

The Welfare Effects of Ad-Blocking

Fengyang Lin¹, Cristobal Cheyre¹, and Alessandro Acquisti^{2*}

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PRELIMINARY, INCOMPLETE DRAFT

Privacy concerns regarding online tracking and excessive advertising have led to a marked increase in the adoption of ad-blocking tools. We conduct a field experiment to study users' valuation of ad-blockers and study how exposing or shielding users from online advertising influences their online experiences, their attitudes towards online advertising, their valuation of ad-blocking tools, and their future usage of such tools. We find that for participants who were using ad-blockers, uninstalling them leads to a deterioration in their online experiences and lower satisfaction with recent purchases. For participants who were not using ad-blockers, installing one led to fewer reported regrets with purchases, an improvement in subjective well-being, and a less positive view of online advertising. In terms of participants' valuation of ad-blockers, we observe a great degree of heterogeneity. Some users are not willing to uninstall their ad-blocker even when offered large payments ($> \$100$). Conversely, a similar number of users are not willing to install an ad-blocker even when offered large payments. However, most users are willing to install/uninstall an ad-blocker in exchange for moderate payments ($< \$20$). Our experimental treatments have a large effect on post-experiment usage of ad-blockers. Former ad-block non-users who were asked to install an ad-blocker are much more likely to keep using an ad-blocker after the experiment ends than non-users who had not been asked to install (their respective control group); and former users who were asked to uninstall their ad-blocker are more likely to continue not-using an ad-blocker relative to users who were not asked to uninstall (their respective control group). However, the magnitude of the treatment effect in the former non-users group is higher than that of the treatment effect in the former users group. This suggests that the post-experiment treatment effects on ad-block usage are not merely due to inertia, switching costs, or priming. Rather, exposure to ad-blocking seems more effective in converting non-users to users than exposure to ads can convert past ad-blocker users.

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The Welfare Effects of Advertising Exposure

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1. Introduction

As the online advertising ecosystem has become increasingly complex, the debate about its effects has expanded from studying its effectiveness (Hu 2014, Ghose & Todri-Adamopoulos 2016, Farahat & Bailey 2012, Frick et al. 2023) and its advantages over traditional advertising (Ayanso & Mokaya 2013, Dinner et al. 2011) to considering the potential negative effects that targeted advertising may have on consumers (Turow et al. 2009, Datta et al. 2015, John et al. 2018) and the privacy concerns it introduces (Ur et al. 2012, Moore et al. 2015, Weinberg 2019). The surge in ad-blocking tools adoption has become a prominent user-led response (Malloy et al. 2016, O'Reilly 2017) to these concerns. Faced with a decline of users that allow ads, advertising technology firms have implemented multiple strategies to sustain their ad-revenue models. Some of them, such as Apple's Tracking Transparency framework, seek to curb users' privacy concerns. Others are trying to make the use of ad-blockers costly and ineffective. For instance, Google's upcoming changes to how APIs can be used in Chrome's extension, which will become fully effective with the phase out of Manifest V2 and its replacement with Manifest V3 (Google 2023), is a change that will largely curtail the effectiveness of ad-blockers within Chrome extensions (Claburn 2023). All these changes highlight the increasing tension between users' receptivity to advertising and privacy concerns, and platform strategies concerning online tracking and targeted advertising. This is a tension of significant social and economic significance as, according to recent industry estimates, online ad spending surpassed 200 billion US dollars per year in 2022 (IAB, 2023).

The literature on online advertising has largely focused on the perspectives of publishers and advertisers. Investigations have delved into how firms and advertisers reap value from online advertising (Blake et al. 2014, Farahat & Bailey 2012, Ghose & Todri-Adamopoulos 2016, Lambrecht & Tucker 2013), how this value is distributed among publishers (Marotta et al. 2019, Shiller et al. 2017) and how ad-blocker adoption may negatively affect websites' quality (Shiller et al. 2018). Scholars have also evaluated the efficacy of online advertising in enhancing usability and marketing outcomes by looking at metrics such as ads click-through rate and the effects of advertising campaigns on brand loyalty (Hervet et al. 2011, Lapa 2007, Bounie et al. 2017, Google 2014, Hollis 2005, Ghose & Todri-Adamopoulos 2016, Farahat & Bailey 2012, Frick et al. 2023). From the user's perspective, researchers have explored the perceptions of online advertising. Several studies have reported that a significant portion of internet users dislike the

amount of advertising they encounter online and find the behavioral tracking and targeting associated with it invasive (Turow et al. 2009, Auxier et al. 2019). However, to date, there is very little evidence about the welfare effects of ad-blocking and advertising exposure. Our understanding of the online advertising ecosystem will remain incomplete until we better examine how the increasing exposure of users to precisely targeted ads affects consumer welfare.

In this paper, we address this gap by studying the welfare effects of ad-blocking vs online advertising exposure on individuals. To do so, we conduct a field experiment to evaluate how exposing ad-blocker users to advertising (or shielding non-users from advertising via ad-blockers) affects their online experience, attitudes towards advertising and tracking, subjective well-being, and valuation and future usage of ad-blocking tools. The effects advertising may have on individuals is nuanced. On one side, advertising exposure may have positive effects on consumers by directing them to products relevant to their interests, providing relevant information about products and prices, and thus reducing search costs (Ebbert 2011, Nelson 1970, Nelson 1974). From the opposite perspective, targeted advertising may have negative effects on consumers by leading them to purchase lower quality or more expensive products (Mustri et al. 2022, Acquisti 2024). From a usability perspective, several studies have highlighted how online users find online advertising intrusive and annoying (Turow et al. 2009, Auxier et al. 2019), are concerned about behavioral tracking, and feel some targeted advertising tactics are creepy (Ur et al. 2012, Moore et al. 2015). Further, advertising exposure may even negatively influence individuals' subjective well-being by fostering unending desires and therefore depressing life satisfaction (Michel et al., 2019). Media reports have also pointed to the proliferation of misinformation through ads and the emerging peril of fraudulent advertising (Waddell 2022, Silverman & Talbot, 2022), which may also be detrimental for consumers. The aim of our work is to study, in a causal framework, how online ad-blocking and advertising exposure affect users' online experiences and welfare.

To measure the welfare effects of ad-blocking and online advertising exposure on individuals, we designed a 4-week long field experiment using an incentive compatible mechanism to capture the value users assign to being exposed to (or to shielding themselves from) online advertising. We recruited participants through Prolific Academic and use the Becker-DeGroot-Marschak (BDM) mechanism to elicit their minimum willingness to accept (WTA) to uninstall their ad-blocker (if they currently use one) or to install an ad-blocker (if they are not currently using one) for 4 weeks. After the elicitation, we conducted an entry survey asking participants about their online experiences, attitudes towards advertising, personal well-being, and satisfaction with recent purchases. Participants with a WTA < \$20.3 were invited to participate in the experiment and were randomly assigned to the treatment or control conditions. Ad-blocker users in the treatment condition were asked to uninstall their ad-blockers (and thus

expose themselves to online advertising) for 4 weeks, and non-users in the treatment condition were asked to install an ad-blocker in all their devices and use it (and thus shield themselves from online advertising) for 4 weeks. Those in the control condition were asked to continue with their prior usage of ad-blockers. Each week thereafter, we invited participants to complete a survey that verified they were still complying with the experimental condition and assessed users' personal well-being and satisfaction with their online experiences and recent purchases. At the end of the 4 weeks period, we re-elicited participants' WTA to uninstall or install ad-blockers (or keep the ad-blocker uninstalled/installed if they were in the treatment condition) and continue participating in the experiment for another 4 weeks using the same incentive compatible mechanism. At this time, we also repeated the questions in the entry survey. Finally, two weeks after the exit survey, participants were invited to complete a survey through which we detected ad-blocker usage in order to determine if those we asked to uninstall their ad-blocker reinstalled it after the experiment ended, and whether those that we asked to install an ad-blocker had uninstalled it.

Our field experiment provides novel evidence on the welfare effects of ad-blocking and advertising exposure. The first aspect to note is that preferences towards both ad-blocking and advertising exposure are highly heterogeneous. A non-negligible group of users have strong preferences for or against online advertising exposure. However, the majority of users can be persuaded to use, or not to use, an ad-blocker with moderate incentives. Our intervention was implemented within the group of users with flexible preferences, and constructed on exposing a randomly chosen group of ad-blocker users to advertising, and shielding a randomly chosen group of users currently not employing ad-blockers from advertising. Although our intervention lasted only 4 weeks, we observe treatment effects that imply online advertising exposure significantly influences different dimensions of users' welfare. Those that uninstalled their ad-blocker reported lower satisfaction with online browsing experiences, and lower satisfaction with recent online purchases. Although imprecisely measured, our results suggest they may also become more likely to regret recent online purchases. In contrast, those that installed an ad-blocker become less likely to regret recent online purchases. Interestingly, non-users, who initially were more likely to agree with statements about the potential benefits of online advertising (compared to users), become less likely to agree with those statements after the intervention. Our result suggests that limiting exposure to online advertising may even have benefits for subjective well-being, as those that were shielded from advertising became less likely to agree with statements regarding negative personal feelings at the end of the experiment.

Our results have implications for the debate regarding the benefits and costs of online advertising and ad-blocking tools. Online publishers have concerns regarding the increasing adoption of ad-blockers, as they limit their ability to monetize their online content. In order to sustain themselves, publishers need users to

accept advertising. At the first level, the heterogeneity of preferences we observe indicates that a considerable fraction of users is not likely to adopt ad-blockers. However, the majority of users may switch between using and not using ad-blockers in response to changes in the advertising ecosystem. In the current state of the ecosystem, our results suggest that many users not currently employing ad-blockers would benefit in tangible ways from reducing their exposure to advertising. Thus, ad-blocker adoption and other advertising avoidance strategies may continue to increase. If publishers and advertisers wish to curb the adoption of ad-blockers, they can do so by increasing the cost of their use (for example, via the current practice of blocking access to ad-blocker users, or by making ad-blocking tools less effective as Google is currently doing with the introduction of Manifest V3), or by improving the experience of advertising exposure. Given that our results suggest advertising exposure is associated with negative welfare effects on users, it seems advisable to focus on improving users' experience with advertising exposure rather than making the adoption of ad-blockers costly.

2. Related Literature

Our research contributes to a rich literature in economics, computer science, and information systems that has explored advertising avoidance and the adoption of ad-blockers. Prior work studying the effect of advertising overexposure has found that it can lead to advertising avoidance behaviors and even a decrease in purchase intentions (Rejón-Guardia & Martínez-López, 2014). There exists a delicate balance between the effectiveness of repeat advertising and the potential of annoying consumers and driving them away from the brand if advertising gets too persistent (Todri et al. 2020). Researchers in the privacy and usability space have explored the penetration of ad-blocking across different countries (Malloy et al. 2016), the demographic characteristics of ad-blocker adopters (Stallone, 2019) and how ad-blocking can be used to increase usability, performance, privacy, and security of apps (Shuba et al. 2018).

Also related to our efforts are studies that have analyzed how the adoption of Ad-Blockers has a positive impact on user engagement with the internet (Miroglio et al. 2018) but may potentially lead to negative consequences for users, as it may result in a reduction of online content quality (Shiller et al. 2018, Gritckevich et al. 2021), or lead to reduced search activities and consumer spending (Todri, 2022). Our study contributes to this literature by directly eliciting the valuation that consumers that dislike advertising assign to the ability to block advertising, and that consumers that enjoy advertising put on the provision of ads. Moreover, we explore how exposing users that normally use ad-blockers to online advertising changes their subjective valuation of their online experiences and well-being. Similarly, we evaluate how making consumers not currently using ad-blockers try one for one month affects their valuation of online experiences and subjective well-being.

4. Experimental Design

Our experimental design follows a growing body of studies that use the Becker-DeGroot-Matschack method (BDM) to assess individuals' willingness to accept to perform an action in digital domains. Examples include studies that have tried to determine users' valuation of their access to digital goods and services (Brynjolfsson et al. 2019), and social media (Allcott et al. 2020). Our study design, which is adapted from the field experiment on social media by Allcott et al. (2020), is explained below.

4.1 Recruitment, Randomization, and Surveys

Participants were recruited using Prolific Academic. We restrict participation to U.S. residents 18 years of age or older. We first invite prolific users to participate in a pre-screening survey, in which we ask them about their ad-blocker usage and an attention check question. The survey also contains a script that detects if the participant is using an ad-blocker. Participants that pass the attention check, and whose stated ad-blocker usage matches what we detect through our script, are invited to participate in the study. The main study consists of an entry survey, three weekly surveys, an exit survey, and a post-exit survey.

In the entry survey we first explain the experiment to participants and ask them to provide their consent to participate. For those that consent, based on the ad-blocking detection script included in the pre-screening survey, we assign them to the ad-blocker user group or non-user group. In the first part of the survey we elicit participants' minimum WTA (using the BDM mechanism³) to uninstall (for the user group) or install (for the non-user group) an ad-blocker. We then ask them to complete a series of questions related to the outcome variables explained in section 4.2. At the end of the survey, participants with a WTA below \$20.3 are randomly assigned to the treatment or the control conditions (50% randomly selected are assigned to the treatment group, and the other 50% to the control group). The \$20.3 threshold was determined based on results from two pilot studies and was chosen to capture ~50% of ad-blocker users. For those in the treatment condition, we ask them to uninstall (for the user group) or install (for the user group) ad-blockers on all their devices. Detailed instructions to complete these steps are provided.

Each week during the experiment we invite participants to complete a short survey that detects if the participant is complying with the experimental condition, and to answer questions about their satisfaction with their recent online experiences, and their subjective well-being. At the end of 4 weeks, we invite participants to participate in the exit survey. In this, we first elicit their minimum WTA to keep their adblocker uninstalled for another 4 weeks for those in the user-treatment condition (or installed for those

³ The basic form of a BDM mechanism consists of asking participants for the minimum amount they would be willing to accept (WTA) in order to perform an action. To make the elicitation incentive compatible, participants are told that they will be paid an offer generated by a random number generator as long as their bid is below that offer. This makes the mechanism incentive compatible because bidding an amount above their WTA will only reduce the likelihood that they are paid.

in the non-user-treatment condition), or to uninstall their ad-blocker for 4 weeks for those in the user-control condition (or to install an ad-blocker for those in the non-user-control condition). We then repeat the same questions as in the entry survey. Finally, two weeks after the end of the experiment, we invite participants to complete a post-exit survey. The main objective of this post-exit survey is to detect if those in the treatment condition re-installed (or uninstalled) their ad-blocker after the experiment ended.

Participants are paid \$5 upon completing the entry survey, \$0.5 after completing each of 3 short weekly surveys, and \$3.5 after completing the exit survey. Users in the treatment group are also paid \$20.3 after completing the exit survey if they complied with the experimental treatment. Finally, participants are paid \$1 for completing the post-exit survey.

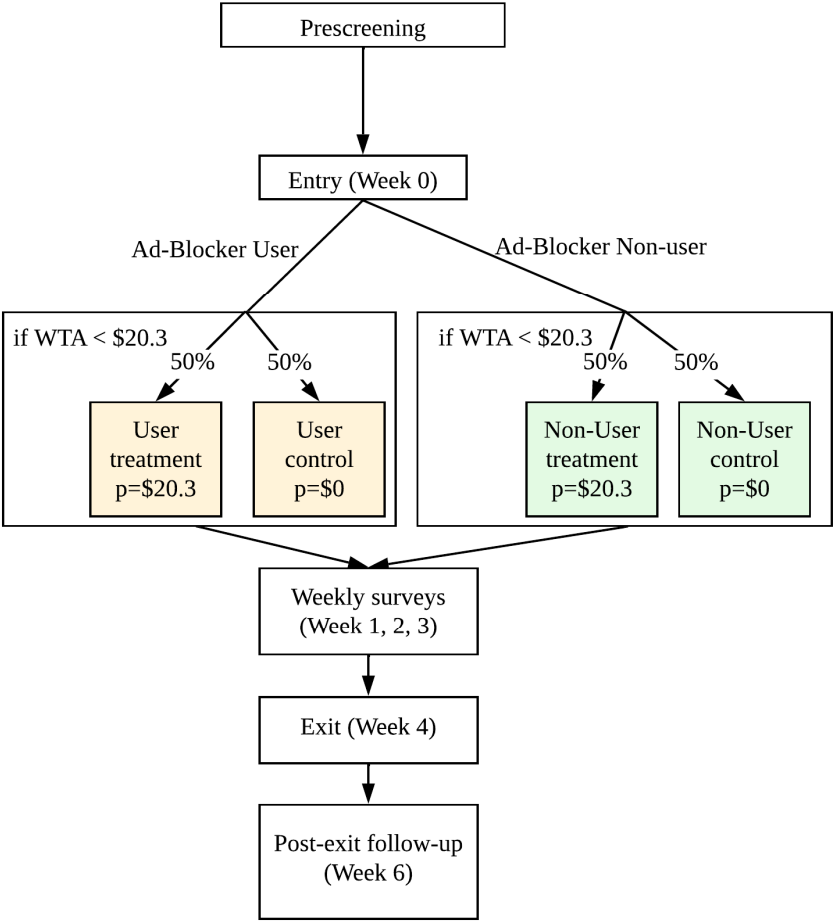


Figure 1: Experimental Design

Figure 1 provides an overview of the experimental design. The experimental protocol and pre-analysis plan was registered in the American Economic Association's registry for randomized controlled trials. In our pre-registration, we stated our aim was to recruit between 75-100 participants in each of the 4 groups, and that we were going to stop recruiting participants once this threshold was reached. Table 1 provides a summary of the number of participants who passed the pre-screening survey, along with the number of participants that completed each step of the study. Note that the number of participants enrolled in the non-user treatment condition is lower than the number of participants enrolled in the control condition. This happened because several of the participants assigned to the treatment condition withdrew from the experiment as they were not willing to install an ad-blocker in their computer (despite being offered a payment above their stated minimum willingness to accept to install an ad-blocker).

Table 1: Recruitment and Sample Size

Group		Passed Prescreening and Invited to Entry	Completed Entry Survey	Invited to Control/Treatment	Completed Exit Survey	Completed Post-Exit Survey
User	Treatment	618	447	112	90	73
	Control			112	99	92
Non-User	Treatment	665	356	108	77	65
	Control			113	104	96

4.2 Outcome Variables

To measure participants' satisfaction with their online experiences, their preferences and attitudes towards online advertising and ad-blocking, their self-reported well-being, and their satisfaction with recent purchases, we collect outcome variables and in five broad areas as described below. Unless specified, all outcome variables are collected at both the entry and exit survey.

Willingness to Accept

A key variable of our analysis is to identify whether the minimum WTA of participants to uninstall their ad-blocker (for the user group) or install an ad-blocker (for the non-user group) changes between the beginning and the end of the study. For doing this, we elicit the participants' minimum WTA to uninstall/install an ad-blocker on their devices using a BDM mechanism during the entry and the exit surveys.

Browsing Speed and Online Satisfaction

One of the key reasons users often mention for adopting ad-blockers is that they improve loading speed and reduce clutter in websites, which can lead to greater satisfaction with online interactions. We thus ask participants questions about their satisfaction with the browsing speed they experience, and their overall satisfaction with online experiences in the entry, weekly, and exit surveys.

Advertising Exposure, Engagement, Annoyance, and Satisfaction.

The adoption of ad-blockers should reduce the exposure of users to advertising. Their effect on users' engagement with online ads is ambiguous. While viewing fewer ads can lead to lower levels of engagement, it can also lead to increased engagement. Ad-blockers are not able to block all ads that users encounter online. It may be the case that when presented with fewer ads, users become more likely to interact with them as it has been shown that excessive advertising has chilling effects on consumers. Thus, at the entry and exit survey, we ask participants for the frequency of seeing or interacting with different online ads. We also ask participants their levels of annoyance and satisfaction with the ads they encounter online.

Attitudes Towards Online Tracking and Advertising

We are interested in evaluating if users and non-users have different opinions about the advantages and disadvantages of online tracking and advertising. We assess participants' perception of the goal of online advertising, their perceived benefits and harms of online advertising and online tracking.

Subjective Well-being and Satisfaction with Online Purchases

We measure the effect of our treatment on participants' subjective well-being in two ways. First, we measure their overall subjective well-being through questions about their happiness, life satisfaction and loneliness. Second, we ask questions about participants' online spending and satisfaction (or regrets) with recent purchases.

5. Empirical Strategy for Data Analysis

To increase compliance with our experimental treatment, and to determine if non-compliance is a significant issue that may influence our results, during the weekly surveys we use our ad-blocker detection script to verify whether participants still have their ad-blocker uninstalled/installed as requested by their condition. We contact non-compliant participants and ask them to uninstall/install their ad-

blocker again, and provide instructions to do so when necessary. While we collect ad-blocker usage status on both desktop and mobile devices, we based our analysis on the compliance status on desktop devices.⁴

To evaluate the impact of our experimental treatment we estimate the local average treatment effect (LATE) of the treatment through an instrumental (IV) framework following the strategy used by Allcott et al. (2020). We estimate the effect of the treatment for the ad-blocker user group and non-user groups separately. For the user group, we estimate the treatment effect of stopping the use of ad-blockers and exposing participants to online advertising, while for the non-user group, we estimate the treatment effect of installing an ad-blocker and thus shielding users from the majority of online advertising.

The regression setup for the user group and non-user groups is analogous. For the analysis, we focus on the sample of participants with a willingness-to-accept (WTA) less or equal than \$20.3. Participants with a WTA over \$20.3 are excluded because they were not asked to install or uninstall their ad-blocker, and are not assigned to either the treatment group or the control group.

We estimate the impact of the treatment by outcome area. Following Allcott et al. (2020), we create area indices aggregating outcomes in each of the broad areas presented in section 4.2. To do this, we use the method outlined in Anderson (2008). We aggregate the outcome variables within each area and build a weighted average index with their inverse covariance. We denote Y_i as the value of the outcome index variable at exit, and $Y_{\{i,entry\}}$ as the value of the outcome index variable on entry. Additionally, the outcome variables are normalized so that the standard deviation for the control group on exit is equal to 1. This allows us to interpret the coefficient estimates in the regressions as effect sizes in terms of standard deviations of the control group.⁵

For our IV analysis we instrument compliance with treatment assignment and the difference between our offer (\$20.3 for the treatment group) and the participants minimum WTA (which we call offer surplus). For the ad-blocker user (non-user) group, we define $Z_i \in [0, 1]$ as the treatment assignment of participant i , which is equal to 1 if the participant is assigned to uninstall (install) their ad-blocker for 4 weeks. We define compliance as a continuous variable D_i that is equal to the fraction of surveys completed in which the participant was complying with the experimental condition. In the first stage we estimate the following equation:

⁴ We also repeat all estimations considering compliance in both desktop and mobile devices and results are qualitatively equivalent.

⁵ We also estimated all regressions presented in this paper without following this normalization process explained above, and instead building the indices as the sum of the responses for all variables included in the area. The results are qualitatively equivalent.

$$D_i = \alpha + \beta_1 Z_i + \beta_2 Offer\ Surplus_i + \beta_3 Y_{\{i,entry\}} + \varepsilon_i$$

In the second stage we estimate:

$$Y_i = \alpha + \delta \widehat{D}_i + \beta \vec{Y}_{\{i,entry\}} + \varepsilon_i$$

In this regression, δ is the estimator of the local average treatment effect of our treatment. We use robust standard error in all models.

6. Results

In this section we focus on the 370 participants that completed both the entry and exit surveys, unless specified.

6.1 Differences Between Groups at Entry

In the entry survey, we ask participants a series of questions about all the outcome variables described in section 4.3. While the goal of our experiment is to determine how these outcomes change when participants are exposed to our treatment, i.e. not use an ad-blocker for one month for users, and using an ad-blocker for one month for non-users, it is interesting to compare the baseline of these variables between users and non-users.

Table 2 and 3 show the summary statistics of participants' WTA in the entry survey. The results in Table 2 included all participants that completed the entry survey, including those who have a WTA > \$20.3 or those that did not respond the exit survey, while Table 3 shows the results only for those who completed the experiment (i.e., those who have a WTA < \$20.3 in the entry and completed both entry and exit survey).

Overall, the WTA between the user group and non-user group are close to each other in the entry survey. In Table 2, while the mean WTA of ad-blocker users (to uninstall their ad-blocker) is lower than that of non-users (to install an ad-blocker), this is driven by a few extremely large payments requested by non-users. The median WTA is the same for both groups. The reported WTAs suggest that some participants have very strong preferences towards using or not-using an ad-blocker. However, half of users and non-users are willing to uninstall (in the case of users) or install (for the case of non-users) an ad-blocker for 4 weeks in exchange for a payment of \$20 or less.

Table 2: Summary statistics for willingness-to-accept among all participants in the entry survey.

	Count	Min	Mean	Median	Max
User	447	1	211.48	20	50,000

Non-User	356	0.5	5,672.15	20	1,000,000
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Figure 2 shows the distribution of WTAs for the user and non-user groups (the figure excludes WTAs greater than \$300 for readability). Focusing in the \$0 to \$100 range allows us to observe some differences between users and non-users. It is apparent that users have slightly stronger preferences than non-users, as their WTAs are less concentrated in lower values.

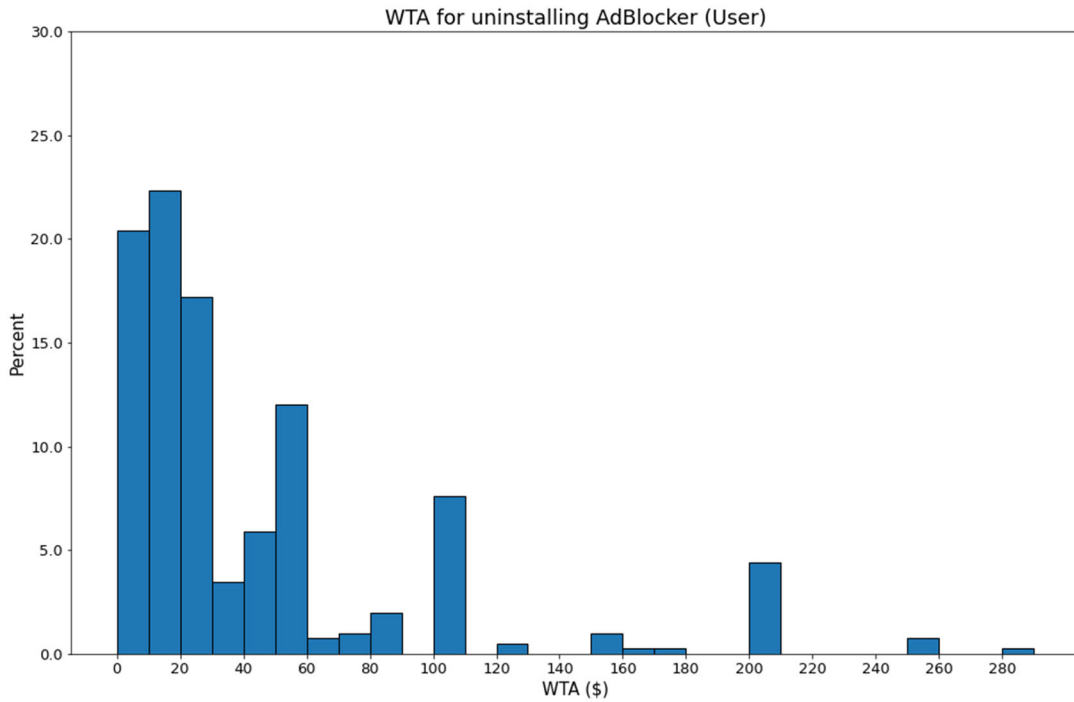


Figure 2(a): Users' willingness-to-accept to uninstall an Ad-Blocker on their devices.

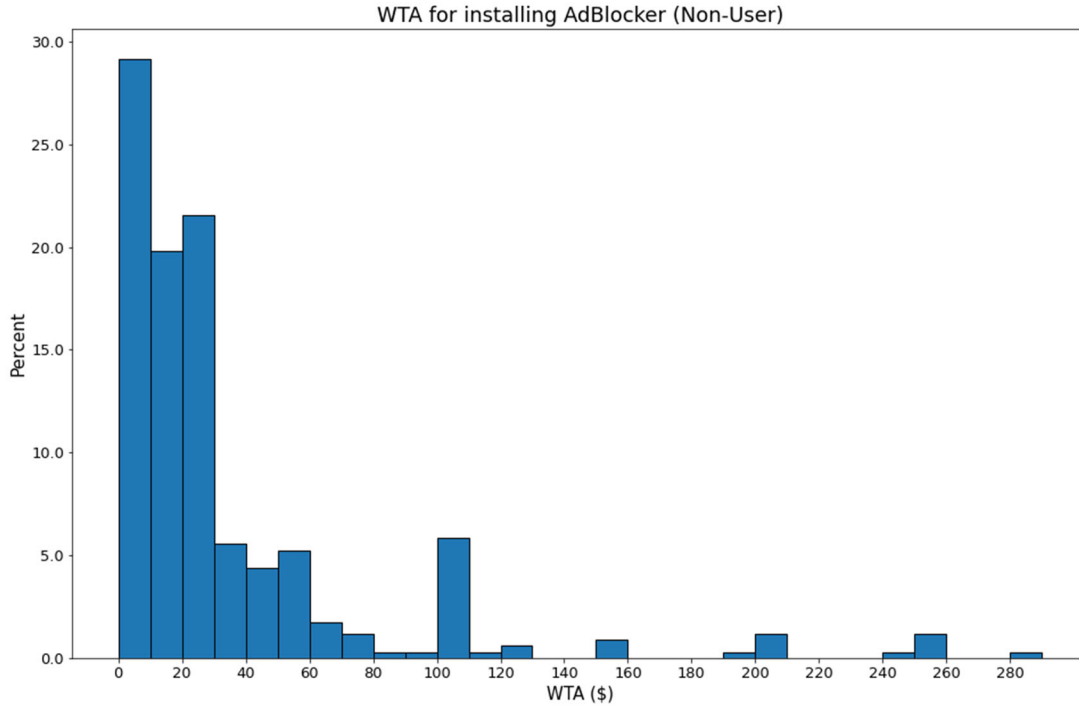


Figure 2(b): Non-Users' willingness-to-accept to install an Ad-Blocker on their devices.

In table 3 we show the minimum WTAs focusing only on the participants that participated in the entire experiment (i.e. those that had WTA < \$20.3 on entry and completed at least the entry and exit surveys). Within this group we observe that while the mean WTA for non-users is lower than that of users, the difference is not statistically significant.

Table 3: Mean WTA in the entry survey among participants completed the experiments

Question	User	Non-User	Diff (p-value)
Please enter the minimum amount of money (in dollars) you would be willing to accept to uninstall/install an Ad-Blocker on all your devices used for personal purposes for the next 4 weeks.	11.05	10.39	0.66 (0.31)

Table 4 shows the question related to online browsing satisfaction. In the entry survey ad-blocker users report slightly higher satisfaction with online browsing speed, and with online experiences, although only the difference about online experiences is statistically significant.

Table 4: Browsing Speed and Online Satisfaction

Question (Likert scale: 1 being strongly disagree, 5 being strongly agree)	User	Non-User	Diff (p-value)
I am satisfied with the online browsing speed (or website loading speed).	3.47	3.41	0.06 (0.35)
I am satisfied with the online experiences in general.	3.53	3.38	0.15 (0.03)

We also ask questions about participants' exposure to advertising and their opinions about the online advertising they encounter (Table 5 and 6). It is not surprising that ad-blocker users report seeing less online advertising and paying less attention to it. Ad-blocker users also report being less annoyed about online ads, which may be related to their lower-level exposure to and engagement with online ads. Both groups present a similar level of satisfaction with online ads.

Table 5: Advertising Exposure and Engagement

Question (Likert scale: 1 being Never, 5 being Very Often)	User	Non-User	Diff (p-value)
Over the past four weeks, how often did you...			
See generic online ads (Ads that you do not believe were targeted to you)	3.16	3.69	-0.53 (<0.01)
See targeted online ads (Ads you believe were targeted to you)	3.34	4.28	-0.94 (<0.01)
See annoying online ads	3.19	3.86	-0.67 (<0.01)
Pay attention to online ads	2.16	2.65	-0.49 (<0.01)
Clicked on online ads	1.58	1.97	-0.39 (<0.01)
Purchase products that were shown to you on online ads	1.31	1.67	-0.36 (<0.01)
Purchase from a website because you clicked on an ad from it	1.30	1.67	-0.37 (<0.01)

Table 6: Advertising Annoyance and Satisfaction

Question (Likert scale: 1 being strongly disagree, 5 being strongly agree)	User	Non-User	Diff (p-value)
Over the past 4 weeks,			
I am annoyed with the online ads that I saw in general	3.28	3.66	-0.38 (<0.01)
I am satisfied with the targeted online ads that I saw.	3.14	3.24	-0.1 (0.52)

When asked about attitudes towards online advertising, participants that don't use ad-blockers are more likely to agree with positive statements about online advertising (Table 7). They are more likely to find advertising relevant, useful, and to agree that advertising saves them time. Meanwhile, users of ad-blockers hold more negative attitudes towards online advertising (although the differences between the groups are not statistically significant). They find it more distractive, intrusive, and disturbing than non-users. These patterns suggest that the decision to adopt ad-blockers may be driven by attitudes towards advertising.

Table 7: Positive Attitudes towards Advertising

Question (Likert scale: 1 being strongly disagree, 5 being strongly agree)	User	Non-User	Diff (p-value)
Please indicate your level of agreement with the statements listed below:			
Online advertising is necessary to enjoy free services on the Internet	3.15	3.1	0.05 (0.7)
In general, I find online advertising to be relevant to my interests	2.97	3.29	-0.32 (0.03)
Online advertising saves me time	2.04	2.71	-0.67 (<0.01)
Online advertising helps me find products that match my personality and interests	2.89	3.1	-0.21 (0.15)
Online advertising saves me money	2.34	2.4	-0.06 (0.66)
Consumers may obtain reliable information through online advertising	3.22	3.32	-0.1 (0.51)
In general, I find that online advertising is useful	2.85	3.24	-0.39 (0.01)
Online advertising contributes to society's economic development	3.42	3.4	0.02 (0.86)
Online advertising promotes competition, which benefits consumers	3.43	3.45	-0.02 (0.89)

Table 8: Negative Attitudes towards Advertising

Question (Likert scale: 1 being strongly disagree, 5 being strongly agree)	User	Non-User	Diff (p-value)
Please indicate your level of agreement with the statements listed below:			
I find that online advertising is distracting	3.46	3.32	0.14 (0.14)
I find that online advertising is intrusive (it distracts me from what I am doing online)	3.52	3.41	0.11 (0.26)
I find online advertising disturbing	3.27	3.09	0.18 (0.2)
I find online advertising annoying	3.47	3.51	-0.04 (0.63)
There is too much advertisement on the internet	3.66	3.67	-0.01 (0.94)
Online advertising is very repetitive	3.60	3.55	0.05 (0.53)

The last part of our survey explores participants' subjective well-being (table 9) and satisfaction with online purchases (table 10). In neither of these tables do we observe any statistically significant differences between the groups, other than non-users being less likely to report feeling bored.

Table 9: Subjective Well-being

Question (Likert scale: 1 being strongly disagree, 5 being strongly agree)	User	Non-User	Diff (p-value)
During the past 4 weeks...			
My life was close to ideal	3.08	3.1	-0.02 (0.86)
The conditions of my life were excellent	3.25	3.19	0.06 (0.58)
I was satisfied with my life	3.29	3.42	-0.13 (0.24)
Feel that you lack companionship	2.39	2.22	0.17 (0.17)
Felt depressed	2.31	2.24	0.07 (0.53)
Felt Anxious	2.58	2.55	0.03 (0.81)
Felt absorbed in doing something worthwhile	3.03	3.07	-0.04 (0.66)
Felt bored	2.65	2.35	0.3 (0.01)

While the differences between the groups are not statistically significant in table 10, on average ad-blocker users report spending less online, and being more satisfied with their purchases.

Table 10: Online Spending, Purchase Regret, and Purchase Satisfaction

Question	User	Non-User	Diff (p-value)
In the past 4 weeks...			
How much do you spend on online purchases per week on average? (Under 50, \$50-\$100, \$100-\$250, \$250-500, \$500 or more)	1.87	1.96	-0.09 (0.37)
I bought thing(s) that I wish I hadn't bought (either online or offline). (Likert scale: 1 being strongly disagree, 5 being strongly agree)	2.72	2.76	-0.04 (0.81)
Overall, I am satisfied with the purchases that I made (either online or offline). (Likert scale: 1 being strongly disagree, 5 being strongly agree)	4.58	4.46	0.12 (0.21)

6.2 Treatment effect

While the patterns presented in section 6.1 show some interesting differences between those that use and don't use ad-blockers, the goal of our study is to understand how those variables are going to be affected by our experimental treatment, which is to expose ad-blocker users to advertising, and shield those that don't use ad-blockers from advertising. In this section, we present the estimation of the treatment effects by families of variables.

In terms of satisfaction with online experiences (table 11), the treatment has a negative and marginally significant effect on ad-blocker users that were asked to uninstall their ad-blocker. While the effect on non-users that installed an ad-blocker seems to be positive, the coefficient estimate is not statistically significant. In table 11 we report both the coefficient estimates of the first and the second stage regressions. In subsequent tables, for the sake of space, we only present the results of the second stage regressions as the first stage regressions are for the most part identical across all specifications.

Table 11: Treatment Effect on Online Browsing Satisfaction Index

	User (Treatment = Uninstall)		Non-User (Treatment = Install)	
	1st Stage	2nd Stage	1st Stage	2nd Stage
Treatment Effect		-0.358*		0.160
		0.202		0.238
Index Baseline	-0.016	0.361***	-0.029	0.148
	0.018	0.092	0.019	0.118
Treatment Assignment	0.798***		0.674***	
	0.062		0.072	
Offer Surplus	0.003		0.003	
	0.006		0.006	
Constant	-0.001	0.026	0.003	-0.019
	0.002	0.089	0.003	0.096
Observations	189	189	181	181

Table 12 shows the effect of the treatment on advertising exposure and engagement. As expected, the treatment has a strong effect on increasing the advertising exposure for those that uninstall their ad-blocker and reducing it for those that install an ad-blocker. Surprisingly, this does not seem to translate into a statistically significant effect on engagement with online ads.

The treatment effect does not seem to have a strong effect on the level of annoyance and satisfaction with online advertising, or to significantly affect participants' positive and negative attitudes towards online advertising (table 13). The only statistically significant effect that we observe is that non-users that were asked to install an ad-blocker become less likely to agree with positive statements regarding the potential benefits of advertising. This is interesting because in the entry survey, one of the differences we found between non-users and users was that non-users had more positive attitudes towards advertising. It seems our treatment diminished these differences.

Table 12: Treatment Effect on Advertising Exposure and Engagement

	Ad-Exposure		Ad-Engagement	
	User (Uninstall)	Non-User (Install)	User (Uninstall)	Non-User (Install)
Treatment Effect	0.856***	-0.647***	-0.216	0.207
	0.138	0.202	0.236	0.227
Index Baseline	0.332***	0.378***	0.314***	0.446***
	0.059	0.074	0.113	0.084
Constant	-0.012	0.004	-0.038	-0.101
	0.088	0.085	0.093	0.088
Observations	189	181	189	181

Table 14 shows the treatment effect on participants' subjective well-being. The only statistically significant effect is that participants that were asked to install an ad-blocker become less likely to report negative feelings.

Table 13: Treatment Effect on Ad Annoyance and Satisfaction, and on Positive and Negative Attitudes towards Advertising

	Ad Annoyance		Ad Satisfaction		Positive Attitudes		Negative Attitudes	
	User	Non-User	User	Non-User	User	Non-User	User	Non-User
Treatment Effect	0.013	-0.286	-0.085	0.019	0.063	-0.500**	-0.034	0.060
	0.153	0.227	0.159	0.207	0.165	0.204	0.174	0.186
Index Baseline	0.245***	0.279***	0.472***	0.236***	0.343***	0.285***	0.296***	0.396***
	0.092	0.091	0.065	0.073	0.084	0.069	0.069	0.063
Constant	0.038	-0.069	0.001	0.014	-0.024	-0.027	-0.048	-0.005
	0.094	0.096	0.085	0.096	0.091	0.093	0.100	0.086
Observations	189	181	189	181	189	181	189	181

Table 14: Treatment Effect on Subjective Well-Being

	Positive Feelings		Negative Feelings	
	User (Uninstall)	Non-User (Install)	User (Uninstall)	Non-User (Install)
Treatment Effect	-0.122	-0.120	0.029	-0.391**
	0.148	0.182	0.121	0.167
Index Baseline	0.521***	0.541***	0.738***	0.691***
	0.064	0.071	0.051	0.058
Constant	-0.056	0.005	-0.132*	0.069
	0.083	0.080	0.070	0.069
Observations	189	181	189	181

In terms of online spending and purchase satisfaction (table 15) we don't observe a statistically significant effect of ad-blocking on online spending. However, participants that were asked to install an ad-blocker become less likely to regret recent purchases, while participants that were asked to uninstall their ad-blocker report lower levels of satisfaction with their recent purchases.

One of our main goals was to analyze changes in participants WTA after experiencing the experimental treatment. Our expectation was that for ad-blocker users, if we observe a large increase in their WTA, it will imply that being exposed to advertising for 1 month reinforced their preferences towards using ad-blockers, and that this group of users is unlikely to be willing to accept advertising again. Instead, if we don't observe an increase, or if we observe a decrease, it will imply that it is likely that, given the right conditions, this group of users would be willing to stop using ad-blockers. In the case of non-users we expected that if they were to revise their WTA upwards, it would imply they value online advertising and are unlikely to ever adopt an ad-blocker, or that they find the costs of using an ad-blocker, such as some websites not working properly, too high. Despite finding the treatment effect suggesting that ad-blocker usage has a positive effect on participants, we don't find any statistically significant treatment effect on participants' WTAs (table 16). Examining changes in WTAs for the different groups reveals that all groups increase their WTA. We interpret this as the increase being driven by fatigue with participating in

the experiment and responding to periodic surveys rather than with a change in users' valuations of ad-blockers.

Table 15: Treatment Effect on Online Spending and Purchase Satisfaction

	Amount Spent		Purchase Regret		Purchase Satisfaction	
	User (Uninstall)	Non-User (Install)	User (Uninstall)	Non-User (Install)	User (Uninstall)	Non-User (Install)
Treatment Effect	-0.177	0.189	0.243	-0.352**	-0.367*	0.231
	0.142	0.212	0.183	0.174	0.203	0.184
Index Baseline	0.282***	0.461***	0.279***	0.391***	0.030	0.320***
	0.070	0.088	0.070	0.066	0.119	0.092
Constant	-0.001	-0.049	-0.074	-0.091	-0.005	-0.042
	0.094	0.090	0.095	0.080	0.099	0.094
Observations	189	181	189	181	189	181

Considering that we don't find significant changes in participants' WTA to use or not use an ad-blocker, it may be more telling to examine the effect our treatment has for ad-blocker usage after the experiment ends. For these regressions we don't include the ad-blocker usage values at baseline because all participants in the user (non-user) group were using (not-using) an ad-blocker at entry. Table 17 shows the treatment effect on post-experiment ad-blocker usage. We observe a strong effect for both users and non-users. A large number of users that we asked to uninstall their ad-blocker did not re-install it after the experiment ended. Similarly, a large number of participants that we asked to install an ad-blocker kept the ad-blocker installed after the experiment ended. This result seems counter intuitive considering that we showed that participants we asked to uninstall their adblocker experience a deterioration in online experiences and other outcomes and those that we asked to install an ad-blocker experienced an improvement. However, notice that the treatment effect is much larger for non-users that installed an ad-blocker, which is the group that experienced better outcomes. Thus, we conclude the effect we observe is a combination of a decision made based on experiences during the experiment and inertia.

Table 16: Treatment Effect on WTA

	User (Uninstall)	Non-User (Install)
Treatment Effect	-7.244	2.091
	9.741	4.274
Index Baseline	1.389**	0.929***
	0.701	0.238
Constant	14.544	7.602***
	11.392	2.791
Observations	189	181

Table 16: Treatment Effect on Post-Experiment Ad-Blocker Usage

	User (Uninstall)	Non-User (Install)
Treatment Effect	-0.968***	2.556***
	0.215	0.460
Constant	0.001	-0.013
	0.104	0.102
Observations	165	161

7. Conclusions

We conducted a field experiment to study users' valuation of being exposed to (or being shielded from) online advertising, and to study how exposing or shielding users from online advertising (through the use of ad-blockers) influences their online experiences, opinions regarding online advertising, subjective well-being and satisfaction with recent purchases. Overall, we observe a great degree of heterogeneity in users' valuations of ad-blocking tools. A sizable number of users are not willing to stop using their ad-blocker even if offered large payments, while a similar number of users are not willing to install an ad-blocker. However, the great majority of users are willing to install/uninstall an ad-blocker in exchange for moderate payments. Asking ad-blocker users to uninstall their ad-blocker led to worse online experiences and lower satisfaction with online purchases. Asking non-users to install an ad-blocker led to fewer

reported regrets with online purchase, a decrease in negative feelings, and a less positive view of online advertising. Overall, our results suggest that, in the current state of the online advertising ecosystem, there is a large fraction of users that benefit from the use of ad-blockers. However, their preferences don't seem to be very strong and could be persuaded not to use an ad-blocker with modest incentives. If publishers and advertisers wish to curb the adoption of ad-blockers they can either increase the cost of their use (for example by blocking access to ad-blocker users), or by improving the experience of advertising exposure. Given that our results suggest advertising exposure is associated with negative effects on online experiences, purchase satisfaction, and even subjective well-being, it seems advisable to focus on improving users' experience for those not using ad-blockers rather than making the adoption of ad-blockers costly.

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