads or Fee

- Instead of using ad blockers as a filter to discriminate users, platforms can also adopt *Ads or Fee* to segregate users by ad sensitivity.
- The *Ads or Fee* plan can be regarded as a combination of the *Ban* and *Fee* plan, and it tries to achieve the best of both plans.
    - Ad-sensitive users will choose the fee option given this plan, which solves the problem in the *Ban* strategy that the ad-sensitive users force platforms to decrease ad intensity.
    - Platforms are available to set a high ad intensity for non-ad-block users and charge a fee from ad-block users in the same time.

Ads or Fee

- *Ads or Fee* strategy seems to have the benefits of the *Allow* strategy plus some extra fee revenue from ad-block users .
- However, does the *Ads or Fee* strategy always dominate the *Allow* strategy?
  - The answer, suprisingly, is not.

Proposition 3: There is still an equilibrium where both platforms allow ad blockers even when adding the *Ads or Fee* plan. In addition, There are regions in the parameter space where this is the unique equilibrium and regions where it is the best equilibrium for platforms among others.

Ads or Fee

- To derive the answer, we extend the model by considering the *Ads or Fee* strategy.
  - In this scenario, platforms need to decide two decision variables: an ad intensity a_i and a fee price p_i.
- We also refine the user ad sensitivity by adding a third segment of non-ad-block users in a mass ν and ad sensitivity η to the model.
  - The reason to do so is that the comparison of *Ads or Fee* and *Allow* depends on the heterogeneity of the ad sensitivity for non-ad-block users .

Ads or Fee

Intuition for Proposition 3

- Now, we have three segment of users with different ad sensitivities. We may examine all possible sensitivities to measure two strategies.
- If γ is very large compared with β and η, platforms want to avoid showing ads to this segment as they will decrease the ad intensity.
  - Both *Ads or Fee* and *Allow* strategies can achieve it.
- If η is sufficiently high, adopting the *Ads or Fee* strategy is better for the platform since they avoid showing ads to users with large ad sensitivity.
  - What if η starts decreasing toward β?

Ads or Fee

Intuition for Proposition 3

- As η decreases, the ad revenue from this segment increases if they were forced to see ads.
- At some point, this revenue will exceed the revenue from the fee by this segment.
- Mathematically, it means a $>$ p but $\eta \cdot$ a $<$ p, which can happen when η is sufficiently small.
    - In this situation, platforms want these users to see ads but they chooes the fee option when adopting *Ads or Fee* strategy, which causes some loss of revenue.
    - In the contrast, as there is no fee option in *Allow* strategy, such loss is covered.

When is *Allow* better off?

- We already know that *Allow* may be an equilibrium after considering *Ads or Fee*, we want to describe when *Allow* is the best strategy for platforms. [1]

Allow$\succ$*Fee*: We want low β and η to increase ad intensity.

Allow$\succ$*Ban*: We want $\gamma > \beta$ and $\gamma > \eta \iff$ high $\frac{\gamma}{\beta}$ and $\frac{\gamma}{\eta}$.

Allow$\succ$*Ads or Fee*: We want $\eta \sim \beta$ closedly $\iff$ low $\frac{\eta}{\beta}$.

- That is, for *Allow* to be the best stategy, we want all subsegments of non-ad-block users to be nearly homogeneous in their sensitivities, and be well separated from the ad-block users .

[1] I use a symbol $\succ$ to represent the strategy preference. A $\succ$ B indicates the strategy A is better than B to platforms.

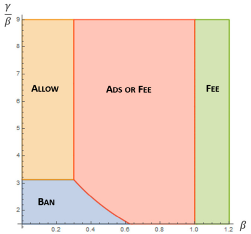
Payoff Matrix with *Ads or Fee* plan

Table A.5. Payoff Matrix in the Model with the Ads or Fee Plan

	Ban	Allow	Fee	Ads or Fee
Ban	$\frac{(\lambda+\mu+\nu)^2}{2(\beta\lambda+\gamma\mu+\eta\nu)}, \frac{(\lambda+\mu+\nu)^2}{2(\beta\lambda+\gamma\mu+\eta\nu)}$	$\frac{(3\lambda+2\mu+3\nu)^2(\beta\lambda+\gamma\mu+\eta\nu)}{2(3\beta\lambda+4\gamma\mu+3\eta\nu)^2}, C$	$\frac{(\lambda+\mu+\nu)^2}{2(\beta\lambda+\gamma\mu+\eta\nu)}, \frac{1}{2}(\lambda+\mu+\nu)$	$\frac{(\lambda+\mu+\nu)^2}{2(\beta\lambda+\gamma\mu+\eta\nu)}, A$
Allow	$C, \frac{(3\lambda+2\mu+3\nu)^2(\beta\lambda+\gamma\mu+\eta\nu)}{2(3\beta\lambda+4\gamma\mu+3\eta\nu)^2}$	$\frac{(\lambda+\nu)^2}{2(\beta\lambda+\eta\nu)}, \frac{(\lambda+\nu)^2}{2(\beta\lambda+\eta\nu)}$	$\frac{9(\lambda+\nu)^2(\lambda+\mu+\nu)^2}{2(3\lambda+4\mu+3\nu)^2(\beta\lambda+\eta\nu)}, \frac{(\lambda+\mu+\nu)(3\lambda+2\mu+3\nu)^2}{2(3\lambda+4\mu+3\nu)^2}$	$\frac{9(\lambda+\nu)^2(\mu+\nu)^2(\beta\lambda+\eta\nu)}{2(3\beta\lambda(\mu+\nu)+\eta\nu(4\mu+3\nu))^2}, B$
Fee	$\frac{1}{2}(\lambda+\mu+\nu), \frac{(\lambda+\mu+\nu)^2}{2(\beta\lambda+\gamma\mu+\eta\nu)}$	$\frac{(\lambda+\mu+\nu)(3\lambda+2\mu+3\nu)^2}{2(3\lambda+4\mu+3\nu)^2}, \frac{9(\lambda+\nu)^2(\lambda+\mu+\nu)^2}{2(3\lambda+4\mu+3\nu)^2(\beta\lambda+\eta\nu)}$	$\frac{1}{2}(\lambda+\mu+\nu), \frac{1}{2}(\lambda+\mu+\nu)$	$\frac{1}{2}(\lambda+\mu+\nu), \frac{\lambda+\beta(\mu+\nu)}{2\beta}$
Ads or Fee	$A, \frac{(\lambda+\mu+\nu)^2}{2(\beta\lambda+\gamma\mu+\eta\nu)}$	$B, \frac{9(\lambda+\nu)^2(\mu+\nu)^2(\beta\lambda+\eta\nu)}{2(3\beta\lambda(\mu+\nu)+\eta\nu(4\mu+3\nu))^2}$	$\frac{\lambda+\beta(\mu+\nu)}{2\beta}, \frac{1}{2}(\lambda+\mu+\nu)$	$\frac{\lambda+\beta(\mu+\nu)}{2\beta}, \frac{\lambda+\beta(\mu+\nu)}{2\beta}$

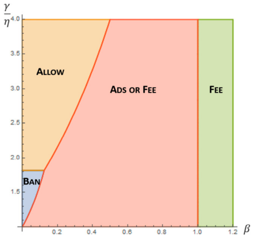
Equilibrium Regions under Different Parameters

Figure 7. (Color online) Equilibrium Regions of the Model with the Ads or Fee Strategy for $\lambda = \mu = \nu = 1$ and $\frac{\eta}{\beta} = \frac{3}{2}$



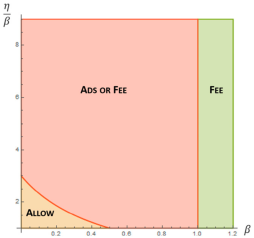
Note. When there is more than one equilibrium, only the best one for platforms is listed (in bold).

Figure 8. (Color online) Equilibrium Regions of the Model with the Ads or Fee Strategy for $\lambda = \mu = \nu = 1$ and $\frac{\gamma}{\beta} = 4$



Note. When there is more than one equilibrium, only the best one for platforms is listed (in bold).

Figure 9. (Color online)Equilibrium Regions of the Model with the Ads or Fee Strategy for $\lambda = \mu = \nu = 1$ and $\frac{\gamma}{\eta} = 4$



Note. When there is more than one equilibrium, only the best one for platforms is listed (in bold).

- ▷ Note that there may be still multi-equilibria in the regions, we only list the best one for platforms.

Proof of Proposition 3

- The proof is similar to the case of the proof of Proposition 1 but now with three segments of users and be more complicated.
- We illustrate only the case that both platforms use the *Ads or Fee* plan here to ease the note.
- Now we have four strategies: *Allow*, *Ban*, *Fee*, *Ads or Fee*, and three segments of users separated from ad sensitivity: $\beta \leq \eta \leq \gamma$.
- This results in four subcases for platform 1:
  - $p_1 < \beta a_1 \leq \eta a_1 \leq \gamma a_1$
  - $\beta a_1 \leq p_1 \leq \eta a_1 \leq \gamma a_1$
  - $\beta a_1 \leq \eta a_1 < p_1 \leq \gamma a_1$
  - $\beta a_1 \leq \eta a_1 \leq \gamma a_1 < p_1$.

Proof of Proposition 3

- Continue to analyze these four subcases but focus on the first and the fourth subcase:
  - $p_1 < \beta a_1 \leq \eta a_1 \leq \gamma a_1$
  - $\beta a_1 \leq p_1 \leq \eta a_1 \leq \gamma a_1$
  - $\beta a_1 \leq \eta a_1 < p_1 \leq \gamma a_1$
  - $\beta a_1 \leq \eta a_1 \leq \gamma a_1 < p_1$.
- In the first subcase, every user prefers to pay the fee, which is as if platform 1 chooses the $\mathcal{Fee}$ plan.
- In the fourth subcase, it is as if platform 1 chooses the $\mathcal{Ban}$ plan.
- Therefore, we can ignore them. This leaves us with two remaining subcases.

Proof of Proposition 3

$\beta a_i \leq p_i \leq \eta a_i \leq \gamma a_i$

- The first segment of indiffernet non-ad-block users are at position x_N satisfying
  $m + 1 - x_N - \beta a_1 = m + x_N - \beta a_2 \iff x_N = \frac{1+\beta a_2 - \beta a_1}{2}$.
- The second segment of indiffernet non-ad-block users are at position $x_{N,2}$ satisfying
  $m + 1 - x_{N,2} - p_1 = m + x_{N,2} - p_2 \iff x_{N,2} = \frac{1+p_2-p_1}{2}$.
- The indiffernet ad-block users are at position x_A satisfying
  $m + 1 - x_A - p_1 = m + x_A - p_2 \iff x_A = \frac{1+p_2-p_1}{2}$.

Proof of Proposition 3

$\beta a_i \leq p_i \leq \eta a_i \leq \gamma a_i$

- The expected market shares of ads and fees of both platforms are $(z_{1,a}, z_{2,a}) = (\lambda x_N, \lambda(1 - x_N))$, $(z_{1,p}, z_{2,p}) = (\nu x_{N,2} + \mu x_A, \nu(1 - x_{N,2}) + \mu(1 - x_A))$, and the profits are $(\Pi_1, \Pi_2) = (z_{1,a}a_1 + z_{1,p}p_1, z_{2,a}a_2 + z_{2,p}p_2)$.
- The optimal ad sensitivities and fees are derived by FOC, i.e., $\frac{\partial \Pi_1}{\partial a_1} = \frac{\partial \Pi_1}{\partial p_1} = \frac{\partial \Pi_2}{\partial a_2} = \frac{\partial \Pi_2}{\partial a_2} = 0$, which gives $a_1 = a_2 = \frac{1}{\beta}$ and $p_1 = p_2 = 1$.
- We need to check the solution satisfying the inequality of this subcase. Therefore, this subcase gives a possible equilibrium.
- Following the same procedure, however, the solution to another subcase contradicts the inequality of it, hence, will not be a feasible equilibrium.

White-List

- Another plan is to ask the ad blockers to *White-List* platforms' ads.
- This idea was launched from Adblock Plus, the most popular ad-blocker. Big techs pays monthly fee to participate in this program to avoid their ads being blocked.
- Moreover, Adblock Plus also started selling ”accepable” ads to publishers.
- This policy was criticized by lots of businessmen, including pulishers and advertisers; they regard it as extorted, unethical and immoral.
  - They now have to share part of reveue with it.
- However, *White-List* services are also the main source of revenue for Adblock Plus.
- The key question is: whether adopting this new option benefits platforms?

White-List

- To answer this question, we extend the original model.
  - Enable *White-List* strategy to platforms: *Allow*, *Ban*, *Fee*, and *White-List* in this discussion.
  - Platforms pay f ≥ 0 to ad-blocker company to display their ads if choosing this strategy. Note that in this context, platforms still allow ad blockers.
  - Three users segments:
    one of non-ad-block users of mass λ and ad sensitivity β;
    one of ad-block users feel ok with *White-List* policy of mass ξ and ad sensitivity ζ;
    one of ad-block users are against all ads of mass μ and ad sensitivity γ.
  - No any assumption imposed on relationship between β,ξ, and γ.

White-List

Proposition and intuition

Proposition 4: When allowing *White-List* strategy, both platforms select *White-List* is an equilibrium. In this equilibrium, platforms are sometimes better of than the benchmark.

Intuition: Remind the context of three segments. Consider the case that $\beta \leq \zeta \leq \gamma$, that is, the users' behavior reveal their preference of ad sensitivity. Therefore, the *White-List* option can help platforms separate the two type of ad-block users .

When is *White-List* better off?

- We want to find the condition where *White-List* is the best option. [2]

Small f: First, we need a sufficiently small f or it will be lavish.

White-List $\succ$ *Fee*: We want low β and ζ to increase ad intensity.

White-List $\succ$ *Ban*: We want $\gamma > \beta$ and $\gamma > \zeta \iff$ high $\frac{\gamma}{\beta}$ and $\frac{\gamma}{\zeta}$.

White-List $\succ$ *Allow*: We want $\zeta \sim \beta$ closedly $\iff$ low $\frac{\zeta}{\beta}$.

- That is, for *White-List* to be the best strategy, we want two sub-segments of ad-block users to be heterogeneous and well separated, and low ad sensitivity of non-ad-block users .

[2] I use a symbol $\succ$ to represent the strategy preference. A $\succ$ B indicates the strategy A is better than B to platforms.

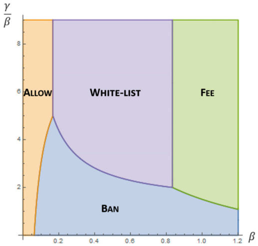
Payoff Matrix with *White-List* Plan

Table A.6. Payoff Matrix in the Model with the White-list Plan

	Ban	Allow	Fee	White-list
Ban	$\frac{(\lambda+\mu+\xi)^2}{2(\beta\lambda+\gamma\mu+\zeta\xi)}, \frac{(\lambda+\mu+\xi)^2}{2(\beta\lambda+\gamma\mu+\zeta\xi)}$	$\frac{(\beta\lambda+\gamma\mu+\zeta\xi)(3\lambda+2(\mu+\xi))^2}{2(3\beta\lambda+4\gamma\mu+4\zeta\xi)^2}, E$	$\frac{(\lambda+\mu+\xi)^2}{2(\beta\lambda+\gamma\mu+\zeta\xi)}, \frac{1}{2}(\lambda+\mu+\xi)$	$\frac{(3\lambda+2\mu+3\xi)^2(\beta\lambda+\gamma\mu+\zeta\xi)}{2(3\beta\lambda+4\gamma\mu+3\zeta\xi)^2}, D$
Allow	$E, \frac{(\beta\lambda+\gamma\mu+\zeta\xi)(3\lambda+2(\mu+\xi))^2}{2(3\beta\lambda+4\gamma\mu+4\zeta\xi)^2}$	$\frac{\lambda}{2\beta}, \frac{\lambda}{2\beta}$	$\frac{9\lambda(\lambda+\mu+\xi)^2}{2\beta(3\lambda+4(\mu+\xi))^2}, \frac{(\lambda+\mu+\xi)(3\lambda+2(\mu+\xi))^2}{2(3\lambda+4(\mu+\xi))^2}$	$\frac{\lambda(2\zeta\xi+\beta(3\lambda+\xi))^2}{2\beta(3\beta\lambda+4\zeta\xi)^2}, \frac{(3\lambda+2\xi)^2(\beta\lambda+\zeta\xi)}{2(3\beta\lambda+4\zeta\xi)^2}-f$
Fee	$\frac{1}{2}(\lambda+\mu+\xi), \frac{(\lambda+\mu+\xi)^2}{2(\beta\lambda+\gamma\mu+\zeta\xi)}$	$\frac{(\lambda+\mu+\xi)(3\lambda+2(\mu+\xi))^2}{2(3\lambda+4(\mu+\xi))^2}, \frac{9\lambda(\lambda+\mu+\xi)^2}{2\beta(3\lambda+4(\mu+\xi))^2}$	$\frac{1}{2}(\lambda+\mu+\xi), \frac{1}{2}(\lambda+\mu+\xi)$	$\frac{(\lambda+\mu+\xi)(3\lambda+2\mu+3\xi)^2}{2(3\lambda+4\mu+3\xi)^2}, F$
White-list	$D, \frac{(3\lambda+2\mu+3\xi)^2(\beta\lambda+\gamma\mu+\zeta\xi)}{2(3\beta\lambda+4\gamma\mu+3\zeta\xi)^2}$	$\frac{(3\lambda+2\xi)^2(\beta\lambda+\zeta\xi)}{2(3\beta\lambda+4\zeta\xi)^2}-f, \frac{\lambda(2\zeta\xi+\beta(3\lambda+\xi))^2}{2\beta(3\beta\lambda+4\zeta\xi)^2}$	$F, \frac{(\lambda+\mu+\xi)(3\lambda+2\mu+3\xi)^2}{2(3\lambda+4\mu+3\xi)^2}$	$\frac{(\lambda+\xi)^2}{2(\beta\lambda+\zeta\xi)}-f, \frac{(\lambda+\xi)^2}{2(\beta\lambda+\zeta\xi)}-f$

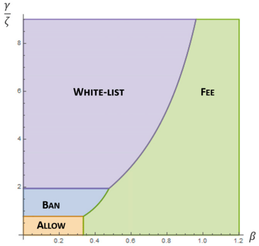
Equilibrium Regions under Different Parameters

Figure 11. (Color online) Equilibrium Regions of the Model with the WHITE-LIST Strategy for $f = 0$, $\lambda = \mu = \xi = 1$, and $\zeta = \frac{1}{2}$



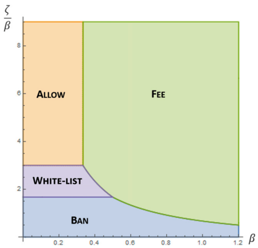
Note. When there is more than one equilibrium, only the best one for platforms is listed (in bold).

Figure 12. (Color online) Equilibrium Regions of the Model with the WHITE-LIST Strategy for $f = 0$, $\lambda = \mu = \xi = 1$, and $\frac{\gamma}{\beta} = \frac{7}{2}$



Note. When there is more than one equilibrium, only the best one for platforms is listed (in bold).

Figure 13. (Color online) Equilibrium Regions of the Model with the WHITE-LIST Strategy for $f = 0$, $\lambda = \mu = \xi = 1$, and $\frac{\gamma}{\zeta} = 2$



Note. When there is more than one equilibrium, only the best one for platforms is listed (in bold).

- Note that there may be still multi-equilibria in the regions, we only list the best one for platforms.

Quality of Content

- The quality of content affects users' decision of which platform to join.
- User Generated Content (UGC) and Professionally Generated Content (PGC) are two main content sources of platforms.
- The revenue-sharing model differs between UGC and PGC. In UGC, platforms with the subscription policy share their revenue with content creators.
  - For example, YouTube shares 55% revenues from ads and subscriptions with creators.
- The question is: how the quality of content is affected by the advent of ad blockers under a revenue-sharing model with the subscriptions policy.

Model extension

- To answer this question, we extend the model by adding content creators.
- Assume that two platforms have their own content creators. Content creators have to decide the quality of content q_i, and they incur some cost $c_i \cdot q_i^2$ when generating content with quality q_i.
- We include an additional term $r \cdot q_i$ to user's utility to capture the effect of quality of content.
- Each platform decides a fixed fraction f_i to share the revenue with their content creators.

Model extension

- The profits for content creators in platform i and platform are

$$\Pi_i^{\text{Content Creators}} = f_i \cdot (\text{Total revenue for platform i}) - c_i q_i^2$$

$$\Pi_i^{\text{Platform}} = (1 - f_i)(\text{Total revenue for platform i}).$$

- The game proceeds the same as before with the addition: The platform and content creators determine determine the strategy and the quality of content in the first step, respectively, then users choose between the platforms in the second step.

Proposition and Intuition

Proposition 5: All the results of the basic model are robust under this extension. In addition, the quality of content is higher for sufficiently high $\frac{\gamma}{\beta}$ and sufficiently low β. Moreover, there is an equilibrium that platforms, users, and content creators are better off.

Intuition: If the platform adopts the $\mathcal{Ban}$ or $\mathcal{Fee}$ strategies, all the extra value generated by the quality of content are collected by the platform and content creators . However, if the platform allows ad blockers, extra value from the higher quality of content benefits users.

Assumption Relaxation

- Remind that we impose two simplifying assumptions to the model:
  - Users without an ad blocker always suffer a negative linear utility from advertising.
  - Users with an ad blocker are only those with high ad sensitivity.
- We want to examine the necessity of these two assumptions.

First Assumption

Concave Utility from Ads

- To remove the first assumption, we assume that the consumers' utility function to ads is concave.
  - It is reasonable because ads in low quantities can actually benefit users for getting extra information.
  - However, on the other hand, ads in high quantities become annoying and result in a negative utility for consumers.

Second Assumption

Endogenous Decisions

- To remove the second assumption, we assume that all users can use ad blockers whenever they want, depending on their utility.
- Users still have varying ad sensitivity, which is expressed by their utility function:

$$u_L(a_i) = \begin{cases} \delta a_i & \text{if } a_i \leq a^* \\ \delta a^* + L(a^* - a_i) & \text{otherwise} \end{cases}$$
$$u_H(a_i) = \begin{cases} \delta a_i & \text{if } a_i \leq a^* \\ \delta a^* + H(a^* - a_i) & \text{otherwise,} \end{cases}$$

where $H \geq L \geq 0$ and $\delta, a^* \geq 0$.

Proposition and Intuition

Proposition 6: When users have a concave utility from ads and their decision to use an ad blocker or not is endogenous, there is an equilibrium where both platforms allow ad blockers. In this equilibrium, when L is sufficiently low and $\frac{H}{L}$ is sufficiently high, platforms are better off.

Intuition: The competition between platforms will decrease ad intensity if both platforms adopts *Ban* strategy, which decline the revenue. If using *Allow* strategy, platforms can avoid competing high ad-sensitive users and increase the ad intensity for those seeing ads.

1. Model Setting

2. Beneficial Ad Blockers

3. Additional Strategies

4. Quality of Content

5. Assumption Relaxation

6. Conclusion

Managerial Implications

- ▷ This research can provide websites with general guidelines regarding the plan they should choose based on the heterogeneity of ad sensitivity for their visitors.

Figure 15. (Color online) Flowchart for Platforms to Decide Which Strategy to Follow Based on the Heterogeneity in the Ad Sensitivity of Their User Base