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Anonymity, Social Image, and the Competition for Volunteers: A Case Study of the Online Market for Reviews

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Anonymity, Social Image, and the Competition for Volunteers: A Case Study of the Online Market for Reviews*

Zhongmin Wang

Abstract

This paper takes a first step toward understanding the working of the online market for reviews. Most online review firms rely on unpaid volunteers to write reviews. Can a for-profit online review firm attract productive volunteer reviewers, limit the number of ranting or raving reviewers, and marginalize fake reviewers? This paper sheds light on this issue by studying reviewer productivity and restaurant ratings at Yelp, where reviewers are encouraged to establish a social image, and two competing websites, where reviewers are completely anonymous. Using a dataset of nearly half a million reviewer accounts, we find that the number (proportion) of prolific reviewers on Yelp is an order of magnitude larger than that on either competing site, more productive reviewers on all three websites are less likely to give an extreme rating, and restaurant ratings on Yelp tend to be much less extreme than those on either competing site.

KEYWORDS: online reviews, public goods, firm strategy, social image, anonymity, restaurant ratings

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1. Introduction

Time magazine selected "You" as person of the year in 2006. This unusual choice is meant to highlight the millions of people who voluntarily contribute to a wave of Internet websites featuring user-generated content.[1] One category of user-generated content is online reviews of products, services, and businesses. Online reviews are an increasingly important source of consumer information, and now appear on many retailers' Internet websites (e.g., Amazon.com, barnesandnoble.com, Costco.com, Macys.com, and Walmart.com) and on specialized review websites (e.g., Angieslist.com, Citysearch.com, Cnet.com, Epinions.com, Tripadvisor.com, Yahoo Local, and Yelp.com). A literature in marketing has found evidence that online reviews affect product sales (e.g., Chevalier and Mayzlin, 2006; Li and Hitt, 2008).

Despite the growing importance of online reviews, the existing literature has not studied the working of the market for online reviews. A prominent feature of this new market is that most online review firms, while operating as for-profit organizations, have relied on unpaid volunteers to write reviews.[2] This business model of relying on free labor naturally raises interesting research questions. What motivates people to volunteer their labor to for-profit firms?[3] How do online review firms compete for volunteers? This question is especially interesting in light of the important study of online communities by Chen et al. (forthcoming). They recognize that the Internet has enabled online communities to form on an unprecedented scale, but most online communities are plagued by the free rider problem. Thus, a key challenge to online community designers is to motivate members to voluntarily contribute. An additional challenge to online review firms is what we call the adverse reviewer selection problem. Extremely angry or happy customers of a business have a stronger than normal incentive to write reviews to rant or rave about the business. Friends or foes of a business may have strong incentives to write fake reviews to promote or sabotage the business.[4] Ranting or raving reviews by customers are not inherently undesirable,

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[1] YouTube, MySpace, Facebook, Twitter, Delicious, Digg, and Wikipedia are some of the most popular Internet websites that feature user-generated content. See OECD (2007) for a discussion of the economic effects of user-generated Internet content.

[2] Epinions.com is an exception in that it offers monetary reward for reviewers. Millions of people volunteer for nonprofit organizations (Freeman, 1997, and Independent Sector, 2001).

[3] We are not the first to think about this question. Steven Levitt posed the question "Why do people post online reviews on Amazon" in the New York Times Freakonomics blog on July 22, 2005. According to Time, Internet users are "helping one another for nothing" and "working for nothing." Lev Grossman, "Time's Person of the Year: You," Time, Wednesday, December 13, 2006.

[4] Dellarocas (2006) offer a theoretical discussion of strategic manipulation of online reviews. It was reported that many Amazon book reviews were written by publishers, authors, and competitors. The true identities of some book reviewers were made public by a software error at

but a disproportionate number of either can bias users' ratings of a business, and fake reviews certainly contaminate the information content of online reviews. Can a for-profit online review firm attract reviewers who write to contribute to the provision of a public good, limit the proportion of reviewers who rant or rave, and marginalize those who manipulate?

To shed light on these issues, this paper studies the rapidly growing online market for reviews of local businesses, a market that combines business directories with user reviews. In this market, Citysearch and Yahoo Local are the incumbents, and Yelp is the late entrant. All three firms provide online reviews to consumers as a public good and collect revenue from advertising. All three firms rely on volunteer reviewers, but have adopted contrasting strategies to attract reviewers. Citysearch and Yahoo Local adopted what we call the anonymity strategy. Reviewers on these two websites cannot engage in any personal communication or social interaction, and thus are completely anonymous to each other and to the general public. In contrast, Yelp enables and encourages reviewers to establish a social image or reputation. Yelp members can evaluate each other's reviews, chat online, become friends, and meet with each other at offline social events. Each Yelp member has a public profile page that records her activities, including reviews written, number of useful, funny, and cool review votes received, Yelp friends made, and compliment letters displayed. Yelp also recognizes some qualified prolific reviewers as "elite" members.

We collected a dataset of nearly half a million reviewer accounts, which covers the vast majority of Yelp and Citysearch reviewer accounts and a sample of Yahoo Local reviewer accounts. We find the following main empirical regularities. First, the number (proportion) of productive reviewers at Yelp is an order of magnitude larger than that at Citysearch and Yahoo Local. For example, 71.2% Citysearch reviewers (or reviewer accounts) wrote a single review, 0.6% wrote 20 or more, and the average is about 2 reviews per reviewer account. In stark contrast, 9.2% Yelp reviewers (or reviewer accounts) wrote a single review, 27.1% wrote 20 or more, and the average is about 25 reviews per reviewer account. Low-output reviewers are marginalized at Yelp but not at Citysearch or Yahoo Local. For example, reviewers with 5 reviews or fewer wrote 64.4% of the reviews at Citysearch, 47.0% at Yahoo Local, but a mere 2.3% at Yelp. Second, more productive reviewers on all three websites are much less likely to give an extreme rating, either a 1-star rating (the worst) or a 5-star rating (the best). Third, matched restaurants tend to have a larger proportion of extreme ratings at Citysearch or Yahoo Local than at Yelp.

Amazon's Canadian site in February 2004. Amy Harmon, "Amazon glitch unmasks war of reviewers," *New York Times*, February 14, 2004.

According to Bénabou and Tirole (2006) and Ariely et al. (2009), without monetary incentive, people may contribute to the provision of a public good due to intrinsic incentive or social image. Intrinsic incentive refers to private preferences for others' well-being, such as pure altruism, impure altruism (Andreoni, 1990), and other forms of prosocial preferences (see Meier, 2007, for a survey). Social image or signaling incentive captures the idea that, given the community norms and values, people desire to be perceived as "good." For example, people like to be perceived as intelligent (e.g., Spence, 1973, on job market signaling), wealthy (e.g., Glazer and Konrad, 1996, on charity giving), public-spirited (e.g., Bénabou and Tirole, 2006, on prosocial behavior), and fair (e.g., Andreoni and Berheim, 2009, on fairness in dictator game). By writing a large number of high-quality reviews, a Yelp member can signal to fellow community members that she is "good": intelligent, fair, knowledgeable, public-spirited, and even "cool." As other members' perceptions of a reviewer, review votes and compliment letters are direct measures of a Yelp member's social image. We find that more prolific Yelp reviewers have more Yelp friends, receive more anonymous review votes per review, and display more compliment letters per review. We note that for a compliment letter to be displayed, the reviewer being complimented must take action to approve the letter, and for two reviewers to be Yelp friends, one must send a friend request that the other approves. We find that 99.5% of the Yelp reviewers with 50 reviews or more have at least one compliment letter or Yelp friend, indicating that prolific Yelp reviewers care about social image.

In this paper, we find strong evidence that social image and reviewer productivity are positively correlated, but our research design does not allow us to rule out the possibility that something other than social image may cause prolific Yelp reviewers to write a large number of reviews. Most would agree that the major difference between Yelp and the two incumbents is the presence or absence of social image incentive.[5] However, Yelp differs from Citysearch or Yahoo Local in many other aspects as well. For example, some may find Yelp's web design more stylish and more attractive. In this paper, we cannot quantify the extent to which these other differences between Yelp and its two competitor websites may have helped Yelp attract a larger number of prolific reviewers.

The rest of the paper proceeds as follows. Section 2 discusses the relationship of this paper to the existing literature. Section 3 documents the market strategies used by three online review firms to attract reviewers. Section 4

[5] For example, Saul Hansell wrote at the New York Times Bits Blog on May 12, 2008 that Yelp "structured the site to motivate people through the praise and attention that their reviews receive from others." "Moreover, the site mimics the structure of a social network, so that active members can see information about and follow the work of other reviewers who interest them. Yelp has also started holding social events for its frequent reviewers."

provides a conceptual framework. Section 5 describes our data set. Section 6 presents our findings. Section 7 concludes and discusses some important issues raised by the online review market that are not addressed in this paper.

2. Relationship to Literature

This paper contributes to the growing literature on online reviews or digital word-of-mouth. Avery et al. (1999) are the first to recognize that the Internet makes it possible to collect and distribute product evaluations on a large scale. The online market for reviews has turned their vision into a reality. However, they did not envision that online review firms would rely on volunteer reviewers. They proposed pricing and subsidy mechanisms to overcome the free rider problem inherent in the provision of online reviews. Li and Hitt (2008) recognize that online product reviews may be subject to self-selection biases. They focus on the idea that early adopters of a product may differ systematically from later customers of the product, causing the early reviews to be biased. See Li and Hitt (2008) and Sun (2009) for summaries of studies that take online reviews as given and focus on the impact of online reviews on product sales. A marketing literature uses the term "self-enhancement" to refer to the image incentive for engaging in word-of-mouth communication (see Dichter, 1966; Sundaram et al., 1998). This literature recognizes that offline word-of-mouth communication may allow a person to gain recognition, enhance image, or suggest status.

This paper also contributes to the emerging literature on eliciting participation in online communities (e.g., Chen et al. and the references therein). In a field experiment on MovieLens, a nonprofit movie recommendation website, Chen et al. find that personalized social information (e.g., the median user's total number of movie ratings) can motivate users below the median to dramatically increase their number of movie ratings. Their setting differs from this study in important aspects. First, unlike social image, social comparison does not appear to require an individual's action to be visible to others to be effective. Second, Yelp reviewers do not receive any direct benefit similar to movie recommendations. This explains why Yelp users are not required to sign up or write a review, but every MovieLens user is required to submit at least 15 movie ratings as part of the sign-up process. Third, social comparison cannot be used to motivate Yelp users below the median because we estimate that over 98% of the Yelp users do not register with Yelp at all.

Zhang and Zhu (2010) study the causal relationship between group size and incentive to contribute public goods by exploring an exogenous reduction in group size as a result of the blockage of Chinese Wikipedia in mainland China. They find the contribution levels of the non-blocked contributors outside of mainland China decrease by 42.8% on average, and they argue that the reduction in contribution is due to the reduced social benefits in smaller groups.

This paper is also related to the literature on open-source software. See Lerner and Tirole (2002) and the references therein. Many unpaid volunteer programmers contribute to the development of open-source software. The first question that Lerner and Tirole (2002, p. 198) ask in their study is what motivates programmers to volunteer their skills to the provision of a public good. Their case studies suggest most programmers respond to two types of incentives: social image (a desire for peer recognition) and career concern. Career concern refers to the fact that programmers participating in open-source software development may gain future job offers from private software companies or future venture capital. Career concern appears to be less important to online reviewers, whose writing skills are not as specialized as coding skills.

A large literature uses experimental methods to study why people may or may not contribute to the provision of public goods. See Ledyard (1995) and Ostrom (2000) for summaries of the main findings in public goods experiments. Levitt and List (2007) question if social behavior found in the lab can be generalized to the marketplace. Lafky (2009) conducts lab experiments to study how altruism, spite, and the cost of writing reviews may affect reviewer behavior. Lafky does not consider the role of social image in motivating online reviewers.

3. Anonymity and Social Image as Market Strategy

Citysearch, Yahoo Local, and Yelp are the primary competitors in the online market for reviews of local businesses (restaurants, shops, contractors, doctors, and any other local business in the Yellow Pages). Restaurants have by far the largest number of reviews on all three websites. We do not consider review websites that focus only on a subset of the market or adopt a very different business model.[6]

We choose to study the online market for reviews of local businesses partly because the three primary competitors adopted contrasting strategies to attract online reviewers, and partly because the incumbents enjoyed significant early-mover advantage in attracting online reviewers. By the time user reviews of restaurants started to appear on Citysearch in May 2002 and on Yahoo Local in April 2004, both websites had already established their online presence and attracted millions of visitors. By the time Yelp was launched in late 2004, Citysearch had already been in the online review market for over two years. Yahoo is one of the most popular websites in the world, and Citysearch was the

[6] Angie's List focuses on contractors and charges membership fees for access to its website. OpenTable, a restaurant reservation system, only allows its customers to write reviews, and it attributes all reviews to "an OpenTable.com user," which prevents us from observing reviewer productivity. Zagat has online user restaurant reviews, but it charges membership fees and does not provide user ratings of restaurants. Tripadvisor.com has restaurant reviews, but only for cities that are top tourist destinations.

42nd most popular website in the U.S. in May 2006, with 15.1 million unique visitors.[7] In contrast, Yelp had only 1 million unique visitors in May 2006. Yelp had received a total of $31 million in funding by July 2009.[8] In comparison, Citysearch had already received funding in excess of $75 million by November 1997.[9] Yet, by the end of our sample period (April 2009), the number of unique monthly visitors at Yelp was roughly the same as that at Citysearch.[10] What explains the dramatic growth of Yelp? We submit that the differences in market strategy explain the difference in market outcome.[11]

Citysearch and Yahoo Local made minimal attempts to attract reviewers. One can argue that they simply waited for anonymous reviewers to fall from cyberspace. The only feedback mechanism at Citysearch and Yahoo Local is reviewers' ability to *anonymously* vote and/or comment on reviews written by other members. Reviewers at these two websites cannot engage in any personal communication or social interaction, online or offline. Hence, reviewers at these two websites are completely anonymous to each other and to the general public.[12] Different from Yahoo Local (or Yelp), Citysearch hired professional staffs to write editorial reviews of local businesses, and news media have observed that Citysearch "buried" user reviews under professional reviews.[13]

Yelp, on the other hand, has invested in building a vibrant community of users by enabling and encouraging reviewers to establish a positive social image by writing a large number of high-quality reviews. Yelp recognizes selected prolific reviewers as "elite" members by offering them a special badge on Yelp and organizing thank-you parties for them. According to Yelp, to qualify for elite status, a member must write "lots of reviews" that are "insightful, irreverent, and

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[7] ComScore press release, June 15, 2006, available at http://ir.comscore.com/releasedetail.cfm?releaseid=245373.

[8] Yelp announcement, available at http://www.yelp.com/press/announcements.

[9] See Citysearch press release, November 13, 1997, available at www.archive.org.

[10] Compete.com reports that the number of unique visitors in April 2009 is 24.8 million at Citysearch and 24.0 million at Yelp. See also Yelp announcement at http://www.yelp.com/press/announcements.

[11] It is also useful to note that two other start-up firms (Insider Pages and Judy's Book) entered the online market for reviews of local businesses around the time Yelp did, but neither offered social networking features. Neither Insider Pages nor Judy's Book succeeded in establishing themselves in this market.

[12] We could not find a way to contact any Citysearch or Yahoo Local reviewers in our sample. Both Citysearch and Yahoo Local offer reviewers a profile page that lists their reviews. Before its recent web redesign in late March and April of 2009, Citysearch also listed the number of review votes a member had received on her profile page. Curiously, this piece of information disappeared after the web redesign. Yahoo Local never offered such a piece of information on a reviewer's profile page.

[13] Claire Cain Miller, "A More Local, Social Citysearch," New York Times Bits Blog on March 19, 2009.

personal," post at least one real photo, use her real first name, and let Yelp know her real family name. Elite membership can be thought of as an effort to establish and reinforce a community norm: A reviewer's social image at Yelp depends on the number of useful, interesting, and truthful reviews she writes at Yelp.

Yelp encourages members to communicate with each other and to evaluate each other's reviews. Yelp members can chat with each other in a talk forum,[14] vote anonymously if a review is useful, funny, or cool, and send each other private messages or compliment letters. Compliment letters are identified by senders and are categorized by titles such as "You're Cool," "You're Funny," "Good Writer," "Hot Stuff," "Cute Picture," and "Write More." As mentioned earlier, for a compliment letter to be displayed on a reviewer's profile page, the reviewer being complimented must take action to approve the letter. Two Yelp members can become friends if one requests and the other approves. A Yelp friend may be an offline friend before joining Yelp, a new friend one has met at Yelp social events, or a virtual friend one has never met offline.

Yelp hires full-time employees to serve as "community managers" to interact and communicate with Yelp members. Community managers write weekly newsletters to be sent to Yelp members, organize parties and social events, meet members, and write online reviews. The number of community managers is small. For example, Yelp has only one community manager for the Boston metropolitan area. Yelp employees are indicated as "ambassadors" on their reviewer profile pages. Yelp encourages members to interact with each other in offline social events. In addition to parties for elite members, Yelp organizes social events for all members to attend. Many elite Yelp members also organize events and parties that are open to all members.

We note that Yelp reviewers' social image or reputation has been used as a screening device. Yelp has a review filter that, according to Yelp, "suppresses reviews written by less established users." In their online conversations, Yelp members often flag businesses with a large number of 5-star reviews that are all written by single-review-no-friend reviewers.[15] It is very unlikely that a ranting, raving, or manipulating reviewer would write a large number of high-quality reviews and make many Yelp friends to "pool" with prolific prosocial reviewers at Yelp. It is extremely unlikely that such reviewers would reveal their true identities to become elite Yelp members. Therefore, reviews authored by elite

[14] Popular chat topics include local questions and answers, food, shopping & product, entertainment & pop culture, news & politics, humor & offbeat, relationship & dating, events, sports, and Yelp site questions.

[15] Go to Yelp's Boston page, and search the word "Spelp" under Talk. The word "Spelp," a combination of spam and Yelp, means fake reviews. Over 400 pages of discussions on fake reviews will appear. If you search the words "fake reviews" under Talk at other major cities covered by Yelp, you will also see hundreds of pages of discussions on fake reviews.

Yelp members or Yelp members with a large number of reviews and friends are much more trustworthy than those reviews authored by a single-review-no-friend reviewer. Citysearch and Yahoo Local cannot use this method of screening reviews because most reviewers at these two websites write a single review.

To write a review on Yelp, Citysearch, or Yahoo Local, one needs to register with the website. There is little difference between the time it takes to register with any of the three websites, and an email account is all that is required to register. Note that one can obtain an email account on the Internet without providing any personal information. Therefore, unlike subjects in lab environments, online reviewers are not restricted in their choice sets—they can choose not to write a single review, and they can write reviews for prosocial or *antisocial* purposes. Tens of millions of people had visited Citysearch, Yahoo Local, or Yelp at least once by April 2009, and we estimate that less than 2% of the visitors wrote a review.[16]

4. Conceptual Framework

Define a reviewer to be a reviewer account or a screen name. Let strategic reviewers refer to those reviewers who write to promote or sabotage a business. Since each reviewer can only review a particular business once, strategic reviewers, should they choose to write a large number of fake reviews, would do so under different screen names. We presume that in the absence of strategic purposes, no individual has the need to rant or rave about a large number of businesses. Ranting/raving customers, strategic reviewers, and prosocial reviewers who are solely motivated by intrinsic incentives may choose to write on any of the three review websites.

To make precise the concept and role of social image, we adapt Bénabou and Tirole's (2006) model of prosocial behavior to the setting of online reviews. The absence of monetary reward allows us to write a prosocial reviewer's utility function as

$$U_i(r) + V_i(E(r)),$$

where $U_i(r)$ denotes reviewer $i's$ intrinsic value of writing r reviews, $E(r)$ measures the social image or reputation of a reviewer with r reviews, and $V_i(\cdot)$ is reviewer $i's$ valuation of her social image. Bénabou and Tirole (2006) presume

[16] A conservative estimate is that both Citysearch and Yelp have attracted over 25 million unique visitors since the time each site started to accept online reviews (see the number of monthly unique visitors reported for these two sites by www.compete.com in footnote 10). Our data suggest that both Citysearch and Yelp have well below half a million reviewer accounts. Therefore, less than 2% of the unique visitors wrote a review.

that the value of social image may be instrumental or affective. A Yelp reviewer's social image has instrumental values. It is the currency that enables a reviewer to make new and selective friends and to attend social events organized for elite members. The value of a Yelp reviewer's social image may also be purely affective—social esteem, attention, or fame may be a hedonic good.

Assume for simplicity that the unit cost of writing an online review by any reviewer is a constant $c > 0$ at any of the three websites. Since the social image of writing online reviews is zero at Citysearch or Yahoo Local, users of these two websites decide how many reviews to write by solving the Kuhn-Tucker condition:

$$U_i'(r_i^*) \leq c, \text{ with equality if } r_i^* > 0. \quad (1)$$

Since they can establish a positive social image, Yelp users decide how many reviews to write by solving the Kuhn-Tucker condition:

$$U_j'(r_j^*) + V_j'\big(E(r_j^*)\big)E'(r_j^*) \leq c, \text{ with equality if } r_j^* > 0. \quad (2)$$

Given our assumption that ranting/raving customers and strategic reviewers do not write a large number of reviews, all prolific Citysearch and Yahoo Local reviewers solve for equation (1), and all prolific Yelp reviewers solve for equation (2). The upper tail of the reviewer productivity distribution at Citysearch or Yahoo Local is then determined by reviewers' intrinsic preference for writing online reviews. The upper tail of the reviewer productivity distribution at Yelp is then determined by the joint distribution that summarizes reviewers' intrinsic preference and image incentive for writing online reviews.

The setup of Citysearch and Yahoo Local is similar to a charity fundraising event where everyone is welcomed to contribute, but no one will be recognized. Since anonymous donations are extremely rare in charity giving (e.g., Glazer and Konrad, 1996; Harbaugh, 1998), we expect that very few reviewers at Citysearch and Yahoo Local write a large number of reviews. Yelp, however, strives to recognize its contributors, and so those who value social image would self select Yelp to write reviews. Consequently, we expect Yelp to have a larger number of prolific reviewers.

An important feature of our context is that we can directly measure a reviewer's social image. A Yelp reviewer's social image is a summary of other reviewers' reactions to and evaluations of her reviews, which include useful, funny, and cool review votes and compliment letters. To the extent that friend requests reflect others' reactions to one's reviews, the number of Yelp friends a reviewer has made can be thought of as a measure of her social image as well. Given the community norm at Yelp, we expect reviewers with a larger number of

reviews to attract a larger number of positive reactions. That is, $E(r)$ is an increasing function of r.

Another important and unique feature of Yelp is that we can directly assess whether prolific Yelp reviewers care about social image. That is, we can assess whether $V_i\big(E(r)\big) > 0$ for those prolific Yelp reviewers. As mentioned earlier, for a compliment letter to be displayed on a Yelp reviewer's profile page, the reviewer being complimented must take action to approve the letter. We submit that a reviewer who does not care at all about others' reactions to her reviews is someone who simply ignores others' reactions. Thus, the existence of compliment letters on one's profile page reveals that the reviewer values her social image. In this regard, compliment letters differ from useful, funny, or cool review votes, which are anonymous and do not require a reviewer's approval. It is possible that a reviewer has a large number of review votes, but is solely motivated by intrinsic incentives. The act of sending or approving friend requests also indicates that a reviewer cares about social image, and so the existence of Yelp friends on one's profile page is additional evidence that a reviewer cares about social image. Assume a reviewer with a large number of reviews or review votes receives some compliment letters and friend requests. We then expect that very few Yelp reviewers with a large number of reviews or review votes have no compliment letters and Yelp friends.

A third important feature of our context is that a reviewer's incentive to write online reviews affects the rating that she gives a business. Since November 20, 2003, all three online review websites in our study have been using a rating scale of 1-star to 5-star, with 1-star as the worst rating and 5-star as the best.[17] A ranting or raving customer, by definition, rates a business either 1-star or 5-star. A strategic reviewer also has the incentive to give her favored business a 5-star rating and her foes a 1-star rating. A prosocial reviewer's ratings presumably reflect her personal preferences and the "quality" of the business. Since prosocial reviewers are not motivated by a desire to rant, rave, or manipulate, they are less likely to give an extreme rating, even for the same business. A reviewer with a small number of reviews is more likely to be ranting, raving, or faking than a reviewer with a large number of reviews. We then expect that the ratings for a business given by those with a large number of reviews are less extreme than the ratings by those with a small number of reviews. If Yelp attracts a large number of highly productive reviewers, the rating distribution of a business at Yelp should tend to be less extreme than that at either Citysearch or Yahoo Local.

[17] Citysearch used a rating scale of 0-star to 10-star on and before November 19, 2003. For this reason, when studying rating distributions, we only consider Citysearch ratings on and after November 20, 2003.

5. Data

Our data set covers the vast majority of Citysearch and Yelp reviewers and a smaller sample of Yahoo Local reviewers. This section describes the data collection process and some sample statistics.

5.1. Collection

Using Perl, we downloaded our data set from Yelp, Citysearch, and Yahoo Local, in that order, during a 6-month period from mid-April 2009 through mid-September 2009. We first obtained a sample of restaurants from each website. We then downloaded the restaurants' information, all the user reviews for the restaurants in the sample, and the profile information of all the reviewers who wrote reviews for restaurants in the sample. The only reviewer account information downloaded from Citysearch or Yahoo Local was the total number of reviews (for restaurants or any other businesses) a reviewer had written. A richer set of reviewer information was downloaded from Yelp.

We downloaded all the user reviews for all the restaurants listed on Yelp and Citysearch in 21 metropolitan areas and a sample of restaurants listed on Yahoo Local in the same 21 areas.[18] The metropolitan areas are listed in column 1 of Table 1.[19] We focused on these 21 areas because they had been listed as popular cities on the front page of Citysearch by January 2007 and on the front page of Yelp by April 2009.[20] On Yelp, the list of restaurants with at least one review is displayed automatically for each metropolitan area. On Citysearch, we obtained the restaurant list by searching the keyword 'Restaurant' for each of the 21 areas.[21] Yahoo Local does not provide a full list of restaurants with at least one user review, nor does it return such a list when searched. For this reason, we used two different methods to select our Yahoo sample. First, Yahoo Local provides a

[18] We manually checked the reviews for many restaurants to make sure that our downloading was accurate.

[19] Our definition of the Los Angeles metropolitan area includes Orange County, and the San Francisco area includes Oakland, Palo Alto, San Jose, and Napa Valley. We always searched for the individual areas separately and then eliminated duplicate observations. For the New York metropolitan area, Yelp lists businesses under three city names: New York, Brooklyn, and Queens. Similarly, we searched for these three areas separately and eliminated duplicate observations.

[20] We searched historical Citysearch.com web pages through internet archive site www.archive.org. We did not consider those areas that appear on the front pages of only one of the two websites. For example, Honolulu and Washington, D.C. are two metropolitan areas that are listed by Yelp as popular cities, but not by Citysearch. Nashville and Raleigh-Durham are two areas that are listed by Citysearch as popular cities, but not by Yelp.

[21] We noticed that Citysearch returns a much larger number of restaurants for the same city when the word "metro" is used than when it is not. We always chose the metro option. For example, when searching for restaurants in New York, we chose the location "New York, NY Metro" instead of "New York, NY."

list of restaurants for each metropolitan area that are sorted by "top results," a criterion that Yahoo Local does not explicitly explain but appears to be correlated with the number of reviews for a restaurant. We downloaded all the user reviews for the first 300 restaurants listed for five areas (New York, Los Angeles, Chicago, San Francisco[22], and Boston), and the first 160 restaurants listed for the other areas in our sample. The rest of the restaurants in the list of top results typically have 5 reviews or fewer. Second, we searched Yahoo Local for restaurants that were popular on both Citysearch and Yelp (with 20 reviews or more). If such restaurants had at least one user review on Yahoo Local, they are included in our sample.

5.2 Sample

In our analysis, we ignore the few restaurants[23] that are not uniquely identified by name, phone, and zip code primarily because most of them suffer from a double entry problem—the same restaurant was listed twice on the same website.[24] Eliminating such restaurants also makes the task of matching restaurants across websites more tractable. We also ignore Yelp and Citysearch reviews written on and after the date of April 16, 2009, and any reviews on Citysearch that were acquired from Insider Pages.

Columns 2 and 3 of Table 1 present by metropolitan area the number of restaurants with at least 1 user review on Citysearch and Yelp, respectively. As expected, larger metropolitan areas tend to have a larger number of restaurants reviewed on both sites. Even though the overall number of restaurants in our Citysearch sample (57,200) is quite close to that in our Yelp sample (57,647), the overall number of user reviews at Yelp (1,509,384) is 3.5 times that at Citysearch (435,407). Yelp started in the San Francisco bay area, which is reflected in the data. The number of restaurant reviews in this single area (555,628) accounts for about 37% of all Yelp restaurant reviews, and it is more than the total number of Citysearch restaurant reviews in our sample. For most of the other cities, Yelp has a larger total number of user reviews and a larger average number of user reviews per restaurant as well (shown in columns 6 and 7).

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[22] The sample of 300 only applies to the city of San Francisco. For Oakland and other areas within the San Francisco metropolitan area, we downloaded the reviews for the first 160 restaurants.

[23] These restaurants account for less than 1% of the total number of downloaded restaurants. We ignore those restaurants without a phone number.

[24] For example, Au Bon Pain in Harvard Square appears twice on Yelp.com. In one listing, which has 14 reviews as of April 16, 2009, the address is "1360 Massachusetts Ave, Cambridge, MA 02138," and the restaurant category is "American (New)." In the other listing for the same business, which has 9 reviews, the address is "Harvard Square, 1360 Mass Ave, Cambridge 02138," and the restaurant category is "Bakeries, French."

Table 1: Restaurant Sample

	Citysearch (CS) and Yelp full sample						Citysearch and Yelp matched sample					Yahoo sample		
Metro. areas	Rest #		Total # of reviews		Review # per rest		Rest #	Total # of reviews		Review # per rest		Rest #	Review #	Review per rest
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	CS	Yelp	CS	Yelp	CS	Yelp		CS	Yelp	CS	Yelp	Yahoo	Yahoo	Yahoo
Atlanta	2,874	1,921	21,065	25,067	7.3	13.0	919	13,962	18,159	15.2	19.8	259	2,959	11.4
Austin	1,487	1,401	13,287	27,849	8.9	19.9	687	9,266	20,248	13.5	29.5	219	1,879	8.6
Boston	1,544	2,401	12,518	77,613	8.1	32.3	723	9,268	37,903	12.8	52.4	325	2,163	6.7
Chicago	4,015	4,531	21,686	132,476	5.4	29.2	1,515	13,525	88,553	8.9	58.5	368	5,708	15.5
Dallas	1,532	702	6,321	7,038	4.1	10.0	300	2,184	4,193	7.3	14.0	150	2,458	16.4
Denver	1,761	1,139	13,161	13,764	7.5	12.1	552	8,089	9,313	14.7	16.9	193	1,271	6.6
Detroit	646	1,439	2,527	5,075	3.9	3.5	235	1,522	1,269	6.5	5.4	153	1,290	8.4
Houston	2,875	859	21,615	7,977	7.5	9.3	566	12,335	6,725	21.8	11.9	153	1,986	13.0
Las Vegas	1,239	1,586	7,331	20,839	5.9	13.1	556	4,285	10,184	7.7	18.3	167	2,827	16.9
Los Angeles	9,308	8,701	67,438	214,896	7.2	24.7	3,540	42,813	154,573	12.1	43.7	682	6,709	9.8
Miami	1,080	1,474	4,892	8,746	4.5	5.9	504	3,173	4,903	6.3	9.7	158	935	5.9
Minneapolis	1,979	682	13,954	5,691	7.1	8.3	414	7,243	4,429	17.5	10.7	171	1,006	5.9
New Orleans	637	549	3,280	4,388	5.1	8.0	256	2,066	3,243	8.1	12.7	154	974	6.3
New York	8,393	10,239	101,376	188,909	12.1	18.4	4,641	81,405	138,380	17.5	29.8	986	7,112	7.2
Philadelphia	2,247	1,352	14,231	18,228	6.3	13.5	648	9,134	12,914	14.1	19.9	151	1,442	9.5
Phoenix	1,667	2,574	6,498	21,924	3.9	8.5	844	4,129	10,943	4.9	13.0	160	1,110	6.9
Portland	2,583	2,067	27,754	22,306	10.7	10.8	1,236	21,280	17,060	17.2	13.8	247	1,344	5.4
Sacramento	1,138	897	4,341	16,404	3.8	18.3	301	1,976	9,742	6.6	32.4	163	1,128	6.9
San Diego	1,193	2,775	2,684	68,101	2.2	24.5	556	1,454	32,241	2.6	58.0	155	1,906	12.3
San Francisco	5,996	7,644	42,219	555,628	7.0	72.7	2,734	29,076	388,232	10.6	142.0	1,042	10,041	9.6
Seattle	3,006	2,714	27,229	66,465	9.1	24.5	1,329	19,728	49,515	14.8	37.3	288	1,652	5.7
Total	57,200	57,647	435,407	1,509,384	7.6	26.2	23,056	297,913	1,022,722	12.9	44.4	6,344	57,900	9.1

Notes: The abbreviations “Rest” or “rest” stand for restaurant. See footnote 19 for the definitions of Los Angeles and San Francisco.

Column 8 reports the number of restaurants that we could match by name and address across Yelp and Citysearch. It is time consuming to match restaurants across websites because they do not follow the same convention to record restaurant names and addresses.[25] In total, we are able to match 23,056 restaurants, of which 3,721 have at least 20 reviews on both Yelp and Citysearch. The data for the matched restaurants (in columns 9 through 12) show patterns that are similar to those for the full sample (in columns 4 through 7).

Our Yahoo sample has a total of 6,344 restaurants with a total of 57,900 reviews, which are shown in columns 13 to 15 of Table 1. As our Yahoo Local sample is much smaller, we consider all downloaded Yahoo restaurant reviews.[26] The number of Yahoo restaurants in 7 of the 21 metropolitan areas is smaller than 160 because many restaurants in the Yahoo "top results" list do not have any user reviews. The average number of Yahoo reviews per restaurant is 9.1, which is slightly larger than that of Citysearch (7.6), but much smaller than that of Yelp (26.2).

Figure 1 shows the number of restaurant reviews at Citysearch and Yelp over time. By October 2004, the first month in which user reviews appeared on Yelp, Citysearch had been in the review market for 28 months and had collected 112,427 reviews, 26% of all Citysearch reviews in our sample. In April 2007, the number of restaurant reviews at Yelp exceeded that of Citysearch for the first time. From May 2007 through March 2009, the average number of new restaurant reviews per month at Yelp was 52,273, which is 7.6 times that at Citysearch (6,835).

The Citysearch user reviews in our sample were written by 273,963 reviewers. In our analysis, we ignore 17 Citysearch employees,[27] 4 aggregate

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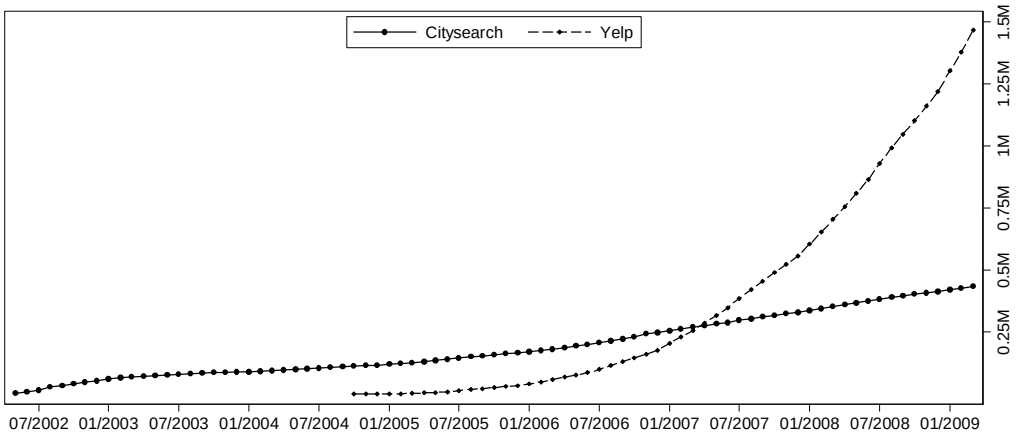
[25] The names and especially addresses of the same restaurant on two websites often differ in ways that are trivial to humans, but material to statistical software. We used the following steps to match the restaurants on Yelp and Citysearch. First, we tried to match restaurants with name, phone number, and zip codes. If all three variables matched, we manually checked if the addresses also matched. If the address did not match, we did not consider it a match. Second, we tried to identify potential matches with name and zip codes only. If these two variables matched, we then manually checked if the address also matched. The phone numbers for the same restaurant sometimes differed across websites. Third, we tried to identify potential matches with phone number and zip codes only. If these two variables matched, we checked manually if name and address also matched. Finally, for any restaurant with over 20 reviews on Citysearch that was not matched by the above three steps, we used search engines to identify if there is a potential match at Yelp. That is, we searched the Yelp website to see if Yelp had a restaurant matching the Citysearch name of the restaurant. Search engines do not require exact matching of names. Again, we manually checked if the search-matched pair of restaurants had the same address.

[26] Yahoo data were downloaded during mid August through mid September of 2009. September 8, 2009 is the last date on which a Yahoo review appears in our sample.

[27] We are able to identify these 17 reviewers as Citysearch employees because their user names are full names and each of them wrote at least 500 reviews, many of which are generic reviews

accounts for mobile phone users,[28] and 192 reviewers without a profile page. The remaining 273,750 Citysearch reviewers wrote a total of 543,714 reviews for all types of local businesses, amounting to an average of slightly less than 2 reviews per reviewer. Since Citysearch mentioned that it had over 600,000 user reviews,[29] our sample includes the vast majority of all Citysearch reviewers.

Figure 1: Number of Restaurant Reviews at Citysearch and Yelp over Time



The Yelp user reviews in our sample were authored by 168,670 Yelp reviewers. In our analysis, we ignore 15 reviewers who are Yelp employees,[30] and 88 reviewers without a profile page. The remaining 168,567 Yelp reviewers wrote a total of 4,232,237 reviews for all types of local businesses, amounting to an average of slightly above 25 reviews per reviewer. Yelp reports on its own website that it had a total of 6 million reviews in May 2009, so our sample includes the vast majority of all Yelp reviewers as well.

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without a rating. These 17 reviewers wrote 594 of the restaurant reviews in our sample and they wrote a staggering total of 104,509 user reviews on Citysearch. We did not attempt to identify Citysearch employee accounts with less than 500 reviews.

[28] The user names for these aggregate accounts are "CSMobileUser," "CSMobileUser2," "CSMobileUser3," and "CSMobileUser4." The user account CSMobileUser, for example, is associated with 7,028 reviews of all types of local business for many cities in the U.S. These four accounts wrote 1,403 restaurant reviews in our sample.

[29] See http://www.citysearch.com/aboutcitysearch/about_us. Last accessed on September 15, 2009.

[30] Yelp designates employees with an ambassador sign on those employees' profile page. Each of these 15 employees wrote more than 500 reviews. They wrote 4,354 of the restaurant reviews in our sample. We did not attempt to identify Yelp employees with less than 500 reviews.

The Yahoo Local user reviews in our sample were written by 35,561 individual reviewers and an aggregate reviewer account.[31] We ignore the aggregate account in our analysis. The 35,561 individual reviewers wrote a total of 111,578 reviews for all types of local businesses, amounting to an average of slightly above 3 reviews per reviewer account. We do not know the total number of user reviews at Yahoo Local.

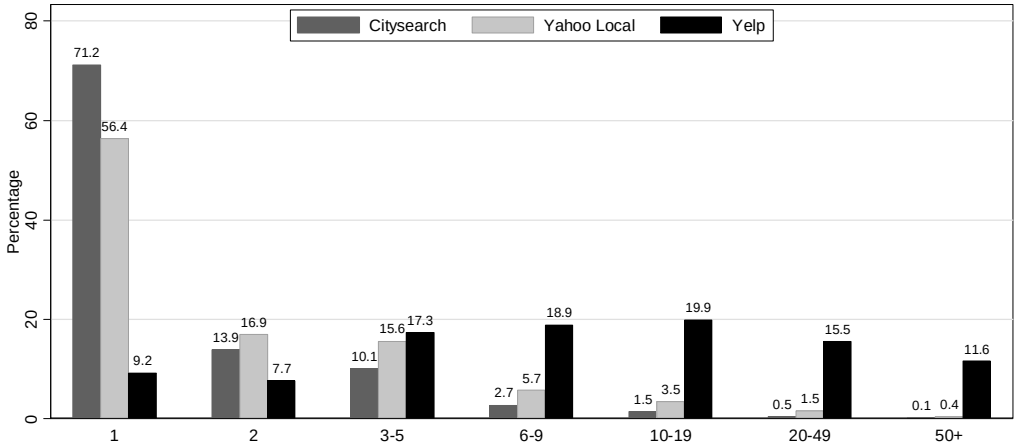
6. Empirical Findings

We present our empirical findings in three subsections. Subsection 6.1 presents the relationship between reviewer productivity and social image. Subsection 6.2 documents the relationship between reviewer productivity and restaurant ratings within websites and compares restaurant ratings across websites. Subsection 6.3 take a brief look at the number of words per review across websites.

6.1 Reviewer Productivity and Social Image

This subsection presents three findings. First, the number of productive reviewers at Yelp is an order of magnitude larger than that at Citysearch or Yahoo Local. Second, low-productivity reviewers are marginalized at Yelp, but not at Citysearch and Yahoo Local. Third, prolific Yelp reviewers care about social image.

Figure 2: Reviewer Productivity Distribution by Websites

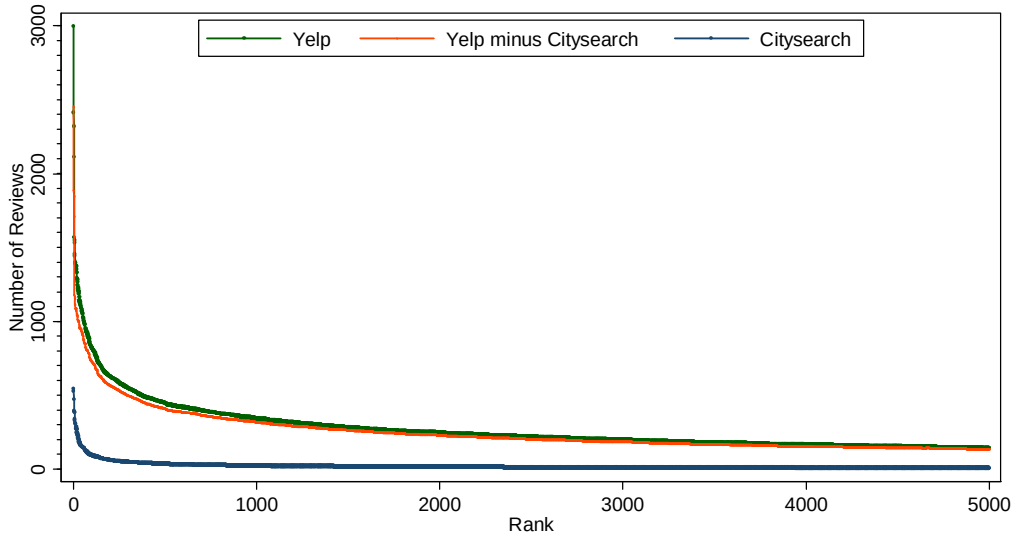


[31] This account is called "A Yahoo! Local User," which is associated with 12,595 of the 57,900 restaurant reviews.

Figure 2 presents the reviewer productivity distribution by website. Of the 273,750 Citysearch reviewers under consideration, 71.2% wrote a single review, and only 4.8% wrote 6 reviews or more. Of the 35,561 Yahoo Local reviewers, 56.4% wrote a single review, and only 11.1% wrote 6 reviews or more. In contrast, of the 168,660 Yelp reviewers, only 9.2% wrote a single review, and 65.8% wrote 6 reviews or more. The percent of reviewers with 20 reviews or more is 27.1% at Yelp, but only 0.6% at Citysearch and 1.9% at Yahoo Local. Yelp had a total of 19,487 members with 50 reviews or more, 8,891 members with 100 reviews or more, and 378 members with 500 reviews or more. In stark contrast, Citysearch had a total of 315 reviewers with 50 reviews or more, 96 reviewers with 100 reviews or more, and 1 reviewer with over 500 reviews.

Figure 3 shows the output of the 5,000 most productive reviewers at Yelp and Citysearch, respectively. It plots the number of reviews a reviewer wrote versus the productivity rank of the reviewer. Reviewer productivity on both sides follows power-law distributions, but the output of a Yelp reviewer is 4 to 15.5 times that of a Citysearch reviewer of the same rank. In fact, the productivity difference between a Yelp reviewer and a Citysearch reviewer of the same rank also follows a power-law distribution. These findings suggest that only a small number of people write a large number of reviews in the absence of social image incentive, and that a much larger number of people write a large number of reviews in the presence of social image incentive.

Figure 3: Output of the 5,000 Most Productive Reviewers at Yelp and Citysearch



It is striking that 71.2 % of Citysearch reviewers and 56.4% of Yahoo Local reviewers wrote only a single review. Why is it that so many reviewers at these two websites wrote a single review? One possibility is that we included a

large number of reviewer accounts that were opened just before the end of our sample period, and so those reviewers had not yet had a chance to write a second review. To assess the relevancy of this argument, we restrict the Citysearch and Yahoo Local reviewer samples to be those who wrote a restaurant review on and before April 15, 2008 and September 8, 2008, respectively. This gives a reviewer at least one year to write a second review. We find that the percentage of reviewers with a single review decreased minimally: 69.82% of Citysearch reviewers and 55.63% of Yahoo Local reviewers in the restricted sample wrote a single review. An alternative explanation is that a large percentage of Citysearch and Yahoo Local reviewers write to rant, rave, or manipulate. If many people write a review only if they have an extreme opinion about a business, then we would observe a large percentage of reviewers with a single review. Subsection 6.2 provides some support for this argument: 77.3% (73.2%) of the ratings given by Citysearch (Yahoo Local) single-review reviewers are either 1-star or 5-star.

Figure 4: Reviewer Groups' Shares of Reviews by Websites

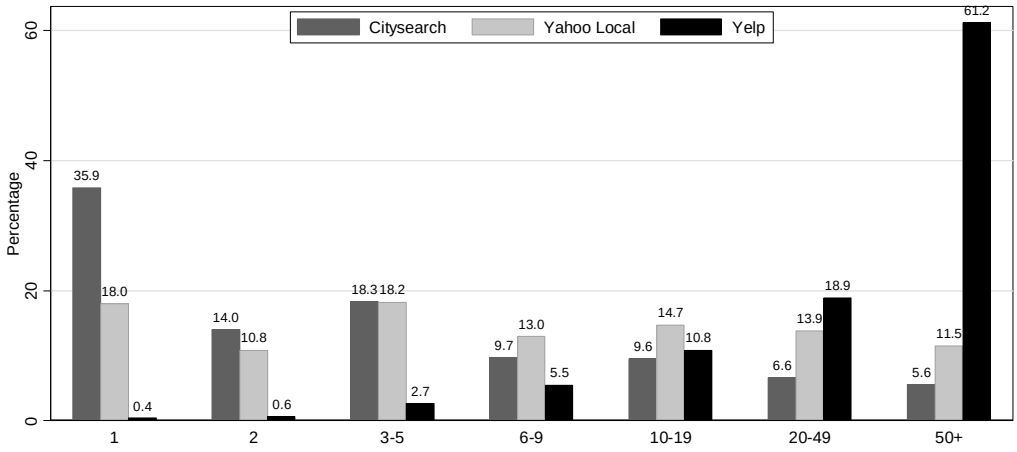


Figure 4 shows reviewer groups' share of reviews by website, where reviewer group is defined by number of reviews. Reviewers with a single review wrote 35.9% of the reviews at Citysearch, 18.0% at Yahoo Local, but only 0.36% at Yelp. Reviewers with 5 reviews or fewer wrote 64.4% of the reviews at Citysearch, 47.0% at Yahoo Local, and only 2.3% at Yelp. While reviewers with 20 reviews or more wrote 12.0% of Citysearch reviews and 25.4% of Yahoo Local reviews, such reviewers account for 80.0% of Yelp reviews. Hence, low-productivity reviewers are marginalized at Yelp, but not at Citysearch or Yahoo Local.

Table 2: Correlations among Reviewer Productivity and Three Social Image Measures

	# of reviews	# of votes	# of friends	# of compliment letters
# of reviews	1			
# of votes	0.61	1		
# of friends	0.39	0.52	1	
# of compliment letters	0.40	0.88	0.65	1.00

Note: Correlations with number of compliment letters are calculated using a 10% random sample of the Yelp reviewers in the sample. Correlations among the other three variables are calculated using all Yelp reviewers in the sample.

Table 2 shows the correlation coefficients among four variables: the number of reviews and the three social image measures at Yelp (anonymous review votes, Yelp friends, and compliment letters).[32] As expected, more prolific Yelp reviewers have more friends and receive more anonymous votes and compliment letters (the p-values for all the correlation coefficients in table 2 are 0.000). In fact, we find that more prolific reviewers tend to receive more anonymous votes per review and more compliment letters per review, indicating that prolific reviewers receive proportionally more positive feedback. However, we find that prolific reviewers do not have proportionally more Yelp friends (the simple correlation between a reviewer's number of reviews and number of friends scaled by number of reviews is -0.02).

To take a closer look at how the social image measures are related to the number of reviews, consider Figures 5(a), 5(b), and 5(c) which display, respectively, the standard box plots of the number of anonymous review votes, the number of compliment letters, and the number of Yelp friends, by reviewer groups. All three measures of social image are very small for reviewers with few reviews, but very large for reviewers with 50 reviews or more. For reviewers with a single review, the median number of all three social image measures is zero. In contrast, for those reviewers with 50 reviews or more, the median number of review votes, compliment letters, and Yelp friends, is 205, 31, and 22, respectively.

Table 3 presents percentages of Yelp reviewers with no compliment letters and no Yelp friends by reviewer groups, which are defined by number of reviews in panel A and by number of anonymous review votes in panel B. Only 0.52% (0.38%) of those reviewers with 50 reviews (review votes) or more have no compliment letters and no Yelp friends. Less than 5% of the reviewers with

[32] We missed downloading the number of compliment letters during our initial round of data collection. For this reason, we had to re-download the number of compliment letters for Yelp reviewers. Due to time consideration, we only downloaded the number of compliment letters for a 10% random sample of the Yelp reviewers in our total sample.

between 30 and 49 reviews (or review votes) have no compliment letters and no Yelp friends. These findings suggest that prolific Yelp reviewers care about social image.

Figure 5(a): Number of Anonymous Review Votes by Reviewer Group

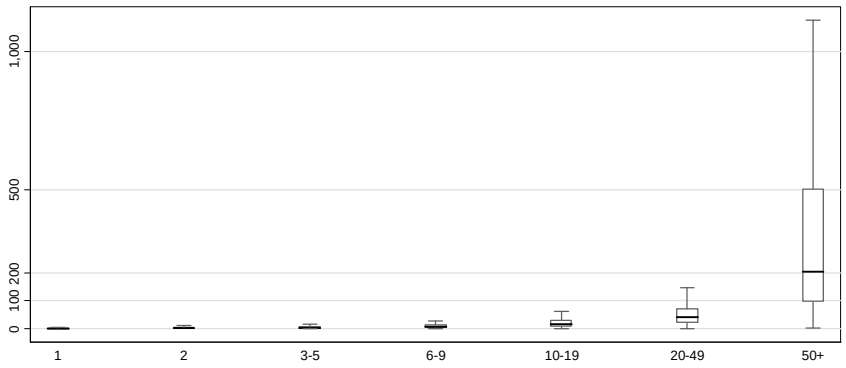


Figure 5(b): Number of Compliment Letters by Reviewer Group

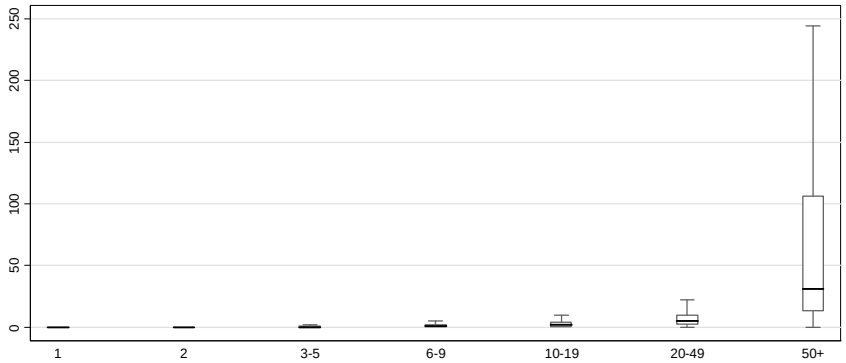
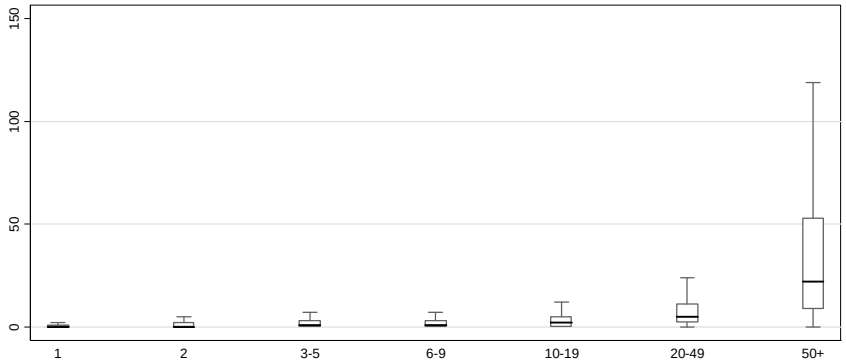


Figure 5(c): Number of Yelp Friends by Reviewer Group



Note: Box plots excludes outside values.

Table 3: Yelp Reviewers with No Compliment Letters and Yelp Friends

Panel A	Reviewer Group Defined by # of Reviews						
	0-5	6-9	10-19	20-29	30-39	40-49	50+
Number of reviewers	5,690	3,145	3,311	1,385	749	497	1,907
Reviewers with 0 letter & friend	2,585	982	492	106	29	9	10
% of reviewers with 0 letter & friend	45.43	31.22	14.86	7.65	3.87	1.81	0.52
Panel B	Reviewer Group Defined by # of Review Votes						
	0-5	6-9	10-19	20-29	30-39	40-49	50+
Number of reviewers	6,511	1,891	2,519	1,302	787	529	3,145
Reviewers with 0 letter & friend	3,224	495	350	80	39	13	12
% of reviewers with 0 letter & friend	49.52	26.18	13.89	6.14	4.96	2.46	0.38

Elite membership is another measure of social image. In our sample, 12,373 reviewers were elite members for at least a year,[33] amounting to 7.3% of all Yelp reviewers.[34] These elite members wrote a total of 1,857,663 reviews for all types of businesses, which account for 43.9% of all Yelp reviews. Over 99% of the elite members wrote 26 reviews or more.

6.2 Reviewer Productivity and Restaurant Ratings

Subsection 6.2.1 confirms that more productive reviewers on all three websites gave smaller proportions of extreme ratings. Subsection 6.2.2 confirms that the rating distribution at Yelp is less extreme than that at Citysearch or Yahoo Local.

6.2.1 Within-Website Comparison

We consider linear probability models, which, for our purpose, have advantages over logistic regressions. The ratings are ordered, but ordered logit models are inappropriate here. The frequency of a rating r (= 1, 2, 3, 4, 5) by reviewer group can be obtained by estimating the following linear probability model separately for each rating r:

$$rating_j^r = g_j^1 + g_j^2 + g_j^{3-5} + g_j^{6-9} + g_j^{10-19} + g_j^{20-49} + g_j^{50+} + \varepsilon_j \,, \qquad (3)$$

where the binary variable $rating_j^r = 1$ if the jth rating equals r and 0 otherwise; reviewer group dummy $g_j^1 = 1$ if the reviewer of the jth rating wrote a single

[33] Yelp elite status is granted on an annual basis. It is not renewed automatically.
[34] We do not count as elite members those 12 reviewers with less than 10 reviews but are somehow designated by Yelp as elite members.

review and 0 otherwise; other reviewer group dummy variables are similarly defined. Since the right-hand variables (without a constant term) are mutually exclusive and exhaustive, the linear probability model is completely general: The Ordinary Least Squares (OLS) estimates are the fractions of ratings that are equal to r conditional on reviewer group. See Wooldridge (2002, p. 457 and p. 509) for more details. Thus, estimating equation (3) for rating r is equivalent to tabulating the frequency of rating r for all restaurants by reviewer group.

Figures 6(a), 6(b), and 6(c) present the rating distributions (as percentages) by reviewer group at Citysearch, Yahoo Local, and Yelp, respectively. On all three websites, lower-output reviewers are more likely to give an extreme rating and are less likely to give the 3-star or 4-star rating. At Citysearch, Yahoo Local, and Yelp, respectively, 77.3%, 73.2%, and 61.5% of the restaurant ratings by single-review reviewers are either 1-star or 5-star. Single-review reviewers at Citysearch, Yahoo Local, and Yelp are, respectively, 22.6%, 26.4%, and 21.5% more likely than reviewers with 50 reviews or more at the same website to give the 5-star rating, and 18.8%, 6.6%, and 15.1% more likely to give the 1-star rating. These probability differences across reviewer groups are highly statistically significant. In fact, even the null that single-review reviewers are as likely as reviewers with 2 reviews to give the 1-star or 5-star rating is rejected at the 0.2% level for all three websites. The differences in the fraction of 2-star ratings between reviewer groups are relatively small for all three websites. These findings, along with the previous finding that slightly over 71% of Citysearch reviewers and slightly over 56% of Yahoo Local reviewers wrote a single review, suggest that a substantial proportion of the reviewers at Citysearch and Yahoo Local may write reviews to rant, rave, or manipulate.

To investigate whether ratings by low-output reviewers are more extreme than those of high-output reviewers for the same restaurant, we add restaurant fixed effects into our linear probability models:

$$rating_{ij}^{r} = rest_i + g_{ij}^{1} + g_{ij}^{2} + \cdots + g_{ij}^{50+} + \varepsilon_{ij} \,, \tag{4}$$

where the binary $rating_{ij}^{r} = 1$ if the jth rating of restaurant i equals r and 0 otherwise, and $rest_i$ represents restaurant dummies. Intuition suggests that the coefficient estimates of equation (4) must still lie between 0 and 1. As we are not aware of any similar applications in the literature, we prove that this is indeed the case in Appendix A. Since we are using within-restaurant variations to estimate the probabilities, we restrict attention to those restaurants with 30 reviews or more when estimating equation (4). This restricted sample includes 2,010 restaurants at Citysearch, 194 restaurants at Yahoo Local, and 12,545 restaurants at Yelp. The fixed-effect estimates (reported in Appendix B) are similar to the OLS estimates.

Figure 6(a): Rating Distribution by Reviewer Group at Citysearch

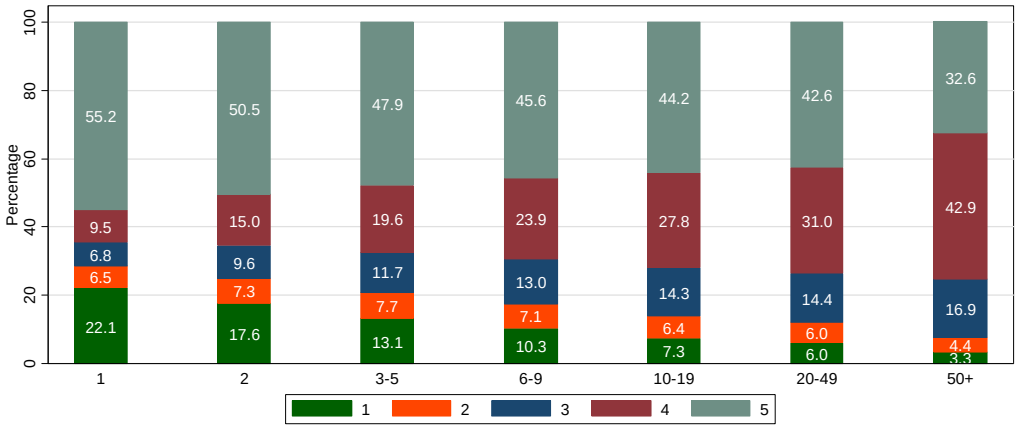


Figure 6(b): Rating Distribution by Reviewer Group at Yahoo Local

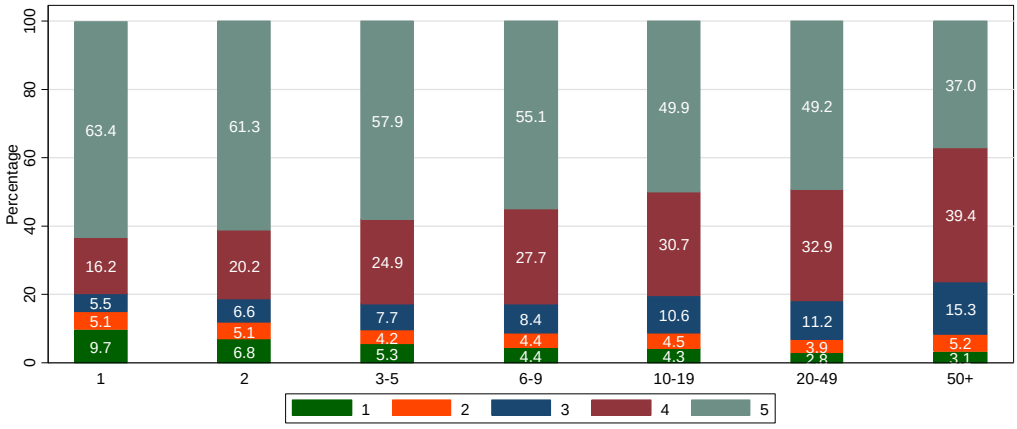
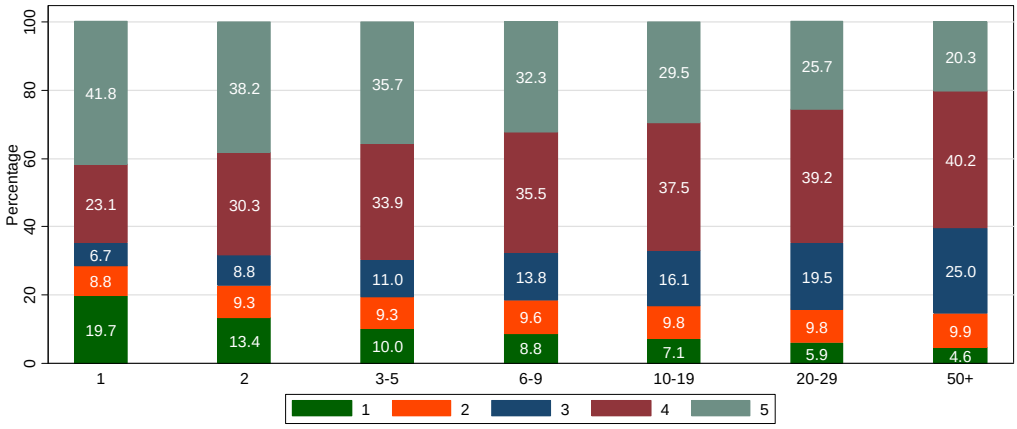


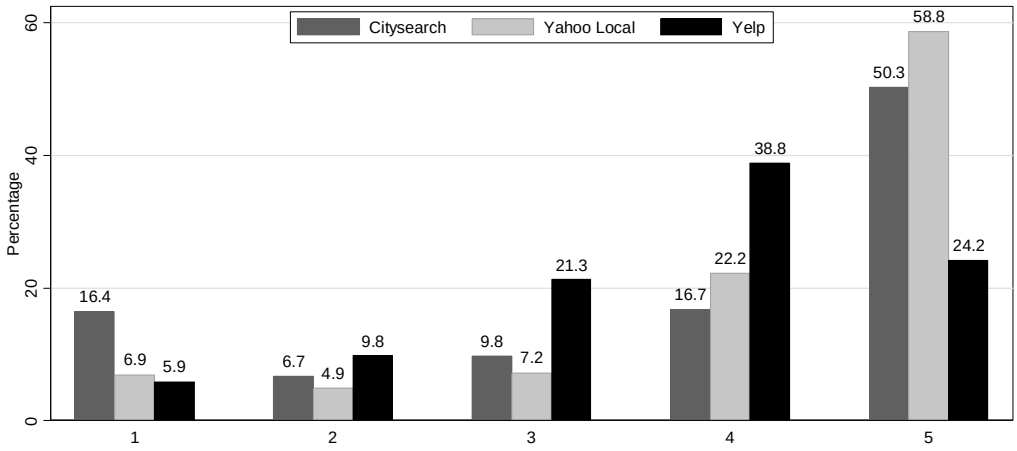
Figure 6(c): Rating Distribution by Reviewer Group at Yelp



6.2.2 Between-Website Comparison

Figure 7 presents the overall rating distribution at each of the three websites. As expected, the rating distribution is much more extreme at Citysearch and Yahoo Local than at Yelp. The proportion of 5-star ratings at Yelp (24.2%) is less than half of that at Citysearch (50.3%) or at Yahoo Local (58.8%). The proportion of 1-star ratings at Yelp (5.9%) is less than half of that at Citysearch (16.4%) and it is also smaller than that at Yahoo Local (6.9%). Correspondingly, Yelp has much higher proportions of 2-star, 3-star, and 4-star ratings than either Citysearch or Yahoo Local.

Figure 7: Overall Rating Distribution by Website



To investigate how the rating distribution differs across the three websites for the same restaurant, we consider the following fixed-effect linear probability model for rating r:

$$rating_{ij}^{r} = rest_i + citysearch_{ij} + yelp_{ij} + yahoo_{ij} + \varepsilon_{ij}, \qquad (5)$$

where the binary variable $rating_{ij}^{r}$ is as previously defined in equation (4), $rest_i$ represents restaurant dummies, the binary variable $citysearch_{ij} = 1$ if the jth rating of restaurant i is authored by a Citysearch reviewer and 0 otherwise, and the binary variables $yelp_{ij}$ and $yahoo_{ij}$ are similarly defined. The coefficient estimates of equation (5) are the fractions of ratings that are equal to r at each of the websites controlling for restaurant fixed effects.

We first estimate equation (5) using Citysearch and Yelp ratings only, and then using ratings from all three websites. In our sample, 1,219 restaurants have 30 user ratings or more at both Citysearch and Yelp, but only 227 restaurants have

20 ratings or more at all three websites (due to the much smaller Yahoo sample). Figure 8(a) presents the coefficient estimates (times 100) when equation (5) is estimated with the Citysearch and Yelp ratings for the 1,219 restaurants. Figure 8(b) presents the coefficient estimates (times 100) when equation (5) is estimated with the ratings for the 227 restaurants at all three websites. The rating distributions in Figures 8(a) and 8(b) are similar to the overall rating distributions shown in Figure 7.

Figure 8(a): Rating Distribution Using Citysearch and Yelp Matched Restaurant Sample

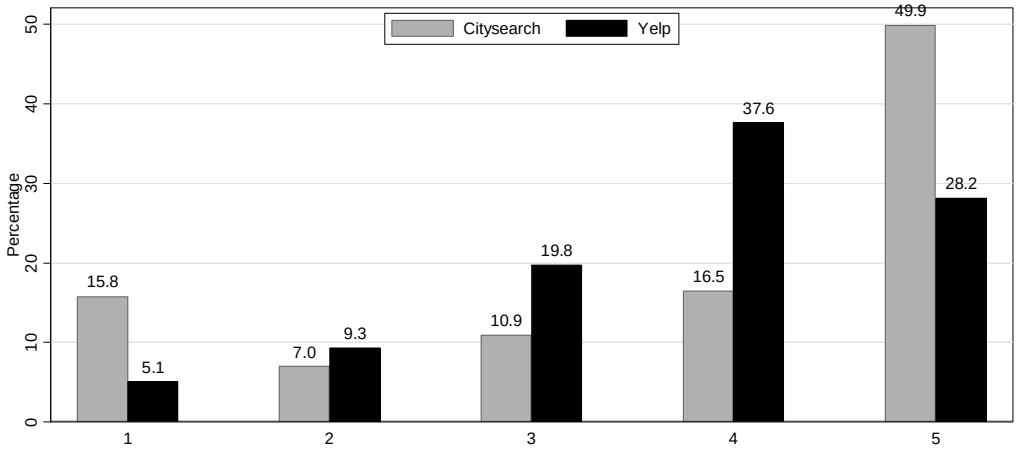
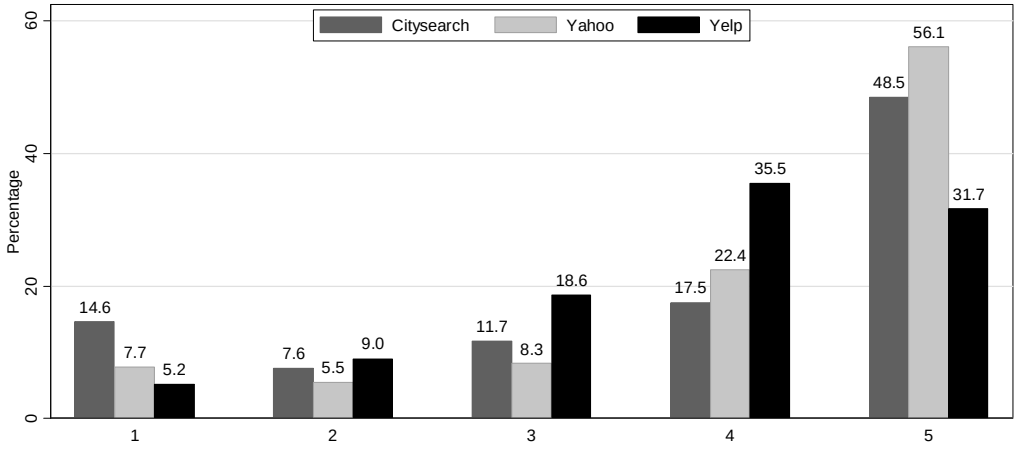


Figure 8(b): Rating Distribution Using Citysearch, Yahoo Local, and Yelp Matched Restaurant Sample



To see what percentage of the 1,219 restaurants have a higher proportion of extreme ratings at Citysearch than at Yelp, we estimate the following equation separately for each restaurant:

$$extremerating_j = c + citysearch_j + \varepsilon_j, \quad (6)$$

where $extremerating_j = 1$ if the jth rating of a restaurant is either 1 or 5, and the dummy variable $citysearch_j = 1$ if the jth rating is authored by a Citysearch reviewer. The coefficient of $citysearch_j$ is the difference in the proportion of extreme ratings between Citysearch and Yelp. Figure 9(a) presents the histogram of the coefficient estimates for $citysearch$ for the 1,219 restaurants. The estimated coefficient ranges from -0.25 to 0.81. Using the t-test, we find that, for 1,024 (84%) of the 1,219 restaurants, the proportion of extreme ratings is statistically higher at Citysearch than at Yelp; for 194 (15.9%) restaurants, the proportion of extreme ratings is not statistically different at the two websites; and for a single restaurant, the proportion is lower at Citysearch than at Yelp.

We use equation (6) (in which $citysearch_j$ is replaced by $yahoo_j$) to study what percentage of the 227 restaurants (with 20 reviews or more at all three websites) have a higher proportion of extreme ratings at Yahoo Local than at Yelp. Figure 9(b) presents the histogram of the coefficient estimates for the 227 restaurants. The coefficient ranges from -0.12 to 0.78. Using the t-test, we find that the proportion of extreme ratings at 169 (74.4%) of the 227 restaurants is higher at Yahoo Local than at Yelp, and the proportion of extreme ratings at the two websites is not statistically different for the other 58 restaurants.

Figure 9(a): Histogram of the Difference in the Proportion of Extreme Ratings between Citysearch and Yelp for 1,219 Matched Restaurants

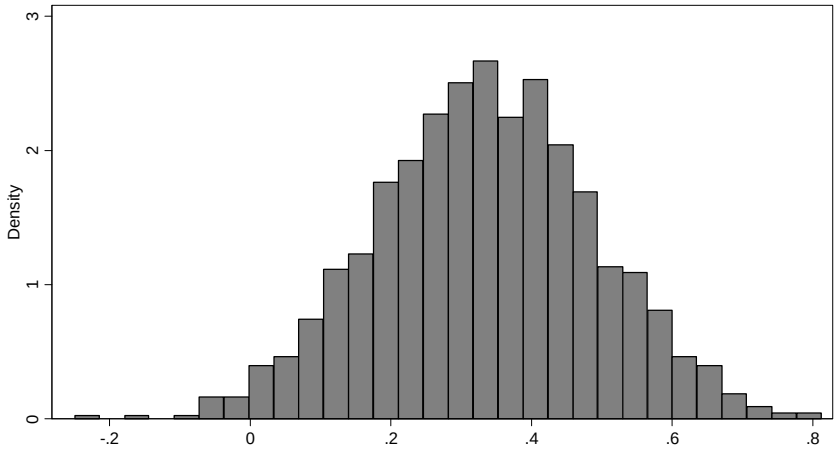
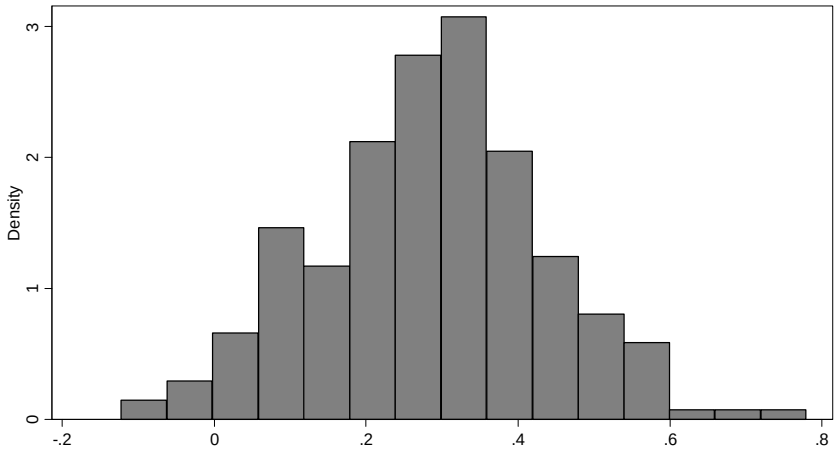


Figure 9(b): Histogram of the Difference in the Proportion of Extreme Ratings between Yahoo Local and Yelp for 217 Matched Restaurants



We emphasize that the above findings regarding rating distributions still hold even if we restrict attention to those metropolitan areas where Citysearch appears to be more popular than Yelp. At the end of our sample period, Citysearch had a larger number of restaurants reviewed in Houston, Minneapolis, and Portland, and had more reviews per matched restaurant in these three metropolitan areas (see Table 1). Using Citysearch-Yelp matched restaurants with 30 reviews or more (a total of 99 restaurants in the three cities), we obtain estimates for equations (5) and (6) that are qualitatively similar to those in Figures 8(a) and 9(a).

6.3 Review Length

In this section, we briefly consider another measure of restaurant reviews, the number of words per review. The number of words per review is a less informative statistic than the rating associated with a review. For this reason, we do not have prior predictions regarding the number of words per review across the three websites. Nonetheless, we find strong evidence that the number of words per review for the same restaurant is much larger at Yelp than at Citysearch or Yahoo Local. This finding is reassuring since it generally takes more time to write longer reviews, and longer reviews may contain more useful information.

To investigate how the number of words per review differs across the three websites, we use a fixed effect model (similar to equation 5) in which the dependent variable is the number of words of the jth review for restaurant i. Using the 1,219 Citysearch-Yelp matched restaurants, we find that an average-length review at Yelp has 140.98 words, 31.11 words longer than an average-

length review at Citysearch. Using the 227 restaurants with 20 reviews or more on all three websites, we find that an average-length review at Yelp has 128.04 words, 25.65 and 67.78 words longer than an average-length review at Citysearch and Yahoo Local, respectively.

7. Concluding Remarks

Asymmetric information between buyers and sellers can lead to market failures (e.g., the lemons problem of Akerlof, 1970). Similar to *Consumer Reports*, the online user review market can provide consumers with valuable market information. However, the business model of the online review firms in our study differs fundamentally from *Consumer Reports*, which uses in-house professionals to conduct product testing and does not accept outside advertising. The online review firms in our study rely on self-selected volunteer reviewers, provide online reviews to consumers for free, and collect advertising revenue from the very businesses being reviewed. This business model naturally raises interesting questions.

In this paper, we have studied the issue of how online review firms compete for volunteer reviewers. We find that the number (proportion) of productive reviewers at Yelp is an order of magnitude larger than that at Citysearch or Yahoo Local, even though Citysearch and Yahoo Local enjoyed significant early-mover advantages. We also find productive reviewers on all three websites are much less likely to give an extreme rating. Consequently, we find that restaurant ratings at Yelp tend to be less extreme than those at Citysearch or Yahoo Local. We are able to measure a reviewer's social image directly, and we find that Yelp reviewers' social image is positively correlated with their review productivity, and that, by way of revealed preference, highly productive Yelp reviewers care about their social image. Our findings suggest that social image is more effective than anonymity in attracting productive volunteer reviewers. However, as emphasized in the introduction, our research design does not rule out the possibility that something other than social image may cause prolific Yelp reviewers to write a large number of reviews.

Our findings are fundamental to understanding the online market for reviews. In light of the difficulties in overcoming the free rider problem in the provision of public goods and simultaneously marginalizing ranting, raving, or manipulating reviewers, what Yelp as a for-profit firm has achieved is remarkable. Our findings also contribute to the emerging literature on how to motivate people to contribute to online communities without monetary compensation, and to the debate on why people behave prosocially. Our results suggest that social image incentives might be used as a market strategy by for-profit firms.

As a first attempt toward understanding the online review market, this paper did not fully assess the quality of online reviews. We found that a large fraction of reviewer accounts at Citysearch and Yahoo Local wrote a single review and expressed an extreme opinion. However, we did not identify the proportions of reviewer accounts that were opened by ranting/raving customers, by strategic (or fake) reviewers, and to a lesser extent, by people who were solely motivated by intrinsic social preferences. Without hard evidence of reviewers' true identities, it is difficult to distinguish a customer's raving review from a business owner's self promoting review. It is also inherently difficult to distinguish a reviewer who writes to vent frustration from one who writes to warn other customers from visiting a bad business. We found that most reviews at Yelp were written by prolific members. Reviews written by prolific reviewers with a positive social image are more trustworthy because they have incurred the cost and effort of writing a large number of high-quality reviews. However, we did not investigate the extent to which Yelp reviewers' ratings of a business differs from an ideal metric that reflects the true "quality" of the business and the preference distribution of the business' customer population. We note that internet users probably do not expect an ideal metric from an online review site. What is critical to them is whether they can trust the reviews they are reading. Yelp has made much progress in this regard.

As online review firms collect advertising revenue from the very businesses being reviewed, what guards the objectivity of the online review firms? Prolific Yelp reviewers are bloggers. What then prevents such reviewers from accepting free dinners and offering biased reviews? These are interesting issues for future research, especially considering that the Federal Trade Commission recently revised its rules regarding the relationship between advertisers and product reviewers because of the growing popularity of blogging and social media. We note that Yelp has a strong incentive to maintain a good reputation. Otherwise, volunteer reviewers may simply stop volunteering.

Appendix A

In this appendix, we prove that the coefficient estimates of equation (4) must lie between 0 and 1 because the independent variables are orthogonal to each other.

Consider the general fixed-effects model

$$y_{it} = \boldsymbol{x}_{it}^{'}\boldsymbol{\beta} + \alpha_{\mathrm{i}} + \epsilon_{\mathrm{it}} ,$$

where $\boldsymbol{x}_{it}^{'}$ is a 1 by k matrix. The within estimator of this fixed-effect model is

$$\boldsymbol{b} = \left[\boldsymbol{S}_{xx}^{within}\right]^{-1}\boldsymbol{S}_{xy}^{within},$$

where

$$\boldsymbol{S}_{xx}^{within} = \sum_{i=1}^{n}\sum_{t=1}^{T}(\boldsymbol{x}_{it} - \bar{\boldsymbol{x}}_{i.})(\boldsymbol{x}_{it} - \bar{\boldsymbol{x}}_{i.})' \text{ and}$$

$$\boldsymbol{S}_{xy}^{within} = \sum_{i=1}^{n}\sum_{t=1}^{T}(\boldsymbol{x}_{it} - \bar{\boldsymbol{x}}_{i.})(y_{it} - \bar{y}_{i.})$$

Let $$\boldsymbol{b}_i = [\sum_{t=1}^{T}(\boldsymbol{x}_{it} - \bar{\boldsymbol{x}}_{i.})(\boldsymbol{x}_{it} - \bar{\boldsymbol{x}}_{i.})']^{-1}\sum_{t=1}^{T}(\boldsymbol{x}_{it} - \bar{\boldsymbol{x}}_{i.})(\boldsymbol{x}_{it} - \bar{y}_{i.})$$

$$= [A_i]^{-1}B_i$$

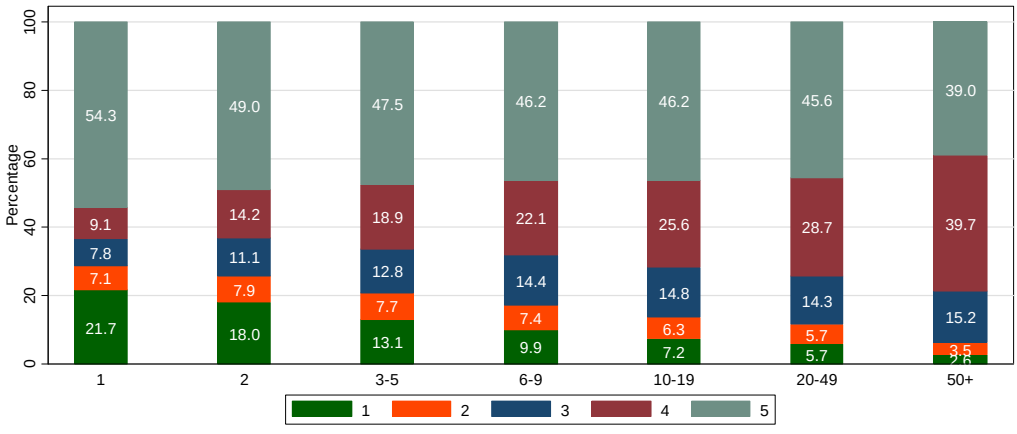
Note that $\boldsymbol{b_i}$, a k by 1 vector, contains the coefficient estimates of a regression in which y_{it} is the dependent variable, $\boldsymbol{x}_{it}$ is the independent variable, and the observations are for the ith cross section unit (restaurant) only. Let the independent variables in this regression be mutually exclusive and exhaustive (e.g., they are orthogonal to each other). Then, A_i is a diagonal matrix and all elements of $\boldsymbol{b}_i$ must be between 0 and 1. The within estimator of the fixed-effect model in which all independent variables are orthogonal to each other is then:

$$\boldsymbol{b} = [A_1 + A_2 + \cdots + A_n]^{-1}[B_1 + B_2 + \cdots + B_n].$$

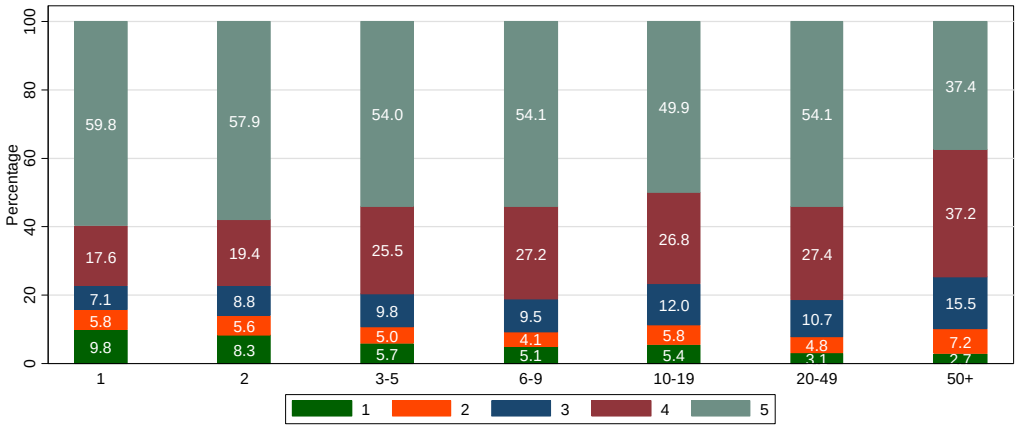
Therefore, all elements of $\boldsymbol{b}$ must be between 0 and 1.

Appendix B

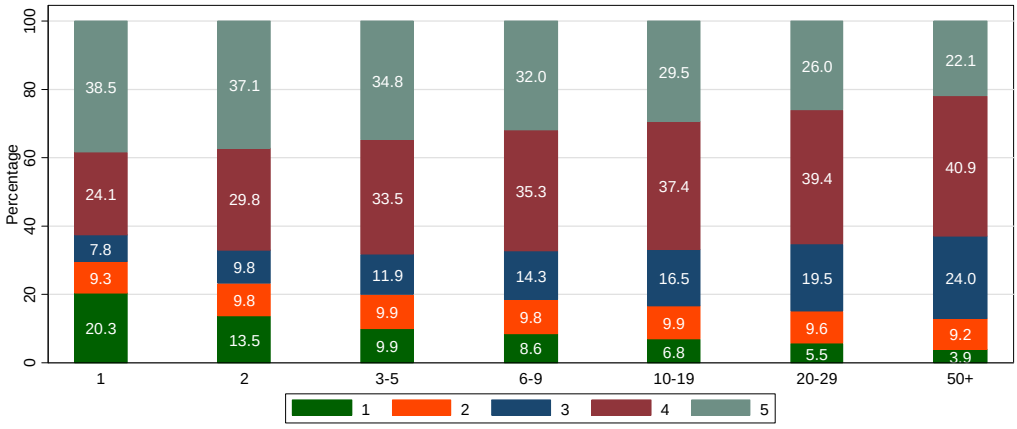
Fixed-Effect Estimates of Rating Distributions by Reviewer Group
Citysearch



Yahoo Local



Yelp



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