Targeted advertising, platform competition and privacy

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Abstract

Targeted advertising can benefit consumers through lower prices for access to websites. Yet, if consumers dislike that websites collect their personal information, their welfare may go down. We study competition for consumers between websites that can show targeted advertisements. We find that more targeting increases competition and reduces the websites' profits, but yet in equilibrium websites choose maximum targeting as they cannot credibly commit to low targeting. A privacy protection policy can be beneficial for both consumers and websites. If consumers are heterogeneous in their concerns for privacy, a policy that allows choice between two levels of privacy will be better. Optimal privacy protection takes into account that the more intense competition on the high-targeting market segment also benefits consumers on the less competitive segment. Consumer surplus is maximized by allowing them a choice between a high targeting regime and a low targeting regime which affords more privacy.

Keywords: platform competition, targeted advertising, privacy policy

JEL classification: D43, L13, L82, M38

1. Introduction

In 2012, internet advertising revenues in the US for the first time exceeded 10 billion dollars per quarter. The share of internet advertising has been rising steadily, currently totalling a third of total US advertising revenues, and almost equals that of the broadcast television.[1]

Internet advertising allows for more precise targeting, compared to traditional media.[2] Whereas a television commercial will be the same for all those watching a particular show, and therefore tailored to consumers' average interests conditional on their watching the show, the internet allows targeting on each individual's specific characteristics.

Targeting of advertisements is valuable to advertisers as it increases the probability that the advertisement leads to a purchase. This is also reflected in pricing schemes, which are increasingly based on click-through rates or other performance measures, rather than mere numbers of viewers. A website that can target its advertisements better will collect higher per-viewer revenues from advertisers, which may be partly reflected in lower subscription prices (if present) or higher quality to attract more visitors.

The advantages of targeting for advertisers induce firms to collect personal information on their consumers. Personal information used for targeting includes keywords entered in search engines, recent browsing history, previous web purchases or even the topics in their emails. Web companies such as Axciom or Bluekai collect information on individuals' web behaviour and use that to categorize consumers into profiles, which they then sell on to advertising sites.[3]

Better targeting has a potential drawback for consumers: consumers may care about the associated loss of privacy. Consumers have limited possibilities to verify what kind of personal information firms collect and how they use this information. How well do firms protect personal information against theft or manipulation by criminals? Do firms use personal information to raise prices for some groups of consumers? In addition, some internet users may feel uneasy

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[1]As reported by the Interactive Advertising Bureau's "Internet Advertising Revenue Report", 2013. See the annex to this paper for an overview of facts and figures on online advertising.

[2]Evans (2009) and Goldfarb (2013) provide overviews of the economics of online advertising.

[3]See e.g. "Who Do Online Advertisers Think You Are?", New York Times, November 30, 2012. In the annex to this paper, we describe the various types of players in this industry in more detail.

when they discover that their movements on the web may be recorded and reflected in the ads they are shown.[4]

These privacy costs are heterogeneous across consumers. A survey by Turow et al. (2009) shows that 66 percent of Americans does not want to have ads tailored to their personal characteristics. Goldfarb and Tucker (2012) find that consumers increasingly refuse to disclose sensitive information online, and Goldfarb and Tucker (2011) demonstrate that these costs are economically relevant, in the sense that they alter consumers' purchasing decisions in response to advertising. See Tucker (2012) for an overview.

One response to such consumer uneasiness is for web companies to offer consumers a choice on how much information can be collected on them. As an example, currently internet provider AT&T offers customers a 29 dollar reduction on their monthly subscription bill if the firm can use their information on browsing behaviour to better target the ads it shows them.[5] Also, many websites allow consumers either to opt for signing in to the site or to browse anonymously. Signing in may increase the quality the site can offer, at the expense of the site storing previous browsing history. Also, consumers may choose not to accept cookies, or may join industry "do-not-track" registers.

There may be a role for public intervention to protect online privacy. For one thing, many consumers may be ill-informed about websites' information gathering activities and privacy policies. It is costly or impossible for consumers to verify whether the websites they visit collect and use personal information. In the absence of verifiable contracts on the degree of privacy protection, these sites may have trouble committing to a strict privacy policy. Government intervention can help in providing a credible standard for privacy protection. Indeed, both in the EU and in the US stricter online privacy laws are being put in place.

In this paper, we show that competition among websites may also drive sites to choose levels of privacy protection that are too low from their own perspective, as well as from their

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[4]There are various forms of targeting, see the annex. In the case of retargeting, an ad for a product which has been previously looked up on the internet may afterwards appear as a banner ad on completely unrelated webpages. Consumers may feel watched and stalked by the product as a result, see e.g. "Web trackers are totally out of control", ITworld.com, March 21, 2013.

[5]"AT&T says your privacy is worth $ 29 a month", Techtimes.com, Dec 12 2013.

consumers' perspectives when these suffer costs from loss of privacy. Government regulation of privacy may then lead to a Pareto improvement, increasing both websites' and consumers' surplus.

We analyze a model of websites that act as two-sided platforms, matching advertisers to consumers. The websites compete for consumers in a Hotelling fashion. Consumers single-home, that is, they visit only one platform. This implies that the websites are competitive bottlenecks (Armstrong, 2006): websites are effectively gatekeepers for advertising access to consumers. This allows them to extract monopoly rents from advertisers. Websites can strategically choose the level of targeting of ads to their consumers. Advertisers have higher willingness to pay (per consumer) for an ad that is better targeted at a consumer's taste, which corresponds to his location on the Hotelling line. We assume consumers dislike being targeted, but their disutility from the amount of targeting that they are exposed to is heterogeneous.

We demonstrate that an increasing amount of ad targeting leads the web platforms to compete more vigorously with each other. Although a larger surplus is created by the better match between advertiser and consumer, this additional surplus is more than dissipated to consumers, reducing the platforms' profits. The intuition is that better ad targeting in particular renders marginal consumers more profitable to the website. Without targeting, these consumers are not very valuable to potential advertisers, as these will focus on the average consumer on the website. This changes when the ad can be better matched to the consumer. The higher ad revenues are channeled through to consumers, as is standard in the competitive bottleneck framework (see e.g. Anderson and Coate, 2005). But in addition, the higher value of the marginal consumer compared to the inframarginal ones spurs competition among the websites (Crampes, Haritchabalet and Jullien, 2009).

In spite of the reduced equilibrium profits, websites maximize targeting when choosing the level of targeting non-cooperatively, if consumers cannot observe that targeting level. Consumers benefit from the increased competition among websites and from the higher advertising revenues that decrease website prices, but if average costs associated with loss of privacy are high, the outcome is socially suboptimal as well. In that case a ban on targeting can be optimal.

Since consumers have heterogeneous costs of privacy loss, one may do better by allowing websites to differentiate the levels of targeting, as in the example of AT&T. We analyze equilibrium outcomes when privacy policy sets and enforces two maximum levels of targeting, one involving high privacy (low targeting) and one with lower privacy and thus more targeting. Websites now compete in menus of two vertically differentiated products: one with high and one with low targeting. We demonstrate that high privacy (low targeting) consumers now also benefit from the more intense competition in the low privacy (high targeting) segment. Prices in the high privacy segment are dragged down through the marginal effect of those consumers whose privacy costs are intermediate, such that they are indifferent between the high price, high privacy product and the low price, low privacy product. We find that a total surplus-maximizing regulator always allows some targeting on the low privacy segment. Consumer surplus maximization involves maximal targeting on the low privacy segment.

Our paper is related to the literature on advertising on two-sided platforms, drawing on Anderson and Coate (2005). We consider the model on a Salop circle, as in Crampes, Haritchabalet and Jullien (2009). Their result that with decreasing returns to scale competition is relaxed ties in with our result on the competitive effect of targeting. In contrast with that paper, in our model the level of targeting is endogenous.

The marketing literature on targeting and competition (e.g. Chen, Narasimhan and Zhang, 2001; Gal-Or and Gal-Or, 2005; Iyer, Soberman and Villas-Boas, 2005) focuses on targeting strategies by product suppliers themselves, and show how this targeting can soften competition. We find an opposite effect when looking at targeting by intermediators, the website platforms. Relatedly, recent literature on privacy focuses on its effects on behavioral price discrimination (see Fudenberg and Villas-Boas, 2006, for an overview). Taylor and Wagman (2014) analyze, using various models of competition, who gains and who loses from privacy regulation. In our setting, firms do not price discriminate in their own product, but try to improve matching of advertisers to consumers. Our paper incorporates the interaction of competition with privacy concerns and privacy legislation. Campbell, Goldfarb and Tucker (Forthcoming) is a recent study in this direction. They focus on entry barriers related to scale economies on the consumer

side of having to familiarize oneself with the privacy policies, and having to consent with them.

2. Model

We consider a model of n horizontally differentiated internet firms ('websites'), competing for consumers who can be homogeneously mapped to a preference space in the form of a circle, following Salop (1979). The utility consumers obtain from visiting a website depends on the distance on the circle between the consumer and the website, as well as on price and privacy policy. Websites' revenues come from two sources. First, the websites offer content to consumers and compete in prices to attract consumers to their sites. In addition, websites also derive revenues from presenting advertisements to the consumers that visit their site. We consider a continuum of horizontally differentiated advertisers, uniformly distributed on the same Salop circle. Advertisers compete perfectly to have their advertisement shown to the websites' consumers.

The focus of our model will be on the websites' ability to target advertisements to consumers. We assume that websites can freely choose the fraction of their subscribers $\rho \in [0, 1]$ for which they gather personal information. When a website has personal information on a consumer, it uses this information to match the consumer to an advertiser. Without that information, it shows consumers an ad of the average best match, which is that of the advertiser located at the same position as the firm itself.[6] Consumers derive disutility from the loss of privacy associated with the collection of personal data. Consumers are heterogeneous in the size of this disutility, θ, and we assume that the distribution of privacy preferences is independent of the consumers' location on the circle. Websites cannot observe the costs θ of individual consumers.

In terms of information, we assume that websites choose their targeting technology ρ and that this choice is verifiable for the regulator, but not observable to consumers. Advertisers are able to verify whether their advertisement was targeted or not, but they do not observe ρ

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[6]The use of Salop's circular city model rather than the Hotelling line greatly simplifies the location of average advertiser.

directly.[7]

2.1. Consumers

We consider a unit mass of consumers uniformly distributed along the Salop circle of horizontal consumer preferences, parametrized by location $x \in [0, 1)$. Consumers subscribe to a single website (i.e. we consider single-homing on the part of consumers). The utility that a consumer located at x derives from subscribing to website i located at position x_i and charging price p_i equals

$$u_i(x, \theta) = w - t|x - x_i| - p_i - \bar{\rho}_i \theta$$

where $|x - x_i| \leq 1/2$ is the distance between the consumer and the website along the circle, t is a travel cost parameter measuring the disalignment between the consumer's location and the location of the website, w is the gross utility of consuming the website's service, which is assumed the same for all websites and consumers.

If a consumer expects that a website has collected personal information, his utility is reduced by θ.[8] We assume that privacy cost θ is independently and identically distributed among all consumers, with distribution function $F(\theta)$ that has continuous density on $[\theta_L, \theta_H]$. The consumer expects that the website has collected his personal information with probability $\bar{\rho}_i$, so that $\bar{\rho}_i \theta$ is the consumer's expectation of the costs of privacy loss when subscribing to website i. We focus on rational expectations equilibrium, where the consumers' expectation of the websites' targeting choice corresponds with the actual equilibrium targeting choice of the website, i.e. $\bar{\rho}_i = \rho_i$ in equilibrium.

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[7]The verification by advertisers can in practice be done by several mechanisms, like pay-per-view, pay-per-click, or by the conversion rate (share of advertisement exposures that result in a click-through to the advertisers own website). More details on such technology can be found in the annex of this paper.

[8]In addition, consumers could have extra direct (dis-)utility of viewing a targeted advertisement relative to viewing an untargeted advertisement. We assume that θ captures the net effect of privacy loss and viewing a targeted advertisement. Note that all consumers are shown exactly one advertisement, which is either targeted or non-targeted. Any generic disutility of advertisements therefore affects all consumers alike.

2.2. Advertisers

We have a continuum of price-taking advertisers, selling products that can be uniquely located at coordinate $y \in [0, 1)$ on the same preference circle as consumers and websites. Advertisers enjoy surplus when consumers are exposed to their advertisements on websites. The size of this surplus, and hence the advertiser's willingness to pay, depends on the quality of the match between consumer and advertiser.

We parametrize the quality of a match by the arc distance between a consumer's location x and the advertiser's location y, as in Wolinsky (1983), and more recently in Chandra (2009) and De Corniere (2013). An advertiser y's perfect match is therefore with the consumer located at $x = y$, generating a match surplus ν. For a match with a less aligned consumer, the advertiser's surplus equals $a(|x - y|)$, with $a(.) > 0$ a decreasing function of the arc distance between consumer and advertiser. This decrease represents the costs of a mismatch. We denote the value of a perfect match by $\nu = a(0)$.

Advertisers contract with the websites to have their advertisement shown to (some of) the platforms' consumers. Each time a consumer visits a website, the website has the opportunity to place one advertisement. We assume that this advertising space is sold at a price that extracts all rents of the advertiser - advertisers are price takers.

2.3. Websites

The n websites are located on the circle at equal distances $1/n$ from each other. Website i sets the subscription price p_i for consumers, and sells ad space aimed at each individual consumer to the advertisers. Since consumers single-home, websites are competitive bottlenecks and extract monopoly surplus from the advertisers (as in Armstrong, 2006). We focus on the case where all consumers subscribe to a website.

We model the choice of targeting intensity by allowing the websites to choose the proportion ρ_i of their customers for which they collect personal information. For simplicity, we assume that information collection is costless; adding a cost does not materially affect the analysis. When a website has personal information on a consumer it can identify his true position on

the line x with probability one. We assume that the probability that a website has personal information on a customer is independent from his location x.[9]

For those customers whose position the website can exactly identify, it will sell the available advertisement space to the matching advertiser at $y = x$, at price ν, the advertiser's willingness to pay for an exact match.

For the $1 - \rho_i$ consumers of website i's content that the website cannot target, the website cannot find perfectly matching advertisers. It does have some information: those consumers' choice of visiting website i rather than another website signals that these consumers are likely to be close to website i. The website will sell advertising space to that advertiser that will bring the greatest match surplus contingent on consumers visiting website i. In a symmetric situation, this best match will be the advertiser located at the same position as the website, $y = x_i$. The price charged for this advertising space will be the advertiser's surplus averaged over all consumers that visit this website.

For a given choice of ρ_i, website i's expected surplus from selling an advertisement to a consumer located at distance $|x - x_i|$ from the platform's location will then be equal to:

$$a(x - x_i, \rho_i) = \rho_i \nu + (1 - \rho_i)a(x - x_i).$$

The timing of the model now is that first websites choose targeting intensities ρ_i and prices p_i. They contract on a per-consumer price with advertisers who can verify whether the advertisement was well-targeted. After all websites have set prices p_i and targeting intensities ρ_i, consumers observe prices p_i and form expectations over ρ_i. They then choose which website to visit. A consumer that is indifferent between website i and $i + 1$ will be located at a distance

$$d_i = \frac{1}{2n} + \frac{p_{i+1} - p_i + (\bar{\rho}_{i+1} - \bar{\rho}_i)\theta}{2t}$$

from website i.

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[9]Websites have no prior information that allows them to stratify customers before collecting information.

3. Targeting and competition

We first consider the competitive equilibrium without regulation. We show that the degree of targeting chosen by the firms affects the intensity of competition among those firms: more precise targeting leads to more intense competition. Yet, ex ante, individual firms find it a dominant strategy to increase their level of targeting ρ_i

To see this, consider a symmetric equilibrium with all websites choosing the same targeting accuracy ρ and price p. Since profits for an individual website i equal

$$\pi_i = \int_{-d_i}^{d_i} (p + a(|x|, \rho))dx,$$

where d_i is the distance between the website's most remote customer and the website itself.[10] In the symmetric equilibrium this leads to the first-order conditions for prices p_i,

$$p_i + a\left(\frac{1}{2n}, \rho\right) = \frac{t}{n}.$$

Substituting the expression for p_i into the firm's profit we find

$$\pi_i = \frac{t}{n^2} + \frac{1}{n}\left(\bar{a}(\frac{1}{2n}, \rho) - a(\frac{1}{2n}, \rho)\right) \tag{1}$$

where

$$\bar{a}(d) = \frac{1}{2d}\int_{-d}^{d} a(|x|)dx, \quad \text{and} \quad \bar{a}(d, \rho) = \rho\nu + (1-\rho)\bar{a}(d)$$

is the average advertising income over all consumers subscribing to website i, without targeting $(\rho = 0)$ and with targeting ρ, respectively.

For $\rho < 1$, advertising income $a(d, \rho)$ is decreasing with the marginal consumer's distance d from the website, the average is higher than the marginal value $\bar{a}(d, \rho) - a(d, \rho) = (1-\rho)(\bar{a}(d) - a(d)) > 0$, and profits are larger than in the case of perfect targeting $\rho = 1$. In terms of the analysis of Crampes, Haritchabalet and Jullien (2009), this is a case of decreasing returns to

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[10] Normalizing the website's location $x_i = 0$; the absolute location of the website does not affect its profits.

audience size.

Finally, since the difference between the marginal and the average advertising revenues decreases with accuracy of targeting ρ, we have the result that

Proposition 1 *In the symmetric equilibrium, profits are decreasing in the degree of targeting ρ.*

The intuition is that an increase in targeting precision ρ increases the value to the website of marginal consumers. Without targeting, advertising impressions on marginal consumers are of low value, since advertisements are tailored to the average consumer. This means that in that case, an additional marginal consumer does not allow the website to increase his revenues from advertisers very much. With targeting, this changes: with perfect targeting, the marginal consumer is as valuable to the website as any inframarginal consumer, as each consumer is linked with its optimal advertiser, providing the website with advertising income ν. In other words, targeting takes away the mismatch between consumer and advertiser, and this mismatch is greater for marginal consumers. This increase in value of the marginal consumer, in turn, heats up competition between adjacent firms for this consumer, and as a result profits go down.

If websites could coordinate on targeting, proposition 1 suggests that they might want to agree to keep targeting to a minimum. However, we next show that individually, websites win by increasing the accuracy of targeting over that of their competitors, so that in the non-cooperative equilibrium, maximal targeting results.

Proposition 2 *Websites gain by increasing the accuracy of targeting ρ above that of their rivals. As a result, in equilibrium all websites will choose maximum allowed targeting.*

Proof of proposition 2 Consider a hypothetical symmetric equilibrium characterized by ρ, p for all firms, and consumer expectations $\bar{\rho} = \rho$. In that case, since market share $2d_i$ does not directly depend on ρ_i (for consumers, only their expectation $\bar{\rho}$ determines their choice of website), we have

$$\frac{\partial \pi_i}{\partial \rho_i} = \frac{\partial}{\partial \rho_i} 2d_i(p + \bar{a}(d_i, \rho)) = 2d_i(\nu - \bar{a}(d_i)) > 0$$

and hence a symmetric equilibrium must have maximum allowed ρ.   *Q.E.D.*

The websites' problem clearly is that they cannot commit toward their consumers on the level of targeting, ρ_i. As a consequence of the strategic interaction outlined in proposition 2, the only equilibrium is where each firm chooses the maximum level of targeting: more targeting is individually profitable and consumers do not observe the deviation.

Maximum targeting is undesirable from the point of view of the websites: from proposition 1, the websites' profits are smallest at maximum ρ, and they would be better off when targeting is not possible at all. But also social welfare may be suboptimal at this equilibrium. Although the improved matching of advertisers to consumers under increasing targeting raises advertiser surplus and hence websites' revenues from advertisers – and this benefit is fully passed through to consumers in the form of lower website prices – consumers who experience privacy costs with increased targeting may lose out.

Intervention by a planner may therefore be welfare improving if the average costs of privacy loss are sufficiently large. Let us here first consider the welfare effects of a simple privacy regulation that puts a maximum on the extent of targeting allowed by firms, $\rho_{max} \leq 1$. Such a regulation provides a credible commitment for firms to keep targeting accuracy ρ at this bound, and is therefore clearly beneficial for the websites.

The analysis of the effect on consumer surplus is also straightforward in the model. Since both price and privacy costs are linear in ρ, consumers prefer either full targeting, $\rho = 1$, or no targeting at all, $\rho = 0$. Average surplus per consumer is given by[11]

$$CS = w - p - \rho\tilde{\theta}$$

where $\tilde{\theta}$ is the average value of privacy costs θ. With price p depending on the marginal value of advertising income

$$p = \frac{t}{n} - a\left(\frac{1}{2n}; \rho\right), \tag{2}$$

and $a(\cdot; \rho) = \rho\nu + (1 - \rho)a(\cdot)$, we find that the optimal value of ρ depends only on the sign of

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[11]ignoring average transportation costs, which are independent of ρ. Also, recall that we assume full coverage, or w high enough that all consumers participate.

$\nu - a(\frac{1}{2n}) - \tilde{\theta}.$

Total surplus, in turn, depends not on the marginal value of advertising, but on the average value per consumer, and its trade-off with average privacy costs. Summarizing,

Corollary 1   *1. Producer surplus is maximized for $\rho = 0$.*

2. *Consumer surplus is maximized at $\rho = 0$ iff $\nu - a(\frac{1}{2n}) < \tilde{\theta}$. Otherwise, $\rho = 1$ maximizes CS.*

3. *Total surplus is maximized at $\rho = 0$ iff $\nu - \bar{a}(\frac{1}{2n}) < \tilde{\theta}$. Otherwise, $\rho = 1$ maximizes total surplus.*

4. Segmentation of the market

Consumers benefit from increased targeting via pass-through of higher advertising surplus (driven by the average value of advertising revenue per consumer), as well as from the more intense competition between websites (reflected in the difference between marginal and average advertising revenue). These benefits are equal for all consumers.

In contrast, consumers are heterogeneous in the costs they experience from loss of privacy that goes hand-in-hand with improved targeting. Those with high privacy costs θ may prefer a lower level of targeting, while those with lower θ will value the benefits higher than the costs.

It therefore makes sense to explore privacy regulations that allow for differentiation in targeting between low- and high-cost consumers. Again, the problem for the website is that of commitment. The websites themselves cannot tailor their levels of targeting to consumer preferences directly, since that level is not observable for consumers. The planner, on the other hand, may help by setting and enforcing a menu of maximum levels for targeting that consumers can choose from.

Let us assume that the planner can set two levels of privacy: one where websites first ask consent (and which consumers can opt out of, e.g. cookies, do-not-track), ρ^{min}. And second,

a maximum level of targeting for those consumers who are willing to give up some privacy in return for lower prices or better quality, ρ^{max}. Government enforced maximum targeting levels allow websites to credibly offer two vertically differentiated products to consumers, one with a government-enforced high level of privacy protection (low targeting), and one which allows a higher degree of targeting by the website.

Consistent with the websites' incentives to increase their level of targeting up to the bound set by the planner, from proposition 2, websites will thus compete in two, vertically differentiated offers, each with a different price. Consumers opting for the high privacy product experience minimal targeting ρ^{min}, and pay price p^h, while those opting for the low privacy subscription will pay the (lower) price p^l, and be exposed to greater targeting ρ^{max}. Hence, this leaves consumers with utility

$$u_i^h(\theta) = w - p_i^h - \rho^{min}\theta - \text{travel costs}, \quad u_i^l(\theta) = w - p_i^l - \rho^{max}\theta - \text{travel costs}.$$

We denote the marginal consumer privacy type indifferent between website i's high and low quality products by $\bar{\theta}_i$. Clearly,

$$\bar{\theta}_i = \frac{p_i^h - p_i^l}{\rho^{max} - \rho^{min}}$$

and those consumers with low (or even negative) θ prefer the cheaper low privacy option to the more expensive high privacy one. Furthermore, we assume that the range of θ's is sufficiently large to ensure that the equilibrium $\bar{\theta}$ is not a corner solution. Having $\theta_L < \nu - \bar{a}(\frac{1}{2n})$ and $\theta_H > \nu - a(\frac{1}{2n})$ makes sure of that.

Websites compete on both products, taking into account the elasticity of substitution of consumers between the low and the high privacy products. We have total profits of website i

$$\Pi_i = F(\bar{\theta}_i) \int_{-d_i^l}^{d_i^l} (p_i^l + a_i^l(|x|; \rho^{max}))dx + (1 - F(\bar{\theta}_i)) \int_{-d_i^h}^{d_i^h} (p_i^h + a_i^h(|x|; \rho^{min}))dx$$

$$\equiv F(\bar{\theta}_i)\pi_i^l + (1 - F(\bar{\theta}_i))\pi_i^h.$$

These total profits are a weighted average of firm i's per-consumer profits π_i^l on the low-privacy

segment (in which all consumers of type $\theta < \bar{\theta}_i$ will self-select) and profits π_i^h on the high-privacy segment.

In the high privacy segment h the website will target with intensity ρ^{min}. This means that on the high privacy segment, we have perfect matching with probability ρ^{min}, while with probability $1 - \rho^{min}$, the advertiser with the best average match is displayed to the user. The same holds on the low privacy segment with targeting intensity ρ^{max}, so that

$$a_i^h(|x|; \rho^{min}) = \rho^{min}\nu + (1 - \rho^{min})a(|x|), \quad a_i^l(|x|; \rho^{max}) = \rho^{max}\nu + (1 - \rho^{max})a(|x|).$$

Turning next to the optimization over prices, $p_i^{h,l}$, we have first-order conditions

$$\frac{\partial \Pi_i}{\partial p_i^l} = 0 \Rightarrow \qquad \frac{\partial \pi_i^l}{\partial p_i^l} = \frac{f}{F} \frac{\pi_i^l - \pi_i^h}{\rho^{max} - \rho^{min}} \qquad (3)$$

$$\frac{\partial \Pi_i}{\partial p_i^h} = 0 \Rightarrow \qquad \frac{\partial \pi_i^h}{\partial p_i^h} = -\frac{f}{1 - F} \frac{\pi_i^l - \pi_i^h}{\rho^{max} - \rho^{min}}. \qquad (4)$$

Previously, we had only a single segment, and profit optimization per consumer on that segment. Now, we have an additional effect: changing prices on one segment not only leads to gains or loss of consumers to rival websites. It also causes some marginal consumers to switch from low to high privacy segment on the same website, or vice versa. Since these segments generate different profits per consumer $\pi^{h,l}$, this switching will affect price setting by the website: the website wants to reduce the incentives of high privacy consumers to switch to the lower priced, and lower profits, low privacy segment. Without such switching, we had, by proposition 1, $\pi^l < \pi^h$: the high-privacy h market is less competitive. When the two markets are both present, and linked through the marginal $\bar{\theta}$-consumer, we see that in equilibrium

$$\frac{\partial \pi_i^l}{\partial p_i^l} < 0 \qquad \frac{\partial \pi_i^h}{\partial p_i^h} > 0$$

so that $p^h < p^{h*} = t/2 - a(d; \rho^{min})$ and $p^l > p^{l*} = t/2 - a(d; \rho^{max})$, where stars denote the price for a single market with level of targeting ρ^{min} or ρ^{max}, given in equation (2). Hence, high-privacy users benefit from the stronger competition on the low-privacy segment, and vice

versa. We can summarize these effects of the marginal consumer's switching among the two privacy levels in the following proposition.

Proposition 3 *When firms can offer both a high privacy (low targeting at ρ^{min}) product and a low privacy (high targeting at ρ^{max}) product, in the equilibrium with consumer segmentation, high-privacy consumers benefit from the presence of the low privacy market: prices are lower than without this second market. Similarly, prices for the low-privacy product are higher than they would be in the absence of the high-privacy product.*

As a next step, using the first-order conditions, we solve explicitly for the resulting prices, given levels of targeting ρ^{min}, ρ^{max} (proof in the appendix)

Lemma 1 *Equilibrium prices for high and low privacy products satisfy*

$$p^l + a(d, \rho^{max}) = 2td - (\bar{\theta} - \nu + a(d))\Delta\rho(1 - F) \tag{5}$$

$$p^h + a(d^h, \rho^{min}) = 2td + (\bar{\theta} - \nu + a(d))\Delta\rho F, \tag{6}$$

with $d = \frac{1}{2n}$ the distance from the website to its marginal consumer, and $\bar{\theta} = \frac{p^h - p^l}{\rho^{max} - \rho^{min}} = \frac{\Delta p}{\Delta \rho}$ satisfying

$$2td(\bar{\theta} - \nu + \bar{a}(d)) + \frac{F(\bar{\theta})(1 - F(\bar{\theta}))}{f(\bar{\theta})}\Delta\rho(\bar{\theta} - \nu + a(d)) = 0. \tag{7}$$

In particular,

$$\nu - \bar{a}(d) < \bar{\theta} < \nu - a(d). \tag{8}$$

Recall that with a single level of targeting, we had $p + a(d, \rho) = 2td$. From the expressions for prices with different levels of targeting, equations (5),(6), we see that p^l is indeed a higher than when in isolation, and vice versa p^h is lower, since $\bar{\theta} - \nu + a < 0$. This is consistent with proposition 3.

We can now again turn to the regulator's choice of optimal $\rho^{min,max}$. For that, we first use lemma 1 to write down the explicit expressions for profits, total welfare and consumer surplus.

Lemma 2 *Total firm profits, Π, equal*

$$\Pi = 2td + \bar{a}(d) - a(d) - \rho^{max} \int_{\theta_L}^{\bar{\theta}} (\bar{a}(d) - a(d))dF - \rho^{min} \int_{\bar{\theta}}^{\theta_H} (\bar{a}(d) - a(d))dF. \qquad (9)$$

with $d = \frac{1}{2n}$. Total welfare is given by

$$TW = w + \bar{a}(d) + \rho^{max} \int_{\theta_L}^{\bar{\theta}} (\nu - \bar{a}(d) - \theta)dF + \rho^{min} \int_{\bar{\theta}}^{\theta_H} (\nu - \bar{a}(d) - \theta)dF \qquad (10)$$

and consumer surplus

$$CS = w - 2td + a(d) + \rho^{max} \int_{\theta_L}^{\bar{\theta}} (\nu - a(d) - \theta)dF + \rho^{min} \int_{\bar{\theta}}^{\theta_H} (\nu - a(d) - \theta)dF \qquad (11)$$

Now let us explore the combinations of targeting levels ρ^{min}, ρ^{max} that optimize these expressions. In doing so, we have to take into account that changing these targeting levels also changes the marginal consumer's privacy cost $\bar{\theta}$. That changes with $\Delta\rho$ according to equation (7).

First, it is clear from the expression for total profits Π that from the point of view of the websites, banning targeting altogether ($\rho^{max} = 0 = \rho^{min}$) maximizes profits. The reason is similar as before: this maximizes the wedge between the advertising income of the marginal consumer $a(d)$, and the average advertising income exceeds the marginal one, $\bar{a}(d) > a(d)$.

From a welfare point of view, allowing some targeting is always desirable. Consider the derivative of total welfare to the targeting intensity ρ^{max},

$$\frac{\partial TW}{\partial \rho^{max}} = \int_{\theta_L}^{\bar{\theta}} (\nu - \bar{a} - \theta)dF + \Delta\rho(\nu - \bar{a} - \bar{\theta})f(\bar{\theta})\frac{d\bar{\theta}}{d\Delta\rho}.$$

Note that at $\rho^{max} = \rho^{min} = 0$, we have from lemma 1 that $\bar{\theta} = \nu - \bar{a}$ since $\Delta\rho = 0$. Hence, the first term is positive at that point, while the second vanishes. The first-order effect of raising ρ^{max} above zero is therefore positive.

Since $\bar{\theta} < \nu - a$ for any value of $\Delta\rho$, the first integral expression in the corresponding

equation for consumer surplus (11),

$$\frac{\partial CS}{\partial \rho^{max}} = \int_{\theta_L}^{\bar{\theta}} (\nu - a - \theta) dF + \Delta\rho(\nu - a - \bar{\theta}) f(\bar{\theta}) \frac{d\bar{\theta}}{d\Delta\rho}.$$

is always positive and raising ρ^{max} above zero certainly increases consumer surplus. In fact, since $\bar{\theta}$ increases with $\Delta\rho$, it is optimal for consumers to set ρ^{max} equal to one. The reason is that for all consumers opting for the low privacy product, the gain from lower prices outweighs the loss in privacy.

Proposition 4 *Firms optimize their profits when targeting is banned, $\rho^{min} = \rho^{max} = 0$. Total welfare maximization requires positive targeting, $\rho^{max} > 0$. Consumer surplus is maximized by allowing full targeting for the low-privacy segment, $\rho^{max} = 1$.*

We cannot make similar definitive statements on ρ^{min}. Whether raising ρ^{min} above zero can be optimal will depend on the actual distributions of θ and the values of a and $\bar{a}$.

Example Let us consider a uniform distribution of privacy costs $\theta \in [0, B]$. In that case, equation (7) for the relation between the marginal consumer's privacy costs $\bar{\theta}$ and targeting intensity difference $\Delta\rho$ can be written as

$$\Delta\rho = 2td\frac{B}{\bar{\theta}(B - \bar{\theta})} \frac{\bar{\theta} - \nu + \bar{a}}{\nu - a - \bar{\theta}}$$

Maximizing consumer surplus now is equivalent to

$$\max B\rho^{max} \int_0^{\frac{\bar{\theta}}{B}} \left(\frac{\nu - a}{B} - \frac{\theta}{B}\right) d\left(\frac{\theta}{B}\right) + B\rho^{min} \int_{\frac{\bar{\theta}}{B}}^1 \left(\frac{\nu - a}{B} - \frac{\theta}{B}\right) d\left(\frac{\theta}{B}\right)$$

over ρ^{max} and $\Delta\rho$. Note that, as $\Delta\rho$ increases from 0 to 1, $\bar{\theta}$ increases monotonically from $\nu - \bar{a}$ to some intermediate value θ^* between $\nu - \bar{a} < \theta^* < \nu - a$. Hence optimization over $\Delta\rho$ is equivalent to optimization over the fraction of low privacy consumers $\frac{\bar{\theta}}{B} \in [\frac{\nu - \bar{a}}{B}, \frac{\theta^*}{B}]$.

By proposition 4, we have that $\rho^{max} = 1$ in the optimum. Writing $\rho^{min} = 1 - \Delta\rho$, and

normalizing to $B = 1$, we need to optimize

$$\tilde{CS} = -\Delta\rho(\bar{\theta}) \int_{\bar{\theta}}^{1} (\nu - a - \theta)d\theta.$$

It is convenient to do the equivalent maximization with respect to $\bar{\theta}$ (over the range $[\nu - \bar{a}, \theta^*]$), rather than over $\Delta\rho$ itself. Taking the derivative gives

$$\frac{d\tilde{CS}}{d\bar{\theta}} = -\frac{d\Delta\rho}{d\bar{\theta}} \int_{\bar{\theta}}^{1} (\nu - a - \theta)d\theta + \Delta\rho(\nu - a - \bar{\theta}).$$

The second term is always positive. For the first, it depends on the sign of the integral. If $\nu - a$ is large, so that there are large benefits of targeting, the optimum will be at $\Delta\rho = 0$, i.e. $\rho^{min} = 1$ as well. Conversely, if $\nu - a$ is small, the optimum consumer surplus will be attained at $\Delta\rho = 1$, with $\bar{\theta} = \theta^*$. In that case, consumer surplus is maximized by having a full privacy product, $\rho^{min} = 0$.

5. Conclusions

In this paper we explored the interaction between competition among internet platforms and the degree of ad targeting they use. More targeting implies stronger competition. Yet, since firms cannot commit to low targeting intensity, they are caught in a prisoners' dilemma: each firm individually benefits from increased targeting. In the equilibrium, firms will therefore drive up targeting. On the one hand, this reduces consumer prices, because of improved matching of consumers with advertisers. However, if consumers dislike the loss of privacy that is a consequence of targeting, privacy policy can lead to better outcomes than the laissez-faire outcome. In that case, also firms can benefit from the less intense competition that goes with this commitment to privacy protection.

In practice, consumers are heterogeneous in the costs they associate with loss of privacy. By allowing websites to offer multiple products, differing in the degree of targeting and price they

offer, welfare can be increased. In this case, even those consumers that opt for the high privacy (and low targeting) product benefit: their prices are reduced as a result of the endogenously higher competition on the low privacy market segment.

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A. Proof of lemma 1

On each segment h, l we have per consumer profits for firm i:

$$\pi_i^{l,h} = \int_{-d_i}^{d_i} dx (p_i^{l,h} + a_i^{l,h}(|x|, \rho)) = 2d_i(p_i^{l,h} + \bar{a}_i^{l,h}(d_i, \rho))$$

and the derivative,

$$\frac{\partial \pi_i^{l,h}}{\partial p_A^{l,h}} = 2d_i - \frac{1}{t}(p_A^{l,h} + a_A^{l,h}(d_i, \rho)).$$

Now, substituting into the first-order conditions for low and high prices, equations (3,4), we get in the symmetric equilibrium with $d_i = d = \frac{1}{2n}$,

$$\frac{\partial \pi_i^l}{\partial p_i^l} = 2d - \frac{1}{t}(p^l + a^l(d)) = \frac{f}{F\Delta\rho}2d(p^l - p^h + \bar{a}_l - \bar{a}_h)$$

$$\frac{\partial \pi_i^h}{\partial p_i^h} = 2d - \frac{1}{t}(p^h + a^h(d)) = -\frac{f}{(1-F)\Delta\rho}2d(p^l - p^h + \bar{a}_l - \bar{a}_h),$$

and subtracting these, we find the condition for the privacy costs $\bar{\theta}$ of consumer who is indifferent between high and low privacy products,

$$2td\left(\bar{\theta} - \nu + \bar{a}\right) + \frac{F(1-F)}{f}\Delta\rho\left(\bar{\theta} - \nu + a\right) = 0.$$

Here we used that $p^h - p^l = \bar{\theta}\Delta\rho$, and $a^h = \rho^{min}\nu + (1 - \rho_{min})a$, $a^l = \rho^{max}\nu + (1 - \rho_{max})a$, with $\Delta\rho = \rho^{max} - \rho^{min}$.

From that condition for $\bar{\theta}$, and $\bar{a} > a$, it directly follows that

$$\nu - \bar{a}(d) < \bar{\theta} < \nu - a(d).$$

Next, we solve for p^h and p^l separately by adding both first-order conditions:

$$2td - F(p^l + a^l(d)) - (1 - F)(p^h + a^h(d)) = 0.$$

from which equations (5,6) follow upon using that $p^h - p^l = \Delta\rho\bar{\theta}$ and $a^h - a^l = -\Delta\rho(\nu - a)$.

$Q.E.D.$

Annex

The Internet advertising industry: market structure, technology, and growth statistics

This annex provides auxiliary information on the Internet advertising industry: market structure, business model, targeting technologies, performance criteria, payment structures, main welfare aspects, and recent market trends.

The online advertising market is in fact a cluster of sub-markets in which the following players operate:

- *Product sellers*: firms that buy the services of advertising firms to promote their product;
- *Web publishers:* firms offering online information content to general public (e.g. news, journals, weather, porn, financial information, restaurants, research), either free or behind a paywall. These web publishers earn additional revenue from offering space to advertisements. Also social networking media like Facebook, LinkedIn and Twitter participate in this business.
- *Online advertising networks*: firms that sell online advertising services, and that commercially intermediate between web publishers and product sellers. This is a heterogeneous group that comprises of:
  - t*raditional advertising and marketing conglomerates*: firms that have developed branches for online advertising.[1] Mostly they operate through multiple advertising media (newspapers, journals, other forms of printed material, billboards, Internet, video, mobile advertisement messages).
  - *Network search intermediaries* like Yahoo!, Google, Facebook, and Bing have joined online advertising by setting up advertising subsidiaries themselves after 2000.[2] For instance, Google has organised its online advertising business through subsidiaries like DoubleClick, AdMob, Adsense, and Adwords.[3]
- *Auxiliary advertising services*: firms that operate in the value chain of online advertising by offering specialist services that enable more effective customer targeting (B2C, B2B) by the advertising networks:
  - *Advertising and data exchanges*: An 'ad exchange' is an auction-based marketplace where sellers or advertising networks can bid to place advertisements in the space offered by websites. A 'data exchange' is a marketplace where advertisers bid for access to data about customers. The data can be that collected through the tracking and tracing of users' online activities and/or from offline sources (e.g. national statistics, census data, etc.).
  - *Data brokers*: Firms that gather, merge and sell aggregated information on individual persons or firms. Part of their data may stem from public records and registries (e.g., census data, real estate records, vehicle registration, phone books, etc.). Other data are bought from third parties like network search intermediaries. By combining these data they offer profiles for individual firms and individuals, or for consumers and firm matching particular selection characteristics. The profiles may comprise simple items like residential address, phone, email address, but also much more

private identifiers like age, gender, race, income range, social security numbers, employment background, debtor history, health data, court and police records.[4]

- o *Tracking companies.* Specialist firms (other than the well-known search engines) that collect behavioural data of Internet users and sell these tracking data commercially. When a user visits a website, tiny tracking files (cookies) watch what they do and develop a profile of the user's behaviour. Often, a tracking company will sell this information directly to advertisers. Some also sell the tracking data to data brokers through a data exchange. The unique identification code embedded in cookies on the user's computer or handheld device allows advertisers to target advertisements to firms or individuals (cf. Angwin and McGinty, 2010; Reimbach-Kounatze, 2013).
- o *Business analytics and profiling firms*, like SAS Institute. Some web intermediaries with search engines also have this function. They use draw available public, legally obtainable data about firms or individuals, and some times combine this with inferred data derived from search behaviour to construct profiles of firms and individuals (their preferences, business behaviour, etc.), which are then offered for sale to third parties like advertising networks.

Of special interest for this research project is the position of web-search intermediates in the online advertising business. The general public only knows Google, Yahoo, Bing, Facebook, Twitter, and other web-search operators from the search and network platform functions they offer for free. Few of them realise that their real business is advertising as Table 1 shows for Google's revenue structure. Also Yahoo, Twitter and Facebook basically are advertising networks.[5]

Table 1   Google revenue structure

		2010	2011	2012
Advertising revenues:				
Google websites	$	19,444	26,145	31,221
Google Network Members' websites		8,792	10,386	12,465
Total advertising revenues		28,236	36,531	43,686
Other revenues		1,085	1,374	2,353
Total Google revenues (advertising and other)	$	29,321	37,905	46,039
Other:				
Motorola Mobile revenues (hardware and other)		0	0	4,136
Total revenues	$	29,321	37,905	50,175

Note: a) Data for Year Ended December 31. Google domestic and international revenues as a percentage of Google revenues, determined based on billing addresses of customers for Google business. Source: Google Inc. Annual Report 2012 (Form 10-K, deposited at US Securities and Exchange Commission, Washington), pp.32 and 34.

Table 2 supplies information on the profitability of the four largest Internet-search and social-networking firms commercial returns. Google and Yahoo are most successful when measured by return on capital and sales margin. Yahoo appears to be extremely profitable; the main reasons is that Yahoo's costs are substantially lower. An important difference with Google is that Yahoo's fixed and R&D investments are substantially smaller. Google has large data storage centres, other fixed investments (e.g. participation in trunk connection lines) and more than $6 billion investments in R&D in 2012.

Table 2 Mixed profitability of Internet-search and social-media intermediates, 2012

	unity	Google	Yahoo	Facebook	Twitter
Sales revenue	million USD	46000	4986	50100	310
Stockholders equity	million USD	71700	14560	11800	759
Net income after tax	million USD	10700	3945	53	-70
Margin on sales	%	23.3	79.1	0.1	-22.6
Return on equity	%	14.9	27.1	0.4	-9.2
Sources: latest Annual Reports (10-K forms, SEC), financial press.					

Facebook had its IPO in 2012, and Twitter in Autumn 2013. Despite the increased role of stockholders, Table 2 indicates that Facebook and Twitter have a profitability problem. To keep their stockholders satisfied they might feel obliged to raise future advertisement intensity on their networking platforms. Legal class actions by Facebook users show that this strategy may become difficult (e.g. Kuchler, 2014). It stands to be seen whether this business model is feasible for both Facebook and Twitter.

Business model in online advertising

The advertisement ('ad') industry is hired by sellers to increase product sales. Consumers differ in their individual reservation price for goods and services. This reservation price in its turn is based on their (only partly observable) individual preferences and knowledge. Apert from this there are non-structural buying triggers that depend on the consumer's real-time situation and needs (e.g. hunger, thirst, current activity). So actual buying decisions depend on the consumer's structural situation and his real-time contextual situation:
- structural: disposable income, desire for the good (long term aspects, e.g. status goods), information about substitute goods, the prices of the good and its substitutes.
- real-time, contextual situation: short-term needs (e.g. hunger, thirst, need for shelter, medical needs), current preoccupation (present activity, search), social context, time of the day, geospatial location, local and social buying triggers (e.g. seeing the consumption of others).

Finding out these buying triggers and and influencing them is the key service that the online advertising industry delivers to their commercial clients.

The online advertising industry provides is innovative in the type of information triggers they use to persuade potential customers into effectively buying the product. Three types of triggers are used.
- The technology provided by online search intermediates made it possible to get a much better idea of the potential customers and their preference structure. The potential customers indirectly reveal their preferences by their web queries, and using this information allows the advertising firms to target much more efficiently which individuals or firms are likely to be interested in the product that they are trying to sell. This allows to target more precisely on these clients, and show them targeted information triggers on the basis of which they might upwardly revise their reservation price. What used to be a latent, unobservable variable only known to the consumer

himself is now increasingly becoming 'visible' via statistical analysis of the consumer's own web behaviour.

- A second determinant in the buying decision is the 'impulse' factor which in the past used to be almost completely invisible for advertisers. On the basis of the potential customer's web behaviour, web intermediates and tracking firms nowadays have more possibilities for determining what time it is for the customer, where he/she is at the moment, and what (web-related) activities he/she is engaged in. Large online advertisers like Google are now able to use this information in real time to create highly targeted information triggers that may appeal to the consumer's 'impulse' factor.
- A third element of information triggers comes from *re-targeting*. This is the identification of potential customers that have at least once shown their interest for a particular product. Such (apparently) hesitating consumers receive highly targeted sales triggers to influence their buying decision variable.

The prime performance criterion for the advertising industry from the perspective of the sellers is the *conversion rate.*, i.e. the relation between the actual buying decision and the information trigger provided by the advertising firm. An old dream of the marketing industry has been to develop interactive marketing, in which the information triggers (to buy products) can be tailored to individual preferences, thus increasing the likelihood of positive buying decisions of potential customers.[6]

Online consumer targeting technology

Particularly since 2000, the technology of online advertising, consumer targeting and finding out individual preferences of potential customers has made revolutionary progress. Advertising has developed from undifferentiated, general-purpose publicity campaigns to tailored, individualised information triggers. The technological change in consumer targeting can be described in five steps.

A. Newspaper-like targeting. The online advertising industry has started immediately after the Internet was opened for commercial participants in 1992. Advertisers buy space on the websites of other parties to show information about their own brands or products. Consumer targeting is relatively crude, and the initial method used was more or less the same for newspaper, TV, radio and the Internet. The basis for consumer targeting is formed by the advertiser's own knowledge or guesses about the preferences of their potential clients (socioeconomic category, age, gender, family status). On this basis the advertiser makes choices as to (a) the content medium (like newspaper, TV channel, website) where the advertising is launched, and (b) the form of the advertisement. Online advertisers place their display ads on websites they expect to be regularly visited by their clients. Advertisements initially mostly had a 'banner' or 'pop-up' character, soon followed by click-through links to the product seller's own website. This type of consumer-preference targeting is quite unspecific, because once the medium has been chosen, the advertisement has a one-size-fits-it-all character.

B. Keyword-based targeting. A next phase in targeting arose around the year 2000 when web-search intermediates gained importance due to the explosion in web-content sites. The position of the search intermediates in the advertising value chain changed drastically. Their position gradually changed from passive suppliers of advertising space from advertisers to active creators of advertising demand. This went together with technological changes. A first step was the introduction of "sponsored search", a form of covert advertising. In 'sponsored search' the web intermediates offers advertisers the possibility to be included in the results of a search for selected and specified search keywords (Jansen and Mullen, 2008; Batelle, 2005). That may be an advertisement popping up alongside the search results, or it can be a higher ranking of the advertiser in the display of the search results. Web intermediates soon started to use auctions to sell such keyword-linked advertising options. GoTo.com created the first sponsored search auction, and Google's sponsored-search auction took place in 2002 (Fain and Pedersen, 2006).[7] Search engines like Google, Yahoo and Bing presently generate substantial revenues from auctioning off their add spaces (e.g. Koh, 2013). Google's AdWords market is an auction where businesses place bids for individual keywords, together with limits specifying their maximum daily budget. The search engine company earns revenue from businesses when it displays the product seller's ads in response to a relevant search query (if the potential customer actually clicks on the ad).

This form of consumer targeting is still fully based in the knowledge base of the advertisers (his choice of tagged keywords), but targeting is much more specific than 'newspaper-like' targeting. Due to the added services and the auction, the role of the search intermediate in the value chain has increased. Smart algorithms ensure that the search intermediate's revenues are maximised by striking an efficient balance between the advertiser's budget and the consumer's search action (e.g. Mehta, 2011). The consumer may not be aware that the ranking of the search results that he obtains is in fact a form of covert advertising (cf. Table 3). Search diversion is evident if one looks for a specific hotel or air flight through Google. Direct links to the particular flight or hotel often can only be found after pages of links to commercial booking sites, which achieved display priority after paying the web intermediate for this service.

Table 3   Open and covert forms of online advertising

Delivery forms	Description
Open advertising	
Pop-ups/pop-unders	A pop-up ad is displayed in a new web browser window that opens above a website visitor's initial browser window. A pop-under ad opens a new browser window under a website visitor's initial browser window.
Floating ad	A floating ad, or overlay ad, is a type of rich media advertisement that appears superimposed over the requested website's content. Floating ads may disappear or become less obtrusive after a preset time period.
Expanding ad	An expanding ad is a rich media frame ad that changes dimensions upon a predefined condition, such as a preset amount of time a visitor spends on a webpage, the user's click on the ad, or the user's mouse movement over the ad. Expanding ads allow advertisers to fit more information into a restricted ad space.
Trick banners	A trick banner is a banner ad where the ad copy imitates some screen element users commonly encounter, such as an operating system message or popular application message, to induce ad clicks. Trick banners typically do not mention the advertiser in the initial ad, and thus they are a form of bait-and-switch. Trick banners commonly attract a higher-than-average click-through rate, but tricked users may resent the advertiser for deceiving them.
Interstitial ads	An interstitial ad displays before a user can access requested content, sometimes while the user is waiting for the content to load. Interstitial ads are a form of interruption marketing.

Text ads	A text ad displays text-based hyperlinks. Text-based ads may display separately from a web page's primary content, or they can be embedded by hyperlinking individual words or phrases to advertiser's websites. Text-based ads often render faster than graphical ads and can be harder for ad-blocking software to block.
Covert advertising	
Sponsored search	Sponsored search (also called sponsored links or search ads) allows advertisers to be included in the sponsored results of a search for selected keywords. Modern search engines rank sponsored listings based on a combination of bid price, expected click-through rate, keyword relevancy, and site quality.
Search Engine Optimization	Search Engine Optimization, or SEO, attempts to improve a website's organic search rankings in SERPs by increasing the website content's relevance to search terms. Search engines regularly update their algorithms to penalize poor quality sites that try to game their rankings, making optimization a moving target for advertisers.
Search Engine Marketing	Search Engine Marketing, or SEM, is designed to increase a website's visibility in search engine results pages (SERPs). Search engines provide sponsored results and organic (non-sponsored) results based on a web searcher's query. Search engines often employ visual cues to differentiate sponsored results from organic results. Search engine marketing includes all of an advertiser's actions to make a website's listing more prominent for topical keywords.
Adware	Adware is software that, once installed, automatically displays advertisements on a user's computer. The ads may appear in the software itself, integrated into web pages visited by the user, or in pop-ups/pop-unders. Without the consumer's consent this should regarded as malware.
Sources: Wikipedia (lemma 'Online Advertising', retrieval: August 2013); PWC-IAB France-SRI (2010).	

C. Contextual targeting (without history). This is a form of advertising that ensures that ads pop up right beside search results or website content that relates to the advertiser's product or service. The prime contextual targeting elements are still the keywords of the search, but the search intermediary uses his own statistical analysis to detect statistical links between keywords (cf. Heaven, 2013), so that the probability and efficiency of hitting the consumer's real preferences increase.[8] A further targeting element that the search intermediate adds information on language, the geo-location, time zone (linked to IP address or routing information), and the real day time at the searcher's location. These targeting elements further increase the likelihood of identifying the searcher's willingness to buy at a given time and location. A controlled biometric study by Yahoo assessed that adding personal and contextual relevance strengthens the impact of online ads. They found that ads which combine both personal and contextual relevance may very fast draw attention, achieve more and longer eye fixation, and get more positive emotional response and cognitive processing (Marlowe and Levine, 2011).

Though the advertiser is still the one who selects the keywords, the share of the search intermediate in targeting the consumer's actual preferences has increased. Network-search intermediates like Google do comprehensive research on the relation between individual keywords (e.g. Levy, 2011). This means that they often know better than the product seller what keyword combinations are best for generating extra advertisement incomes. They sell this knowledge to the product sellers or their advertising firms, thus increasing their share in the value chain of online advertising (compared to targeting technology B).

D. Contextual targeting with a historical user profile. One step further in consumer-preference targeting is achieved if the search intermediate uses the individual consumer's *past* searches as an input for a better contextual interpretation of a *current, real-time* search action. The historic profile is used to improve the personal-relevance component of targeting, thereby possibly increasing the consumer's reservation price for a specific products. Such

exploitation of 'big data' by the search intermediary will further enhance the efficacy of the ad. The extra services go beyond what most individual advertisers could ever hope to achieve themselves with respect to consumer targeting.[9] The intermediaries' share in the advertising value chain is likely to further increase due to this type of targeting services.

E) Re-targeting or re-messaging. This further step in targeted advertising is fully based on a consumer's search behaviour in the past. A consumer's earlier interest in a particular product or product group is used to re-target them afterwards with directed advertisements. According to industry observations, some 90% of visitors to E-commerce websites leave these websites without actually making a purchase (Antarieu et al. (2010). The intermediates register such patterns, because they form a signal that the visitors are potentially interested consumers, and such valuable information can be sold to advertisers.

Specialisation in online advertising industry

The online advertising industry is subject to specialisation in the value chain between consumer and product sellers. A growing share of the online advertising market is applying behavioural targeting (i.e. types C, D, E). In the USA the expenses for behaviourally targeted advertisements were estimated at US$ 925 million in 2009, which would be about 5% of total online ad revenues.[10]

The auxiliary firms in the online advertising chain like specialist online tracking firms have displayed strong growth during the last few years. Evidon (2013) identified 1300 different firms that specialise in tracking traffic to and from particular websites in 2013. In the USA the average number of trackers deployed per website amounts to 9, in the UK 8.4, in The Netherlands 7.4 , and 5.9 in China.[11] The trackers can be split in four categories depending on their tracking specialisation (cf. Table 4).

Table 4 Types of tracking firms that collect data on traffic to and from particular websites, 2013

| Type	Activity	Examples	Average speed of tracking action in milliseconds a)	Average share in total worldwide tracker count
Ad scripts	Deliver ads and track website users for future ad delivery	Google Adsense, DoubleClick (Google), Quantcast, Google Adwords Conversion, Microsoft Atlas	534.1 ms	46%
Analytic scripts	Provide data to website owners about their audience	Google Analytics, Omniture, Stacounter	510.1 ms	22%
Behavioural trackers	They segment users for ad and content targeting	Rambler, DoubleClick Floodlight (Google), eXelate,BlueKai	526.6 ms	21%
Page widgets	Collect data from users while providing some function to the user (e.g. via apps)	Facebook Connect, Facebook Like Button, Google +1, Twitter Button, AddThis, LiveInternet, Twitter Badge, ShareThis, Tumblr, AdFox	542.0 ms	11%
Note: a) Action speed is measured in latency (milliseconds of time required for retrieving main tracking information on traffic between source and destination). Source: Evidon, Global Tracker Report (March 2013).				

Slightly less than half of all trackers concentrate on delivering ads and track users for future ad delivery. One-fifth of all trackers is in the business of behavioural tracking, i.e. classifying web users for future ad and contents targeting. The trackers typically gather their information in - on average- about half a second. However, further evidence by Evidon (2013) shows that in particular the Google-owned trackers can do it in less than 200 milliseconds, which is probably a big competitive advantage in contextual and keyword targeting.

Trends in online advertising markets

The growth of the US Internet advertising market is depicted in Figure 2 by the quarterly Internet advertising revenues. The figure displays an overall growth that was mildly interrupted by the 2002-3 "dotcom crisis" and more harshly by the 2008-10 financial crisis.[12] after the demise of Lehman Brothers. In the 4th quarter of 2012 the US revenues in online advertising for the first time topped the $10 billion mark (IAB-PWC, 2013).

Figure 2   Development of US Internet advertising market, measured by quarterly revenues, 2001-2012
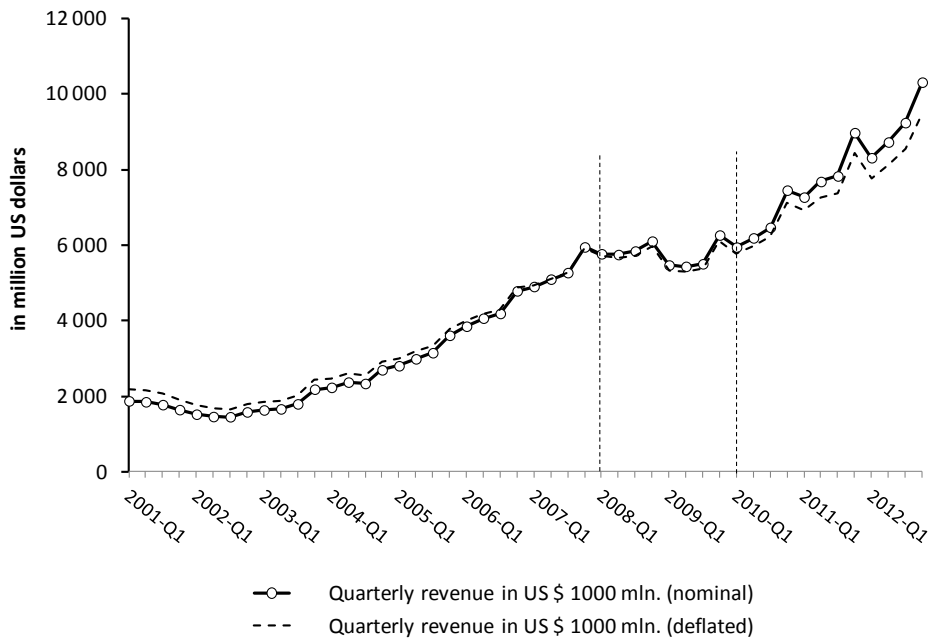
Data sources: Interactive Advertising Bureau/ PWC (2013); GDP deflator data (2007=100): Federal Reserve Bank of St. Louis.

Table 5 depicts the different forms that online advertising may take. The Interactive Advertising Bureau predicts continued growth in mobile advertising with the adoption of location-based targeting and other technological features not available or relevant on personal computers. Industry groups such as the Mobile Marketing Association have attempted to standardize mobile ad unit specifications, similar to the IAB's efforts for general online advertising. Mobile advertising is growing rapidly for several reasons. There are more mobile devices in the field, connectivity speeds have improved (G3-G4 networks), screen

resolutions have advanced, mobile publishers are becoming more sophisticated about incorporating ads, and consumers are using mobile devices more extensively.

Table 5   Different media for online advertising

Type of online medium	Description
Mobile Advertising	Mobile advertising is ad copy delivered through wireless mobile devices such as smartphones, feature phones, or tablet computers. Mobile advertising may take the form of static or rich media display ads, SMS (Short Message Service) or MMS (Multimedia Messaging Service) ads, mobile search ads, advertising within mobile websites, or ads within mobile applications or games (such as interstitial ads, "advergaming," or application sponsorship).
Social media marketing	Social media marketing is commercial promotion conducted through social media websites. Many companies promote their products by posting frequent updates and providing special offers through their social media profiles.
Email Advertising	Email advertising is ad copy comprising an entire email or a portion of an email message. Email marketing may be unsolicited, in which case the sender may give the recipient an option to opt-out of future emails, or it may be sent with the recipient's prior consent (opt-in).
Affiliate Marketing ('lead generation')	Affiliate marketing (sometimes called lead generation) occurs when advertisers organize third parties to generate potential customers for them. Third-party affiliates receive payment based on sales generated through their promotion.
Online classified advertising	Online classified advertising is advertising posted online in a categorical listing of specific products or services. Examples include online job boards, online real estate listings, automotive listings, online yellow pages, and online auction-based listings. Craigslist and eBay are two prominent providers of online classified listings.
Sources: Wikipedia (2013); Antarieu et al. (2010).	

The share of Internet in the total advertising market has steadily increased over other advertising media such as broadcast TV, newspapers, cable TV and radio. Figure 3 pictures for the USA the share of different media in total advertising revenues over the period 2005-2012.[13] The annual market growth rates of Internet as advertising media have outpaced other advertising media, although also Cable TV (local and national networks) had a positive growth of its market share over the observation period. The market share of newspapers as advertising outlet has steadily decreased. A possible reason from the perspective of advertisers is that newspapers perform worse in targeting their advertisements.

Until recently, overall Internet traffic used to be transmitted through fixed lines (copper, fibre optics), but the share of mobile Internet access through handheld devices is rapidly growing. This is also reflected in the growth of advertisement revenues related to mobile Internet (cf. Table 6). North America and the Asia-Pacific region together represent 80% of the market for online Internet advertising, with growth rates especially strong in North America.[14] Europe accounts only for about one-sixth of the global market for mobile Internet advertising.

Figure 3   Market share (%) per advertising medium in total US advertising market (revenue-based), 2005-2012
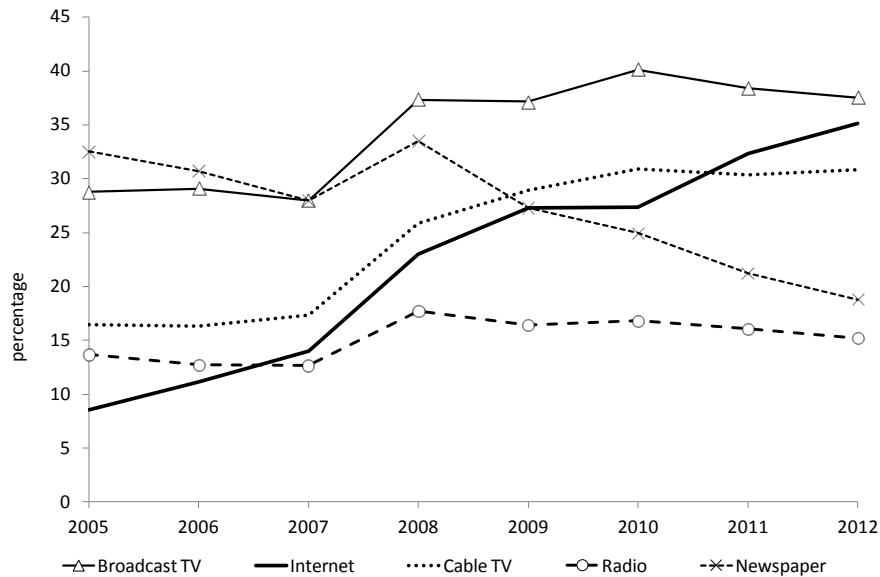
Source: calculated on the basis of data of Interactive Advertising Bureau/ PWC (2013).

Table 6   Estimated mobile advertising revenues (in million Euros), by region, 2011-2012

By region	2011	2012	Change %
Asia-Pacific	1732	2769	60
North America	1302	2743	111
Western Europe	610	1167	91
Central Europe	51	87	71
Middle East & Africa	50	85	70
Lat. America	23	39	70
Total	3768	6890	83
Source: Knapp et al. (2013)			

For mobile advertisements three advertisement 'technologies' may be distinguished:
- search-related targeted advertisements: advertisers pay online companies to list and/or link the advertiser's company site domain name to a specific search word or phrase;
- display ads: the advertiser pays an online company for space on one or more of the online company's web pages to display a static advertisement, banner or logo;
- advertising through text messaging services, tailored to be delivered through wireless mobile devices such as smartphones and media tablets.

In Western Europe 60% of all mobile advertisement revenues is estimated to be related to search-related ads, and this share is higher than in North America or the Asia-Pacific region (cf. Figure 4). In Central Europe, the Middle East and Latin America, messaging services still form a substantial source of mobile advertisement revenues.

Figure 4   Decomposition of regional mobile advertising revenues by type of advertisement, 2012
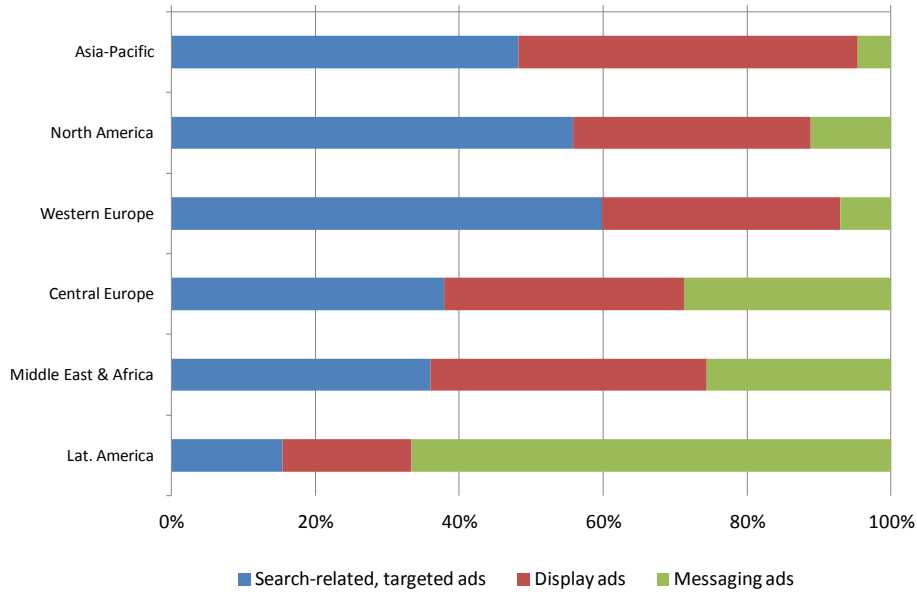
The largest part of total online ad revenues is related to search-based advertising, followed by traditional advertisements where the advertiser's banner, logo or ad text is displayed (cf. Figure 5).[15] In dynamic terms, the growth of online ad revenues was strongest in ads for mobile devices (share went up from 5% in 2011 to 9% in 2012).

Figure 5   Market revenues by online advertisement format, USA 2012 (share in %)
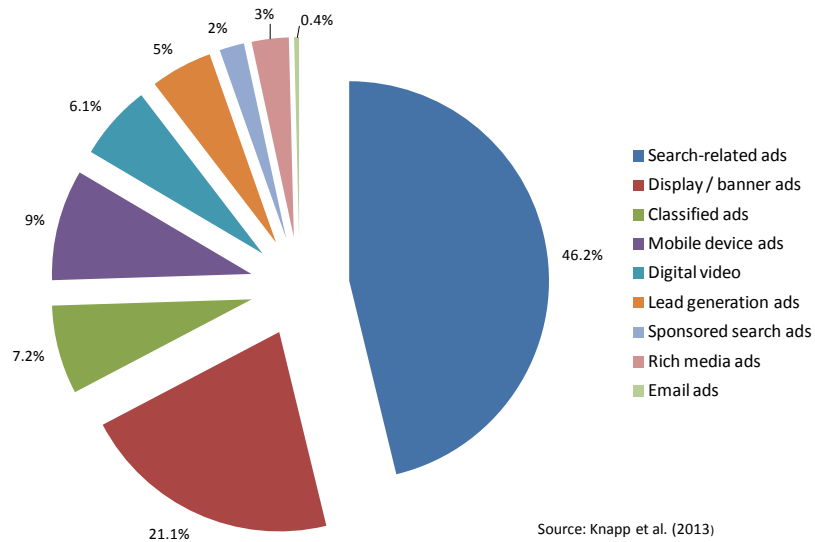
Payment models in online advertising

The growth of the online advertising industry has brought dynamic changes in the relations between product sellers, advertising firms and website owners. One element of the changes is the incentive structure of the advertising contracts. It has led to new types of contract models:

- *no cure, no pay*: the advertiser receives a fee for advertising that results in a positive buying decision. The problem in this contract type is the attribution of new customers; are they only the result of the online advertising or are still other factors at play?
- *mixed payment systems*: advertising network is paid for each click-through to the product seller's website (*pay per click*), or for the number of times that a banner has been displayed to web-site visitors (*pay per view*). Both '*pay per click*' and '*pay per view*' can be based on website statistics nowadays.[16]

The online advertising markets has a heterogeneous structure. The intermediaries' revenues come from the third-party E-commerce sites (advertisers), which typically pay fixed fees proportional to the number of consumer visits (per click) or to the total value of sales generated. There are several forms of payment and incentive systems running alongside each other. Here are some of the most popular payment systems:

- *Cost per Mille (CPM)*, or "*Cost per Impression*": compensation system in which advertisers pay a fee to the search intermediary for every thousand displays of their advertisement/message to potential customers. This form of compensation is gradually losing popularity because it is susceptible to fraud as many incidents show.[17]
- *Cost per Click (CPC)*: advertisers pay the publisher (typically a website owner) when the ad is clicked. compensation system in which advertisers pay a fee to the search intermediary each time a user clicks on the advertisement. This form of measurable performance has become more popular over the years (cf. Figure 6). Pay per click (PPC) (also called cost per click) is an It is defined simply as "the amount spent to get an advertisement clicked."[1]
- *Other performance-based compensation systems* are 'Cost per Action' (also called 'Cost per Acquisition') and 'Pay per Performance' (PPP). These system imply that the advertiser pays for the number of potential customers that perform a desired action.

**Figure 6   Development of pricing models in market for online advertising, USA 2012**
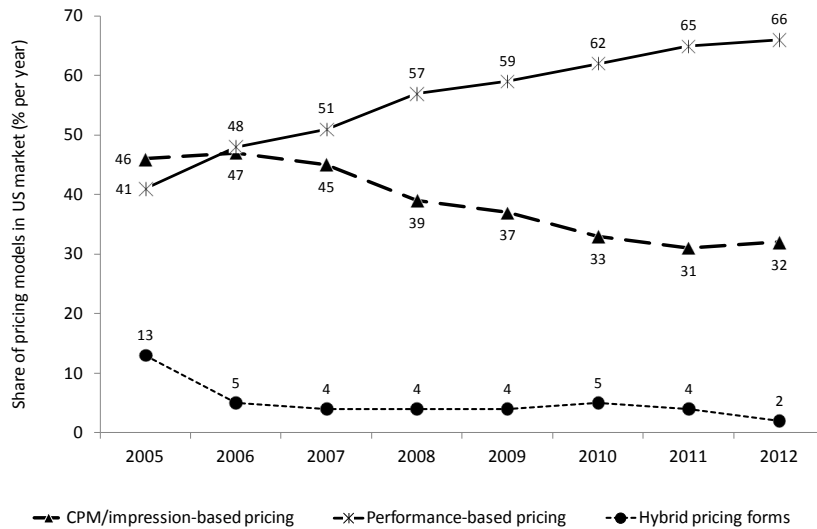
The highest placed advertisement-links generally collect more clicks than those place at the lower positions. This score performance per link is measured by the so-called 'click-through rate'. The most common type of auction is generalised second-price, shortly GSP, which means that each advertiser bids on the 'per-click' price of the link, and his total payment to the search intermediary is the 'per click' price multiplied by the 'click-through rate'. It is enlightening how Google advertises its own advertisement space and keyword-linked search ranking:

> "*AdWords gives you control over your advertising costs. There's no minimum amount that you have to spend. You set an average daily budget and choose how you'll spend your money. Go to your account at https://adwords.google.com to see full reports of your advertising costs and billing history anytime. Every time someone searches on Google, AdWords runs an auction to determine the ads that show on the search results page, and their rank on the page. To place your ads in this auction, you first have to decide what type of customer action you'd like to pay for. For example, you might choose to pay for the following actions:*
> *1. **The number of times your ad shows.** This is known as a cost-per-thousand-impressions, or CPM, bid. We recommend the CPM bidding method if you want to increase awareness of your brand. Note that CPM bidding is available for Display Network campaigns only.*
> *2. **Each time one of your ads receives a click.** This is known as a cost-per-click, or CPC, bid. We recommend the CPC bidding method if you want to drive traffic to your website.*
> *3. **Each time people take a specific action on your website after clicking on one of your ads.** This is known as a cost-per-acquisition, or CPA, bid. We recommend the CPA bidding method for seasoned AdWords advertisers who are interested in conversions, like purchases or signups. These are called your bidding options. Most people starting out in AdWords use the basic **CPC bidding** option, which means they accrue costs based on the number of clicks they get on their ads. If you use this option, the amount you're charged per click depends in part on the maximum cost-per-click bid you set in your account, also called maximum CPC bid. This represents the highest amount that you'll ever pay for an ad click (unless you're setting bid adjustments, or using Enhanced CPC). In fact, you'll be charged only the amount necessary to keep your ad at its position on the page (including any applicable service fees that may apply to Display Network campaigns).*"[18]

The market for online advertising services is a multisided market with a high concentration of market shares. Figure 7 indicates that in the USA only 10 firms accounted for almost three quarters of all revenues in 2012.

Figure 7   Market concentration: share (%) of total revenues from selling online advertising, USA 2012
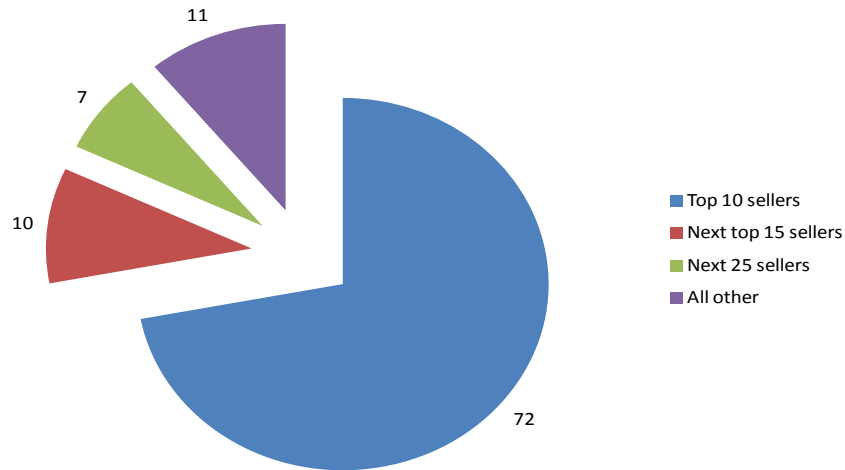
Source: Knapp et al. (2013)

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Endnotes

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[1] With conglomerate firms like WPP Group, Publicis Omnicom Group, Young & Rubicam, Saatchi & Saatchi, BBDO, McCann, Dentsu, Havas, and Interpublic.

[2] Cf. Batelle (2005); Jansen and Mullen (2008); Levy (2011).

[3] The Google 2012 Annual Report describes the relationship between Adwords and Adsense: *"The goal of AdWords, our primary auction-based advertising program, is to deliver ads that are so useful and relevant to search queries or web content that they are a form of information in their own right. With AdWords, advertisers create simple text-based ads that then appear beside related search results or web content on our websites and on thousands of partner websites in our Google Network, which is the network of third parties that use our advertising programs to deliver relevant ads with their search results and content. [..] Our AdSense program enables websites that are part of the Google Network to deliver ads from our AdWords advertisers that are relevant to the search results or content on their websites. their websites."*

[4] Large data brokers are LexisNexis (mainly B2B business background checks), Experian (focus on credit information), Acxiom, Accurint, Everify, Graydon (Netherlands, mainly in creditworthiness checks). More specialist data brokers such as LocatePeople.org, MelissaData.com and 123people.com provide localisation data like personal addresses, email addresses and phone numbers (cf. Reimsbach-Kounatze et al., 2013). Illustrative is data broker Everify.com (see: www.Everify.com). The firm advertises with instantaneous background checks for individual persons in the USA, providing data on name, phone numbers, birth date, criminal and court records (lawbreaking activities, sex offences, law suits), bankruptcies, marriage/divorce records, property ownership, address history, names of relatives and associates. Price: $19.99 for a simple profile. On top of this you may obtain (for an additional price) data from Everify's *Deep Web Search* tool, which scans further information on a person by searching social media; this would yield photos, videos, blogs, professional interests, social networking profiles, archives and publications.

[5] Yahoo's Annual Account 2012 (Form 10K, SEC, p.3) states its business as: "*We create value for advertisers and their brands by connecting them with targeted audiences of users through their daily habits. Advertisers can build their businesses through advertising to these targeted audiences on our online properties and services ("Yahoo! Properties"), or through our distribution network of third-party entities ("Affiliates") who integrate our advertising offerings into their Websites or other offerings (those Websites and other offerings, "Affiliate sites"). We generate revenue principally from display advertising on Yahoo! Properties and some Affiliate sites and from search advertising on Yahoo! Properties and Affiliate sites. Additionally, we generate revenue from other sources including listings-based services, facilitating commercial transactions, royalties, and consumer and business fee-based services*". In 2012, 81% of Yahoo!'s worldwide revenues came from online display and search advertisements (Form 10K, p.110). Facebook and Twitter had sales revenues of, respectively, about $5 billion and $310 million in 2012, mainly from advertising. Facebook states the following about its advertisement business: "*Advertising revenue is generated by displaying ad products on the Facebook website or mobile app and third-party affiliated websites or mobile apps. The arrangements are evidenced by either online acceptance of terms and conditions or contracts that stipulate the types of advertising to be delivered, the timing and the pricing. Marketers pay for ad products either directly or through their relationships with advertising agencies, based on the number of impressions delivered or the number of clicks made by our users. The typical term of an advertising arrangement is approximately 30 days with billing generally occurring after the delivery of the advertisement. We recognize revenue from the delivery of click-based ads in the period in which a user clicks on the content. We recognize revenue from the display*

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of impression-based ads in the contracted period in which the impressions are delivered. Impressions are considered delivered when an ad is displayed to users." (Annual Account, Form 10K, SEC,p.66)

[6] E.g. Blattberg and Deighton (1991): "*It is a marketer's dream - the ability to develop interactive relationships with individual customers Technology, in the form of the database, is making this dream a reality. Now companies can keep track of customer preferences and tailor advertising and promotions to those needs*".

[7] GoTo.com was renamed Overture in 2001, and acquired by Yahoo! in 2003.

[8] One-by-one approaches in keyword analysis is not always successful at matching content to ads because many words have additional meanings (polysemy), and the correct meaning may be hard to determine using individual keywords without contextual information elements. Contextual advertising is more likely to connect the advertiser's ad to the right search context.

[9] The Google 2012 Annual Report mentions the following about the newly introduced service Google Now: "*[It] is a predictive search feature that gets you just the right information at just the right time. It tells you the day's weather before you start your day, how much traffic to expect before you leave for work or school, when the next train will arrive as you're standing on the platform, or your favorite team's score while they're playing—all automatically with cards appearing throughout the day at the moment you need them*".

[10] Calculated on the basis of PWC-IAB data for the USA in 2009.

[11] The top-10 tracking firms active in the Netherlands in 2013 were in the following order: Google Analytics, Google Adsense, Facebook Connect, Google +1, Facebook Like Button, DoubleClick (Google), Twitter Button, AddThis, Omniture, and Quantcast (Evidon, 2013).

[12] Note that the US advertising revenues already went into stagnation three quarters before the 2008-Q4 demise of Lehman Brothers and the financial crisis that it evoked.

[13] Data from Interactive Advertising Bureau (2013). The IAB (headquartered in New York) is the branch organisation of more than 500 leading media and technology companies that are responsible for selling 86% of online advertising in the United States. IAB evaluates and recommends standards, guidelines on interactive advertising and supports research in this area. The IAB has regional branches in Europe and many European countries, which also operate in the same activities.

[14] The North American market for mobile advertising is by far the most developed of all regions. Per mobile subscription advertisers in North America spent € 7.10 in 2012, against € 2.20 in Western Europe and € 1.0 in Asia-Pacific (Knapp et al. 2013).

[15] Some clarification regarding the legend elements of Figure A4 that have not mentioned before in this paper. Search ads include paid listings, contextual text links and paid inclusion in search results. Digital video refers to ads that appear before, during or after digital video content. Lead generation includes referrals. Email includes embedded ads only; excludes mobile ad spending. Lead generation is a form of ads in advertisers pay a fee to online companies for referring qualified potential consumers to being contacted by a marketeer. Classified ads refer to fees paid to advertisers by online companies to list specific products or services (e.g. in Yellow Pages). Rich media means ads that integrate some component of streaming interactivity (e.g. Flash or Java script) or in-banner / in-text videos

[16] Although these statistics may not be entirely undisputed, as will be shown later in this paper.

[17] Cf. Story (2007); Jacob (2013); Chen et al. (2012); Shields (2013).

[18] The text above is literally retrieved (August 2013) from Google's commercial pages: https://support.google.com/adwords/answer/1704424?hl=en&ref_topic=3121763 (web links removed).