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The past decade has seen the explosive emergence of online advertising as a major source of revenue for Internet publishers. Analyses of this phenomenon are mostly conducted in the sway of Google's hugely successful search advertising program. In the early days of the Internet, before Google, virtually all advertising revenues were related to simple display ads. Yet by 2008 search advertising accounted for over $10.5 billion of the $23.4 billion in total online advertising, and pundits were forecasting continued growth at rates of 12% per year over the next five years.[1]

Internet advertising markets have broken sharply from the advertising markets for traditional media. In the older media, every consumer that received a particular magazine, listened to a particular radio program, or watched a particular TV show would read, hear or see the same advertisement. An advertiser that wanted to reach an audience with particular characteristics could do so only within narrow limits. For example, a beer company might advertise on televised football games and a maker of fashion clothing might advertise in women's magazines. Although publications do some tailoring of their offerings, as when a newspaper has different local editions, audience mix is nevertheless constrained by the audiences for each type of publication, rather than by the objectives of the advertiser or the current intentions of the viewer.

The Internet changes that. When a consumer types "running shoes" into a search box at Google or Yahoo or Bing, it provides direct information about the searcher's *intent* ---

[1] *IAB Internet Advertising Revenue Report*, March 2009, and *Think Media: The Opportunity in Non-Premium Display Advertising*, May 4, 2009.

what the searcher wants to see and buy *right now*. There is also a direct route to measuring the searcher's response to advertising through click behavior. The combination of targeting and measurement makes search advertising extremely effective, particularly for advertisers hoping to satisfy immediate needs.

Other online settings share certain features of search advertising. Viewer *interest* can be inferred from context or from past browsing behavior. So a consumer reading a blog about running, or who has recently searched for "running shoes," may be an excellent target for running shoe ads. And although far fewer users may be tempted to click on display ads, there is still the potential to use clicks to measure ad effectiveness and refine the matching of advertising to users.

One view of internet advertising, therefore, is that it will move increasingly toward finer and finer ad targeting, with every impression treated as distinct and unique. Indeed , if we distinguish without limit among users in different locations, with different past behavior, looking at different content, then every impression is different. But is this sort of differentiation the best way to organize well-functioning markets? What are the disadvantages to treating each impression separately?

To put the problem in perspective, we begin by discussing the experience of a few other “commodity” markets. We introduce the idea of *conflation*, in which similar but distinct products are treated as identical in order to make markets thick or reduce cherry-picking. We report some illustrative anecdotes of how excessive ad targeting can work out badly. We then describe some trade-offs in designing online advertising markets, and the ingredients for a theory of the optimal market organization.

I. Background

The standard definition of a commodity in economic research is the one introduced by Gerard Debreu (1959): "A commodity is characterized by its physical properties, the date at which it will be available, and the location at which it will be available" (p. 28).

What is appealing about this definition is that it allows a commodity's description to depend on anything that might be relevant to a buyer. On a very hot day in Los Angeles, air conditioning demand at 3:00 PM can cause an electric power shortage even when there is plenty of extra capacity at 9:00 AM the same day, or at the same 3:00 PM hour in San Francisco. Time and location do matter. Moreover, Debreu's language sets up his famous extension to contingent commodities.[2]

Despite its theoretical appeal, however, Debreu's definition is flawed. Because no two objects can ever be available at the same time and place, Debreu's definition would seem to require that every two objects are different commodities. Real commodity definitions are based on *standards* and use *conflation*: certain "small" differences among units are systematically disregarded.

A useful historical example is the market for wheat, a typical commodity product. In the early 19th century, wheat was traded in bilateral transactions between farmers and middlemen and ultimately retailers. Bushels of wheat could vary in composition, weight and cleanliness, among other characteristics, and buyers took grain samples as part of the negotiations. Transaction costs were high. As described by Peter Dondlinger (1908, p.

[2] In the extension, "a contract for the transfer of a commodity now specifies, in addition to its physical properties, its location and its date, an event on the occurrence of which the transfer is conditional" (Debreu, p. 98).

222), "the movement of vast crops from scattered sources became very unwieldy and difficult under the old methods of selling by sample."

Technology affects market organization. In the 19th century, the railroads wanted to combine the production of smaller farmers, enabling them to use grain cars to transport wheat in bulk. Standards were created to define wheat grades. In New York, red winter wheat, number 2, was required to be "sound, plump, dry, and reasonably clean, contain not more than 10 percent of white winter wheat, and weigh not less than 58 pounds [per bushel]. Winchester standard." (Dondlinger, p. 224).

In principle, standardization solves several problems. It reduces measurement costs and adverse selection and facilitates the creation of futures contracts and related markets. But standards can also have other effects. One is the mixing of grains to create products that just barely meet each standard. Another is the discretion created for inspectors. The "grade requirements have been couched in obscure and indefinite terms and phrases, and responsibility for their interpretation has been left largely to the grain inspectors." (Dondlinger, p. 221).

To a uninformed consumer, wheat and diamonds would seem to lie at the opposite ends of the product spectrum: each diamond, one might think, is unique. Yet, except for the largest and finest stones, wholesale diamonds are not sold as individual pieces. One producer, BHP Biliton, conducts auctions for its diamonds. These begin by categorizing the stones into nineteen *deals* (categories of stones). Each deal is further subdivided into *splits*. The seller makes a sample split from each deal available and conducts an auction to establish a uniform price for each deal. It then adjusts the price of each split using its rate book to determine the relative value of the particular split compared to the sample.

This is a subtle scheme. The initial price is set by an auction that conflates distinct splits, but the price of each split is adjusted for its quality using a formulaic procedure. This combination of practices reduces measurement costs (each buyer needs to examine only one split closely), encourages thick markets (many buyers bidding for each deal), and protects buyers from adverse selection (by adjusting the prices of individual splits).

A third example is the sale of radio spectrum in government run auctions. The main determinants of relative value of a spectrum license across a set of neighboring frequencies band are the bandwidth (which determines how much information can be carried) and the geographic area covered, but there are other determinants as well. Nearby frequency bands can differ in the amount of radio interference they receive or in transmission rights in border areas.

In the UK, recent auction proposals call for initially selling spectrum by the amount of bandwidth nationwide, and then holding a secondary auction round to determine which bidder gets which slice of the spectrum. As with auctions for diamonds, the initial step entails conflation, but there is a deconflation mechanism to adjust pricing for different slices of spectrum after the main auction determines the quantities to be assigned.

How does this apply to Internet advertising? And, what are the advantages of conflation, compared to just allowing bidders to bid for the bundles they want?

II. Conflation in Online and TV Advertising

As most commonly explained, Internet search advertising involves a separate auction for each individual impression. A bidder specifies a keyword, such as “running shoes,” a maximum price per click, and the text ad it wants to display on the search page. The bidder can also determine how much leeway the search engine operator has to match this keyword to related terms, such as “athletic shoes” or “athletic footwear” or “athletic supplies.” This control is typically coarse, such as permitting only *exact* match, or *narrow* match, or *broad* match, or allowing a user to specify whether the same keywords are to be used for content matching, that is, to post ads on blogs and other relevant content.

So while search auctions offer bidders tremendous flexibility, they also impose limits that force conflation in the bids that can be made. A bid in a search auction does not specify a price that varies by the ad’s position on the page, or by the user’s demographic characteristics, or by cookies that encode information about past browsing behavior. It may not even specify a difference between placement on a search page on relevant non-search pages where ads are typically less effective.

Just as in the diamond and radio spectrum examples, the market organizer does adjust prices for some characteristics. The price per click used for search is automatically reduced to reflect the lower value of a click from non-search pages, and the click rates used for pricing are varied with the degree of match quality. The development of an extensive industry supporting search engine marketing testifies to the complexity of these issues and the value to making good choices about which keywords are relevant and how much conflation is suitable.

From the auctioneer’s perspective, a big advantage of conflation is that it helps to create thick, competitive markets. One way to express this idea is to notice that in a market for N items, with conflation, it takes just $N+1$ serious bids to get a near-competitive outcome. But with each item sold separately, it takes $2N$ bids and some good luck in the way that bidders are coordinated.

Paul Milgrom (forthcoming) models this idea by assuming that each bid causes the bidder to incur a small positive cost, perhaps just for calculating the bid and monitoring its performance over time. In a pure equilibrium of a set of simultaneous, independent second-price auctions with bid costs, a bidder will not make any losing bids, since the bidder could earn a strictly higher payoff just by dropping those. If each of several items is sold in a second-price auction, any pure equilibrium must entail just one bid for each item, and hence the auction price is at the reserve: let's call it zero.

In the actual generalized second-price auction that Google runs, prices are determined in a similar way, but bids specify a single price per click for *all* positions, not just for one. The winning bid for the n+1$^{\text{th}}$ position determines the price of the n^{th} position, and only the last position has its price determined by a losing bid. Equilibrium analyses of this mechanism have been offered by Hal Varian (2007) and by Benjamin Edelman et al. (2007). Adding small bid costs into their models amounts to reducing the number of bidders to be equal to the number of positions. If the last position has a sufficiently low value compared with the top positions, then the equilibrium prices are hardly affected by this omission: prices are then close to the Vickrey and competitive levels.

The preceding analysis points out a benefit of conflation that is missing from the cited models. The costs of conflation are also missing from these models. The obvious cost is that conflation coarsens the matching of ads to positions, although this can be subtle.

One subtlety is that conflation in the market may not determine the ultimate match of ads to users. Advertising on cable television provides an example. Cable TV companies have information about the viewing patterns of each household, for instance whether a household regularly watches *Sesame Street* or *Monday Night Football*. Suppose Ford wins the right to place an advertisement in a certain time slot for a particular TV show – a conflated purchase, given the variety of households served. Despite this conflation, Ford may be able to deliver a minivan ad to a household with children and a sports car ad to the household that watches football.

The example illustrates a situation where advertising is matched finely despite the set of products offered in the market being much coarser. And it brings us back to the question of why there has been so much emphasis on de-conflating in markets for online advertising: how much value is achieved, and at what cost?

III. Costs of Excessively Fine Targeting: Stories from the Internet

One cost of excessively fine targeting in an Internet advertising market is the possibility of cherry-picking by savvy advertisers. One anecdote we have heard is illustrative, if possibly apocryphal. It involves a proposed contract between McDonalds and Yahoo! under which Yahoo! would have shown Happy Meal ads when the sun was shining or the stock market was up. Presumably this "Happy Contract" would have left rainy days when the market was down for untargeted Burger King or Wendy's ads.

The possibility of cherry picking makes markets unsafe for buyers. An advertiser who purchases impressions to be shown on a newspaper web site may expect that its ad will be shown to a representative cross-section of the newspaper's readers, just as in the print newspaper. But if the publisher does not protect this representativeness, the advertiser could be stuck with a collection of picked-over impressions. Even if advertisers are aware of this prospect, the unsafe nature of the market can still create the sort of high transaction costs that good market design avoids – forcing advertisers to monitor where their ads are being shown and how the ads are performing.

A second hazard of targeting is that it leads to thinner markets, which can create problems for accurate pricing. For example, a recent Forbes article reported that Facebook's suggested price for advertising to Harvard economics majors was between 3 and 13 cents a click. Ads targeted at the full set of Harvard graduates, however, were running 54 to 71 cents a click.[3] Notwithstanding the possibility that economics classes might make Harvard students less desirable advertising targets, the prices suggest that not many of Facebook's advertisers currently are interested in such narrow targeting, creating a thin market for the Economics majors.

A variant on the thin market problem is what Preston McAfee has called the "orphan categories" problem. An online publisher might sell ads targeted by context (what is the user looking at) or reader characteristics (gender, age, location, browsing history), or combinations thereof. But what about impressions that do not fit neatly into a desired category? Are they to be sold in one undifferentiated bundle as "remnant" advertising? Or can we expect the market to effectively price not just every category an advertiser wants to create, but also its complement?

IV. The Three-Way Trade-Off

In our view, the efficient design of markets for Internet advertising needs to trade off three main effects. First, finer targeting of the right sort allows better matching of advertisers to impressions, which can add substantial value. Nobody doubts this effect: irrelevant ads are annoying and wasteful. Second, as in the *Happy Contract* example, excessively fine targeting can promote adverse selection, making it costly to participate

[3] "Facing up to Facebook's Value," by Taylor Buley, *Forbes*, April 7, 2009. We thank Hal Varian for this reference.

safely in the market. This discourages bidder participation and raises costs for those who do participate. Third, as in the *Facebook Harvard Graduates* story, excessively fine targeting can create a problem of monetization. It allows advertisers to game publishers, paying low prices for valuable inventory. This is the flip side of the adverse selection story for advertisers, expressing a kind of adverse selection against Internet publishers.

The argument for finely targeted purchases presumes that there is a value to better matches, and also that the information necessary to find better matches resides with advertisers. Is the latter assumption a good one?

When advertisers bid for a keyword on Google and allow for broad matches, they express the belief that Google has the information to identify relevant opportunities. Several features of sponsored search advertising make this belief plausible. There is a fairly natural measure of ad performance (clicks) and Google has extensive data and a structured environment in which to assess performance. The advertiser also enjoys some protection: if an ad is placed poorly, it may not be clicked and the advertiser doesn't pay.

These conditions are not obviously satisfied in Internet display advertising. A user's interests at the current moment may be harder to discern, the environment is less consistent, clicks may be less indicative of ad effectiveness, and inventory and data are more disaggregated. So it seems plausible that the ability to identify relevant opportunities resides at least to some extent with advertisers or third parties acting to aggregate information.

Can one allow advertisers to communicate the relevant information in a way that avoids the pitfalls discussed above? As the extreme, one can imagine a market that involves a separate auction for each impression, with advertisers able to bid for each impression in an unrestricted manner. We have argued above that such a design may score poorly on the dimensions of safety and monetization.

One approach to keeping participants safe is for an Internet publisher to offer a contract providing its advertiser with a representative cross section of impressions across a relatively broad target audience. In fact, these types of "premium" contracts are common between advertisers and (large) publishers and typically command higher prices than highly targeted non-premium ads. Such contracts are attractive to advertisers whose primary goal is to reach a large audience, perhaps exposing them to the same ad or a similar one multiple times. Moreover, Arpita Ghosh et al. (2009) point out that delivery on such a contract can be implemented (within limits) even in the context of an impression-by-impression second-price auction against sophisticated opponents.

An alternative (and not necessarily exclusive) approach to conflation is to limit too-narrow targeting of small sets of impressions. Such an approach aims to resolve the trade-off between targeting and market thickness. It is important recognize as well that thickness problems are not solely attributable to targeting. Advertising opportunities are not storable, and may not be very predictable. This variation can lead to temporary market imbalances that substitution helps to address.

It is far from clear that the future of display advertising on the Internet will involve continued increases in fine targeting of the sort seen in the recent past. Many display advertisers are interested in reach and repetition, aiming to advertise to a large number of the customers in their target groups and to reach each a certain minimum number of times. Impression-by-impression auctions are not the obvious way to accomplish such goals, and they incur the important costs that we identified above. We will not be surprised to see the old trend muted, and new sorts of guaranteed delivery advertising contracts spreading further into the Internet publishing sector.

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