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Working Paper 18-088

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Abstract

Collaborating with Yelp and the City of San Francisco, we revisit a canonical example of quality disclosure by evaluating - and helping to redesign - the posting of restaurant hygiene scores on Yelp.com. Implementing a difference-in-differences strategy, we find that posting restaurant hygiene scores on Yelp leads to a 12% decrease in purchase intentions for restaurants with low scores (as predefined by the City) relative to those with higher scores. We then create a "hygiene alert" – a message that appears only for restaurants identified by the City as having "poor" operating conditions with "high-risk" hygiene violations (using the same low score threshold as above) – and find a further 9% decrease in purchase intentions. Moreover, the presence of an alert reduces the restaurant's likelihood of getting a second alert. We conclude that disclosure policy should focus not only on what information to disclose, but also on how and where to design disclosure.

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1 Introduction

Restaurants are regularly inspected for food safety violations and are given a hygiene score at the end of the inspections. Beginning in the late 1990s, there has been a movement to require restaurants to visibly post their hygiene scores on their doors, even if they received a passing score. Studying a mandatory posting policy in Los Angeles, Jin and Leslie (2003) show that posting hygiene scores led to higher demand for restaurants with higher scores, an increase in average hygiene scores, and a reduction in the rate of foodborne illness. Based largely on this study, hygiene posting is frequently cited as a success story of quality disclosure policies (Fung et al., 2007).

Despite the success of the Los Angeles initiative and broad support among public health officials, the introduction of mandatory posting is challenging from a practical perspective. The restaurant industry opposes mandatory posting of health code violations.[1] Moreover, a mandate requires cities to deliver signs to every restaurant after each inspection, and relies on restaurants to comply by posting the signs. Perhaps unsurprisingly, the vast majority of major U.S. cities thus still do not require posting, with only a few (including New York City since 2010) requiring scores to be visibly posted. To the extent that local policymakers are able to mandate disclosure of hygiene scores, posting on doors is arguably less relevant, as customers increasingly are turning to online platforms such as Yelp to search and look up information about the quality of local businesses (Luca, 2016).

The rise of online platforms raises the opportunity to revisit not only the potential for information disclosure, but also the use of a design economics lens to improve decisions about where and how disclosure is delivered. In particular, online platforms can help to supplement traditional disclosure policies in at least three different ways. First, since customers are more often using online review platforms to learn about products and services, these platforms provide the opportunity to deliver information while customers are making their decisions. Second, online platforms can reduce the costs of disclosure and help to overcome political economy constraints. For example, the City of San Francisco was unwilling to mandate disclosure by restaurants, but was willing to share data for Yelp to publicly post scores. Third, online platforms allow for more direct and immediate measurement of responses to disclosure, and the opportunity to redesign disclosure policies based on initial responses.

With this in mind, we collaborated with Yelp and the City of San Francisco to publicly post restaurant hygiene scores on Yelp and to investigate the effect of this digitized disclosure policy on consumer restaurant demand, measured by consumer behavior through Yelp. In this paper, we document the initiative and resulting impact of disclosure.

Should we expect this posting to have an effect on restaurant demand? A priori, the answer is unclear for the posting intervention in San Francisco. Before posting restaurant hygiene scores on Yelp, the city already had made the scores publicly available – although they generally were unadvertised and potentially underutilized – on the Department of Public Health website. More-

[1] For example, in a meeting we attended in a large U.S. city that was considering such a policy, a representative of the local restaurant association voiced strong opposition to such policies.

over, if the restaurant hygiene information is already embedded in the ample consumer reviews on Yelp, the posting of hygiene scores may not give any new information to consumers. Lastly, a growing body of research within psychology and behavioral economics suggests that the impact of disclosure depends not only on its informational content, but on its salience (Luca and Smith, 2013; Loewenstein et al., 2014). This implies that the effects of disclosure on Yelp might depend on the salience of the posting.

Our intervention proceeded in two stages. In the first stage, which began in early 2013, hygiene scores were introduced on Yelp for all restaurants within San Francisco – roughly 4,000 restaurants. We analyzed the impact of the initial posting using a difference-in-differences strategy, comparing changes in demand for restaurants with low hygiene scores relative to those with high scores, before and after the initiative began. We find that disclosure of scores on Yelp has an important effect on demand for restaurants with low hygiene scores. For restaurants with low scores (as predefined by the City), posting restaurant hygiene scores on Yelp leads to a 12 percent decrease in purchase intentions (a proxy for demand, drawing on factors such as whether a user calls or seeks directions to a restaurant).

The literature on behavioral economics suggests that the impact of disclosure should depend on its salience. While this has generally been studied with a descriptive lens, our goal was to explore the potential of using a design economics lens by increasing the salience of disclosure in order to increase its impact. After observing initial effects, we worked with Yelp to develop a "hygiene alert" – a salient message that appeared only for restaurants identified by the City as having "poor" operating condition with "high-risk" hygiene violations.

We find a further 9 percent decrease in purchase intentions for restaurants with an alert, nearly doubling the effect of the score posting for these businesses. Although there is no evidence on improvement of restaurant hygiene scores across all restaurants, we find a decreased probability of receiving a second alert for alert restaurants. Overall, the results of this paper, taken in conjunction with the existing literature on hygiene posting, highlight the potential for online platforms and design economics to improve the efficacy of disclosure.

2 Background

2.1 Related Research

Information about product quality is necessary for markets to function. A large theoretical literature dating back to Grossman (1981) and Milgrom (1981) has explored the conditions under which market pressure will lead firms to voluntarily disclosure information about quality. As summarized in Dranove and Jin (2010), full unravelling fails when there are costs associated with disclosure, such as seller costs to acquire quality information (Matthews and Postlewaite, 1985), uncertainty about the information (Stivers, 2004), or consumer deviations from full rationality (Fishman and Hagerty, 2003; Hirshleifer et al., 2004). In practice, voluntary disclosure is far from complete (Bundorf et al., 2009; Bederson et al., 2016).

In response, governments can require businesses to disclose information. The literature on the impact of disclosure on demand has been mixed. For example, after Los Angeles County mandated the posting of restaurant hygiene grade cards in 1998, restaurants with a grade of A received more sales than other restaurants (Jin and Leslie, 2003). Bollinger et al. (2011) find that mandatory calorie posting in Starbucks in New York City lead the average calories per transaction to fall. However, Seira et al. (2017), studying the effect of disclosure on indebted consumers in the credit card market, find no effect of interest rate disclosure on consumer indebtedness and only modest effects of comparison and de-biasing information. Our paper contributes to this literature and suggests the necessity of a shift from "does disclosure work?" to "how should disclosure be designed?".

Our paper is also closely related to the behavioral literature on responses to information. One strand of literature has found that salience affects the effectiveness of disclosure. Pope (2009) finds consumers respond to ranking of hospitals rather than the more detailed continuous scores that the ranking is based on when both are available. Luca and Smith (2013) find that college applications respond to the college ranking when the colleges are presented in the ranking order, but do not respond to ranking when colleges are presented alphabetically with the information constructing the ranking. We contribute to this literature by incorporating insights from the behavioral foundations of decision-making into the design of disclosure policies, digitizing and redesigning the disclosure policy to make it more salient to customers.

2.2 The Empirical Setting

Hygiene Scores Hygiene inspections vary by city. In San Francisco, the city's Retail Food Safety Program is overseen by the San Francisco Department of Public Health (SFDPH), which administers inspections of "restaurants, markets, and all other retail food operations," such as bars, pushcarts, and bakeries. The inspections, which occur unannounced, are used to calculate hygiene scores based on the site's compliance with health and safety regulations. Each inspection results in a score on a scale from 0 to 100; a restaurant that receives no violations will receive a score of 100, and deductions are then made for each violation. The Department of Public Health classifies violations into three types: "high risk – violations that directly relate to the transmission of food borne illnesses, the adulteration of food products and the contamination of food-contact surfaces; moderate risk – violations that are of a moderate risk to the public health and safety; low risk – violations that are low risk or have no immediate risk to the public health and safety". More serious violations are subject to larger score deductions. Depending on the hygiene score, the site is categorized as in one of the following operating conditions: "Good," with a score above 90; "Adequate," with a score between 86 and 90; "Needs Improvement," with a score between 71 and 85; and "Poor," with a score 70 or below. In particular, a"poor" operating condition is a result of several "high-risk" violations.[2]

[2]See https://www.sfdph.org/dph/EH/Food/Score/default.asp.

About Yelp Yelp is a platform where consumers can leave reviews for restaurants and other businesses. Based in San Francisco, Yelp was founded in 2004 and is part of the crowdsourcing movement. As of the time of this research, Yelp is a main source of reviews for local businesses, with more than 100 million unique visitors per month and roughly 40 million reviews. See Luca (2016) for further discussion of Yelp.

Measuring Demand Because we do not observe offline purchases, we use an array of metrics on consumer engagements with a restaurant's Yelp page to measure purchase intentions. The first metric is the number of page views, which is the number of times consumers land on the restaurant's Yelp page. The second metric, called "leads," sums the number of consumer actions taken on the business's Yelp page that are indicative of purchase intentions. It consists of clicks on the request for directions button or on the restaurant's map, clicks on the phone number to directly call the restaurant through the mobile app or mobile site, and clicks on the restaurant's own external link. The third metric is the number of reviews left on the restaurant's Yelp page. The fourth metric is the number of take-out orders the restaurant received through the Yelp platform.

Cleaner Restaurants Have More Demand In figures not shown in the draft, we plot the scatter plot and the fitted quadratic curve of each restaurant's monthly average consumer metrics and average hygiene scores throughout the sample period between May 2012 and November 2016. Overall, we see a positive but weak relationship between hygiene scores and consumer purchase intentions. The quadratic fit shows that the number of page views, leads, and reviews increases with hygiene scores at a decreasing rate. Cross sectional regression of monthly average purchase intention metrics on hygiene score and its square term using sample before the hygiene score posting also shows statistical significance. It suggests that even in the absence of hygiene posting on Yelp, restaurants with high hygiene scores have higher Yelp ratings and somewhat more demand. This is consistent with Kang et al. (2013), who find that natural language processing of Yelp reviews can help predict hygiene violations. The finding suggests that hygiene conditions could have already been incorporated to some extent in restaurant review ratings.

The San Francisco Posting Initiative on Yelp In San Francisco, restaurants are not required to disclose their hygiene scores, but the SFDPH has run the online hygiene disclosure program since well before the collaboration with Yelp. While consumers can search on SFDPH's website to find the hygiene score of any restaurant operated in San Francisco, the SFDPH has found the website's utilization rate to be low.[3] At the same time, consumers have increasingly turned to review websites for information about product quality. To reflect this trend, the SFDPH agreed to collaborate on this project and provide Yelp with a weekly feed of its scores, allowing each restaurant's hygiene score to be posted on the restaurant's Yelp page. This effort is part of Yelp's Local Inspector Value-Entry Specification (LIVES) initiative that allows municipalities to publish restaurant inspection

[3]See https://101g-xnet.sfdph.org:8443/ords/eeopn/f?p=132:1.

information to Yelp.

We initially matched 2,307 inspected restaurants with the Yelp restaurant listings, and the trial period of hygiene score posting started on January 17, 2013. By March 25, 2013, we matched hygiene scores for 3,042 restaurants in San Francisco and officially posted the scores on their Yelp pages. The average hygiene score of the matched restaurants is 91.3 and the standard deviation is 8.1. While 61.6% of the restaurants are in good condition and have scores above 90, 2.4% of restaurants are in poor condition and have scores less than or equal to 70.

3 The Effect of Hygiene Score Posting

The Yelp page of a typical business with a hygiene score is shown in Figure 1. To make the hygiene score easy to access for consumers, the score, termed "health inspection," is displayed in the restaurant information box together with other restaurant attributes. The consumer can click on the score to get more information about the restaurant's hygiene violation: for example, individual violations found in the most recent inspection of the restaurant and scores from previous inspections.

In the following section, we examine the effect of hygiene score posting on consumers. If consumers respond to the score posting, we should expect consumer purchase intentions to become more sensitive to hygiene scores. As described in the previous section, we do not observe demand, so we use various consumer engagement measures to approximate purchase intentions. We examine the effect using the following baseline specification:

$$Y_{jt} = \alpha \ln(Score_j) \times Post_t + \beta_1 Post_t + \mu_j + \epsilon_{jt} \tag{1}$$

where $Score_j$ is restaurant j's hygiene score posted on the website at the beginning of the hygiene posting period, $Post_t$ is an indicator that equals to one if the time period t belongs to the period after the hygiene score posting intervention, μ_j is the restaurant's fixed effect, and Y_{jt} are the outcomes of interest. To help compare the sizes of effects on different outcomes, we standardized the outcomes by their mean and standard deviation before the posting period. In the results we present in Table 1, we also control for the common linear time trend t and attribute-specific time trends, which interacts t with restaurant attributes such as priciness and the posted star rating of the restaurant before the score posting intervention.. The coefficient of the interactive term α identifies the impact of hygiene score posting by comparing the differential changes in outcomes between high and low scores restaurants due to score posting.

The main outcomes that approximate consumer demand are the number of consumer leads and reviews. Although the number of views of the restaurant's Yelp page could be an indicator of consumer interest, it is a worse measure of consumer response to the posting of hygiene scores than the number of leads. Consumers can only see hygiene scores once they land on a restaurant's Yelp page, and hygiene scores are not used to rank the search results of restaurants, so the page view is not directly affected by the hygiene score posting. It is possible that consumers are less likely to

revisit the restaurant's Yelp page after noticing that the restaurant has a poor hygiene score, but the effect could be secondary. We do not find a short-term effect of score posting on page views.

The identification of the differential effects of hygiene score posting on consumer purchase intentions relies on the assumption that the outcomes of restaurants with different hygiene scores would follow the same trend if there were no intervention. We check this assumption by testing differential time trends for restaurants with different hygiene scores. The results are shown in Panel A of Appendix Table A3. Using monthly standardized outcomes before the posting of hygiene scores, we do not find significant differences in the trends of outcome variables with respect to the restaurant's hygiene score. When we plot the standardized weekly outcomes for restaurants with hygiene scores above and those with scores 70 or below separately in Figure 2, we can see the two time trends closely track each other before the posting of scores.

To avoid using hygiene scores changes after the score posting due to potential endogeneity, we fix $Score_j$ in specification (1) to be the restaurant's hygiene score initially posted on Yelp, although the restaurant's score may change due to new inspections during the period of our study. During the three months after the official hygiene score posting day on March 25, 2017, 38% of the restaurants have received new inspections, but the absolute magnitudes of the changes in scores are small. The median absolute change from the original score is 4%, and 83% of the restaurants have an absolute change in score that is less than 10%. With measurement errors in the hygiene scores, we may underestimate the hygiene score posting effects.

Using monthly observations from three months before the start of hygiene score posting trial period on January 17, 2013, to three months after the start of the official hygiene score posting period on March 25, 2017, Table 1 shows the results of the regression equation (1). Since the posting efforts are not completed and not all restaurants have their hygiene score posted in the trial period, we analyze the effects in the the trial period and in the posting period separately. Panel A of Table 1 shows the results for consumer leads and reviews. In each column, we use the same specification, controlling for the common time trend, attribute-specific trends, and restaurant fixed effects.[4] For each measure, we use both standardized counts and their log-levels as the outcome. As expected, the hygiene score posting makes restaurants with higher hygiene scores more attractive to consumers. In particular, with the posting of hygiene scores, a 10% increase in hygiene scores causes the number of leads to increase by 0.022 standard deviations and by roughly 3.8% in absolute value and causes reviews to increase by 0.025 standard deviations and by 2.5% in absolute value. The point estimates for the official hygiene posting period differ only slightly from those of the trial period, and the differences are not statistically significant. Besides leads and reviews, we also examine whether the score posting affects the average rating of new reviews written about the restaurant. We present the results in Appendix Table A4. We do not find reviewer ratings to respond to the hygiene score posting.

Besides examining the differential effects with respect to continuous scores, we are also interested in effects with respect to the category of poor restaurants defined by the SFDPH. Given the high-risk

[4]Effects without controlling for time trends are larger.

hygiene violations found in the poor restaurants, it is desirable if consumers avoid such restaurants. At the initiation of the hygiene posting period, there are 60 such restaurants, or 3%. We examine the differential effects using specification (1) and replace $\ln(Score_j)$ by the indicator of whether the restaurant is poor, or ($Score_j \leq 70$). The outcomes are in panel B of Table 1. In the official posting period, we find that restaurants with hygiene scores 70 or below experience a 0.10 standard deviation reduction in the number consumer leads in the official score posting period, and a roughly 12.1% reduction in the absolute amount. The effects are smaller in the trial periods. The effect on the number of reviews is noisy and hence not statistically significant, but the negative impact is as expected. The effects are intuitively illustrated in Figure 2, in which we separately plot the weekly trend of standardized counts of leads and reviews for restaurants with scores 70 and below and those with scores above 70. The figures show that restaurants with low hygiene scores follow similar trends as those of other restaurants before the hygiene posting testing period, but the number of leads and reviews of poor restaurants falls below the levels of other restaurants immediately after the posting of hygiene scores.

4 The Effects of Hygiene Alert

4.1 The Design of Hygiene Alert

A growing economics literature has found that the impact of information depends on how salient the information is (Mullainathan et al., 2008; Kling et al., 2012; Luca and Smith, 2013). More generally, the role of attention is one of the most robust findings from the behavioral literature (DellaVigna, 2009). This raises the possibility that in practice, policymakers can take salience and limited consumer attention into account when deciding how to operationalize a disclosure policy in the field. With this in mind, we partnered with Yelp to create a second round of disclosure with increased salience, drawing attention to the hygiene information.

To attract consumers' attention, the hygiene alert, shown in Figure 1, is a message box that blocks the consumer review section of the restaurant's Yelp page. Given the salience concern, we designed the message content taking into account the factors that improve the effectiveness of disclosure discussed in Loewenstein et al. (2014) – the disclosure message should be simple, be standardized, and contain information for comparison. The alert message contains two key pieces of information. One is that the hygiene score is associated with food safety and is the result of government inspection. The other is that the alert is the result of the restaurant getting a score falling in the poor category in the most recent hygiene inspection (within six months), and the score is within the bottom 5 percent of the San Francisco score distribution.

The alert is also designed not to be too intrusive. Instead of a pop-up that blocks the entire business page , the alert box only blocks the review section, which lies below essential information such as average rating, location, and the restaurant's information box, as shown in Figure 1. In web browsers, the alert box is not immediately visible on the screen when a consumer lands on the page. On mobile devices, the alert is not visible in the first screen of the page, as shown in

Appendix Figure A1. Consumers who visits the page and leaves without scrolling down to the review section will not see the alert, for example, consumers who casually explores the restaurant. This also includes consumers who visit the restaurant's Yelp page only to make a reservation or order a takeout who don't have to scroll down the page to do so. We should take into account this design feature when interpret the size of the hygiene alert effects.

The hygiene alert was launched on October 20, 2015, simultaneously for all restaurants within San Francisco. An alternative approach would have been to randomize the posting of alert across restaurants, which would have the benefit of creating within-city variation. However, such a scheme may confuse consumers and make it difficult for them to make inferences. In particular, if a user see that a hygiene alert is posted on one low-score restaurants but not on others, the users may form wrong beliefs about what low hygiene scores imply. This is why we focus on a difference-in-differences strategy, comparing alert and non-alert restaurants.

4.2 The Effect of Hygiene Alert

We first compare attributes of restaurants with hygiene alerts and those without. Among 4471 restaurants on Yelp with hygiene scores in San Francisco, 151 restaurants have a score of 70 or below, or 3.4%. If restaurants with scores 70 or below have very low consumer ratings or very few reviews, they may not appeal to consumers and we do not need hygiene alerts to keep consumers away from these restaurants. In Appendix Figure A3, we compare restaurant attributes that have prominent presences on Yelp – price category and posted rating. The alert restaurants are slightly less likely to be very expensive and less likely to have posted ratings of 4.0 and above, but the differences are not large. Also, some restaurants with scores 70 or below have more than a thousand reviews. So based on observed restaurant attributes, consumers will not be able to distinguish alert and non-alert restaurants.

We evaluate the effect of the alert using the same specification as the one we used for estimating the effect of the score posting. We foscus on the difference-in-differences strategy that compares the changse in outcomes due to alert posing between alert and non-alert restaurants. Using standardized outcomes, the parallel trend tests do not find differential trend between alert and non-alert restaurants before the implementation of the alert, as shown in Panel B of Appendix Table A3. The parallel trends are also obvious in Figure 3.[5]

The launch of the hygiene alert does not interrupt hygiene score posting, so the effect of the alert we estimate is generated by consumer responses to the alert beyond the posted hygiene scores. If consumers have already paid attention to the scores and have fully incorporated the information content of the scores in their decisions, we expect no consumer response to the hygiene alert. In addition, several factors could dampen the effect of the hygiene alert. First, as discussed above, consumers will not see the hygiene alert if they do not scroll down the screen, so not all consumers landing on a restaurant's page will notice the alert. Second, as consumers take into account review

[5]Note that the outcome variables in their original levels differ between alert and non-alert restaurants. Figure 3 shows no difference before the alert since we have standardized the outcomes by their mean levels before the alert.

ratings when they choose restaurants, more than 70% of the alert restaurants have a review rating 3.5, the median posted rating on Yelp, or above. . Third, consumers who have visited the alert restaurant and had a good experience with it before the alert may choose to trust their own experience more than the alert.

Using monthly data from three months before the alert launch to three months after, we evaluate the effect of hygiene alerts on the number of consumer leads and reviews. In addition, Yelp launched a delivery partnership service, Eat24, on its platform in mid-2013, so we are able to obtain the data on takeout orders for restaurants that have signed up to use Eat24. The estimates of the effects of the alert is shown in Table 2, identified by the coefficient of "Alert Period×(Score≤70)". We show the effects on consumers in column (1)-(6). We find that hygiene alerts reduced reduced the number of consumer leads at alert restaurants by 0.07 standard deviations, reviews by 0.10 standard deviations, orders by 0.11 standard deviations. Using log-level outcomes, we find that alerts reduce alert restaurants' number of leads by 7.4%, reviews by 11.3%, and takeout orders by 12.8%. The effect on orders is not statistically significant. The effects are also illustrated in Figure 3. The figures clearly show a negative effect in all three outcomes. The results shows that alerts further reduce consumer demand for dirty restaurant, but the extra effects of the alert are slightly smaller than those of the initial score posting. In Appendix Table A5, we also test the effect of the alert on review ratings and the value per takeout order. The effects are all small and statistically insignificant.

The negative effects of the hygiene alert suggests that the alert message did deliver new information to consumers, even though they have already been presented with hygiene scores. But did the alert prompt consumers to pay more attention to hygiene scores in general? If the alert increases consumer attention to hygiene scores, we might expect consumers to become more sensitive to hygiene scores after the posting of the alerts even at restaurants without alerts. To test this, we drop all alert restaurants and test whether non-alert restaurants with higher hygiene scores differentially enjoy better outcomes after the implementation of alerts. As the results in Panel A and C of Appendix Table A6 show, we do not find such an effect in the short run. In an alternative specification shown in Panel B of Appendix Table A6, we compare restaurants with scores between 60 and 70 and restaurants with scores between 70 and 80. The effect sizes identified are similar to the effected identified using the full sample, suggesting that the effects come mainly from consumers responding to restaurants with alerts.

5 Discussion

Our results contribute to the literatures on the economics of digitization, quality disclosure, and behavioral economics. By circumventing some of the typical challenges involved in mandatory disclosure on doors, a partnership with Yelp and the City of San Francisco allowed us to visibly disclose hygiene scores at a time when customers were actively searching for restaurants using review websites. The setting also allowed us to vary the salience of disclosure, drawing on insights

from the behavioral economics literature.

We also examined restaurant responses to the posting of hygiene scores and alerts. As shown in Appendix Table A7, we find that after the implementation of hygiene alerts, restaurants that got an alert are less likely to get a second alert compared to non-alert restaurants. However, we do not see evidence of broader improvement of hygiene scores, perhaps because the posting the hygiene scores on Yelp was less salient to restaurants than in situations in which they are required to post scores on their doors.

Overall, our results suggest that policymakers and managers should think not only about what information to disclose, but also how disclosure should be designed. Moreover, online platforms present new opportunities to understand and design disclosure policies.

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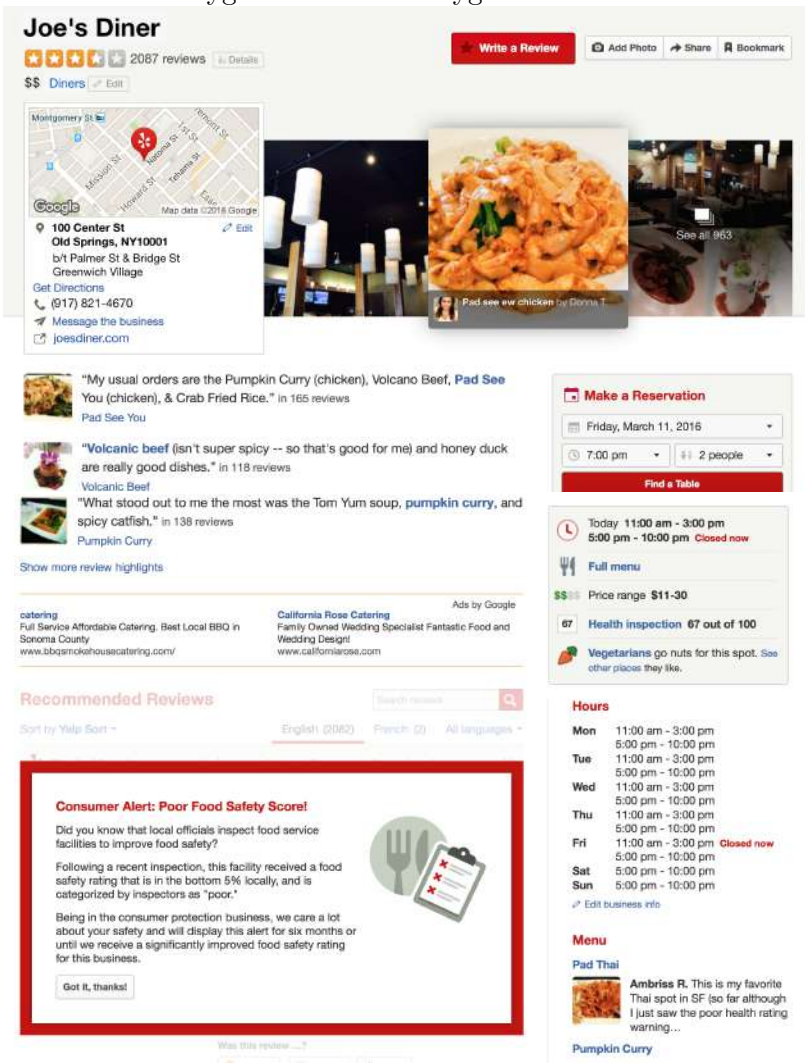
Figures and Tables

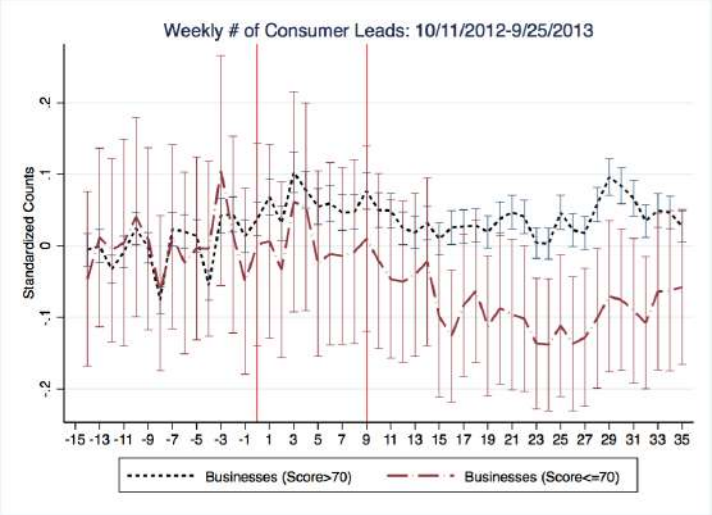
Figure 1: Screenshot of the Hygiene Score and Hygiene Alert on a Restaurant's Yelp Page



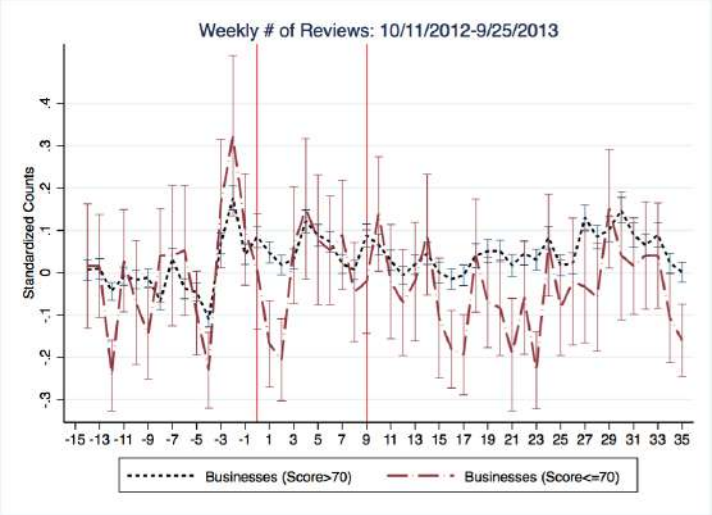
Note: **1** The figure above shows the hygiene alert on a restaurant's Yelp page. The hygiene score, 67, is shown in the information box on the right. **2** The hygiene alert blocks the consumer reviews section. The alert is visible only to users who scroll to read reviews. **3** Consumers can get more information, such as specific hygiene violations during the restaurant inspection, by clicking the "Health Inspection" link beside the score.

Figure 2: The Impact of Posting on Purchase Intentions

(a)

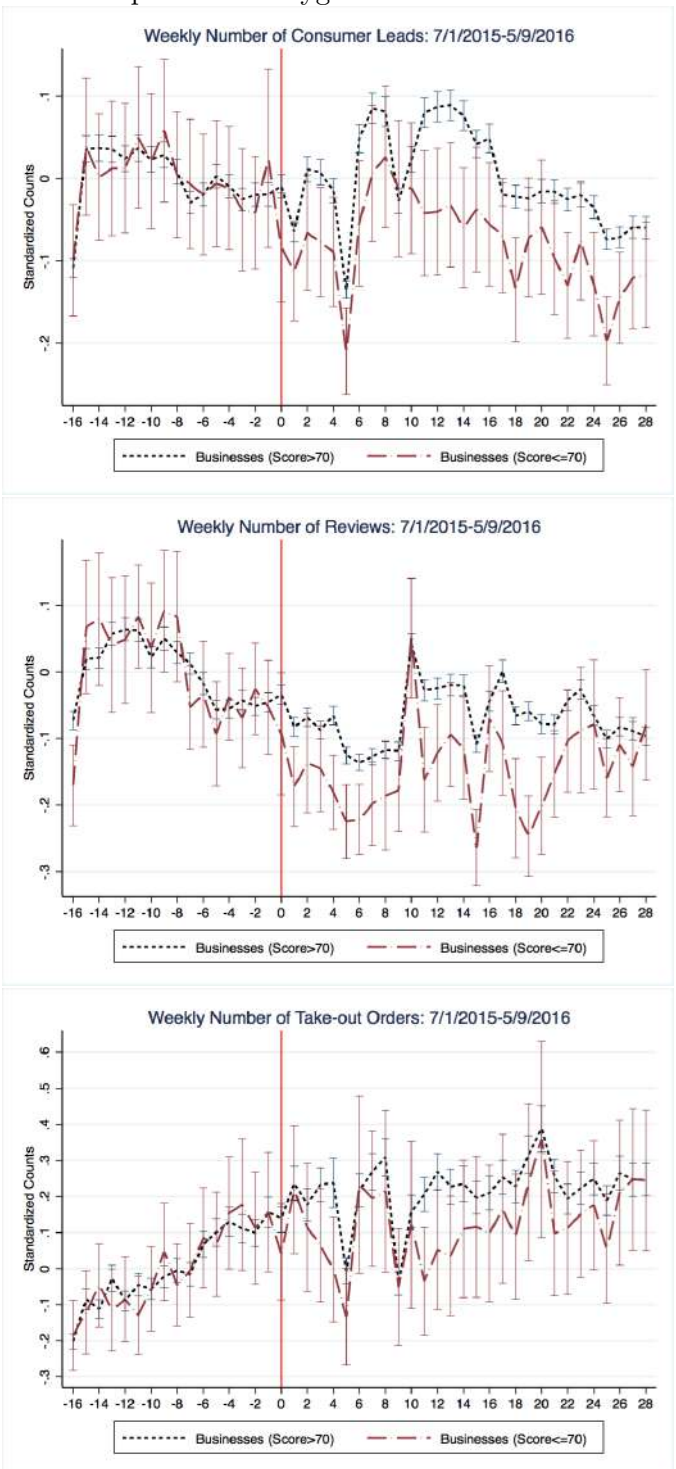


(b)



Note: **1** The figures plot the standardized weekly counts of consumer leads (the top figure) and reviews (the bottom figure) with standard error bars separately for businesses with hygiene scores above 70 and businesses with hygiene scores of 70 or below. Consumer leads consist of calls to businesses through the Yelp app or mobile website, clicks on the business's URL on its Yelp page, and clicks on the direction request button or the business's map on its Yelp page. **2** The standardization is done using the sample mean and standard deviation within 15 weeks before the score posting interventions. **3** The two vertical lines represent the start of the health score posting trial period on 1/17/2013 and the official posting period on 3/25/2013.

Figure 3: The Impact of the Hygiene Alert on Purchase Intentions



Note: **1** The figures plot the standardized weekly counts of consumer leads (top left), reviews (top right), and takeout orders (bottom) with standard error bars separately for businesses with hygiene scores above 70 and businesses with scores of 70 or below. **2** The standardization is done using the sample mean and standard deviation within 16 weeks before the hygiene alert interventions. **3** The vertical line represents the week that the hygiene alert was implemented (10/20/2015).

Table 1: The Impact of Score Posting on Purchase Intentions

Panel A. *Differential effects by Ln(Score)*				
	(1) Standardized # of Leads	(2) Ln(# of Leads)	(3) Standardized # of Reviews	(4) Ln(# of Reviews)
Trial Period× Ln(Score)	0.218	0.383	0.227	0.247
	(0.0524)	(0.108)	(0.0910)	(0.109)
Posting Period× Ln(Score)	0.211	0.427	0.196	0.192
	(0.0608)	(0.125)	(0.0991)	(0.0931)
N	16,409	16,409	15,499	15,499

Panel B. *Differential effects by the 70 cutoff*				
	(1) Standardized # of Leads	(2) Ln(# of Leads)	(2) Standardized # of Reviews	(4) Ln(# of Reviews)
Trial Period× (Score≤70)	-0.0558	-0.106	-0.0685	-0.0661
	(0.0198)	(0.0676)	(0.0483)	(0.0651)
Posting Period× (Score≤70)	-0.101	-0.124	-0.0926	-0.0797
	(0.0350)	(0.0658)	(0.0654)	(0.0548)
N	16,409	16,409	15,499	15,499

Note: **1** All linear regression specifications control for restaurant fixed effects, period dummies (trial period and posting period), a linear time trend, and attribute-specific linear time trends. The attribute-specific trends are the interaction terms between time trend and restaurant attributes, including priciness and the posted star rating of the restaurant before the score posting intervention. Standard errors are clustered at the business level. **2** The regressions use monthly data at the business-level between 10/16/2012 and 6/20/2013, from three months before the trial period started on 1/17/2013 to three months after the official posting period started on 3/25/2013. Month 0 starts on 1/17/2013, and we assume 31 days for each month. The trial period lasts a little less than two months, and we take months 0-1 as the trial period and 2-4 as the posting period. **3** The hygiene score of a restaurant is its score in the most recent inspection before 1/17/2013. Among all restaurants, 2,038 have hygiene scores above 70, and 60 have scores of 70 or below. **4** Dependent variables are standardized by the mean and standard deviation during the period before score posting. **5** We drop restaurants that have never received any review in the entire sample period in the regression for reviews, which causes the drop in the sample size in Column (3) and (4).

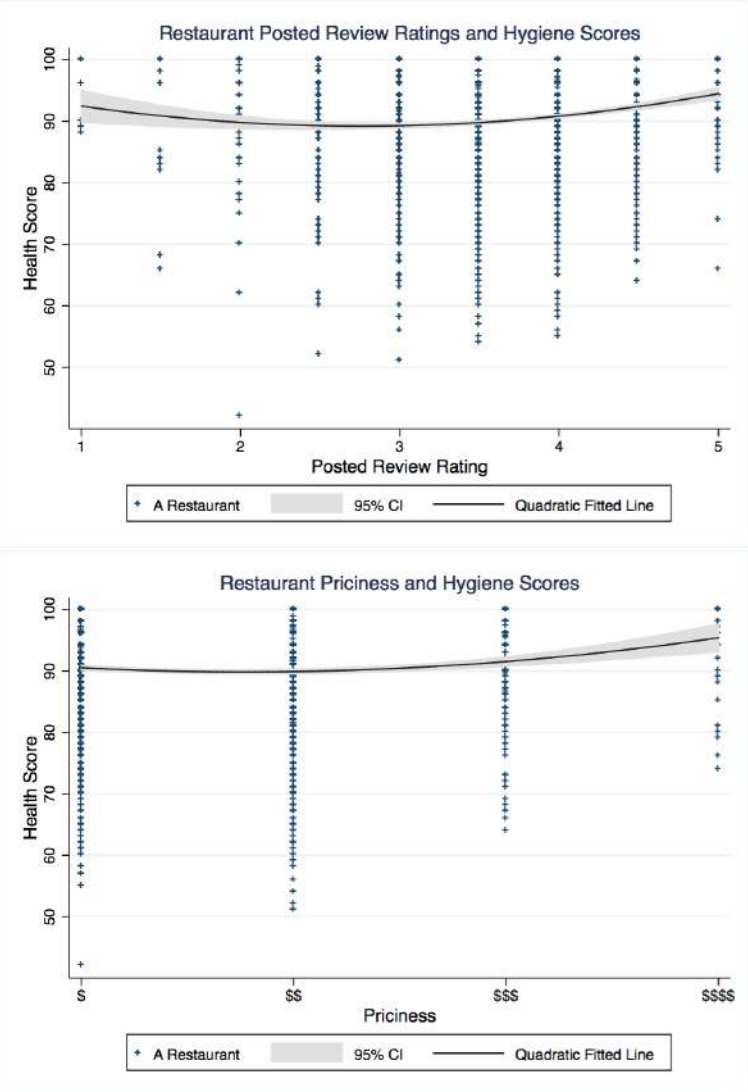
Table 2: The Impact of the Hygiene Alert on Purchase Intentions

	(1) Standardized # of Leads	(2) Ln(# of Leads)	(3) Standardized # of Reviews	(4) Ln(# of Reviews)	(5) Standardized # of Orders	(6) Ln(# of Orders)
Alert Period× (Score≤70)	-0.0657	-0.0738	-0.0982	-0.113	-0.111	-0.128
	(0.0247)	(0.0360)	(0.0314)	(0.0370)	(0.0728)	(0.120)
Alert Period	0.00902	-0.0329	-0.0376	-0.0505	0.0433	0.0216
	(0.00302)	(0.00895)	(0.00852)	(0.0123)	(0.0244)	(0.0303)
N	26,911	26,911	24,359	24,359	5,011	5,011

Note: **1** The specifications in column (1)-(6) are the same as in Table 1. **2** The regressions in column (1)-(6) use monthly data at the business level between 7/1/2015-1/31/2016, from three months before to three months after the implementation of the hygiene alert on 10/20/2015. Month 0 starts on 10/20/2015, and we assume 31 days for each month. The hygiene score of a restaurant is its score in the most recent inspection before 10/20/2015. Among all restaurants, 4,336 have hygiene scores above 70, and 149 have scores 70 or below. Dependent variables are standardized by the mean and standard deviation during the period before the hygiene alert. **4** The drop in sample size in the regression for reviews is due to dropping restaurants with zero reviews in the sample period. Only restaurants that have signed up on Yelp's EAT24 platform has take-out order data available, so we have a much smaller sample for regressions in Column (5) and (6).

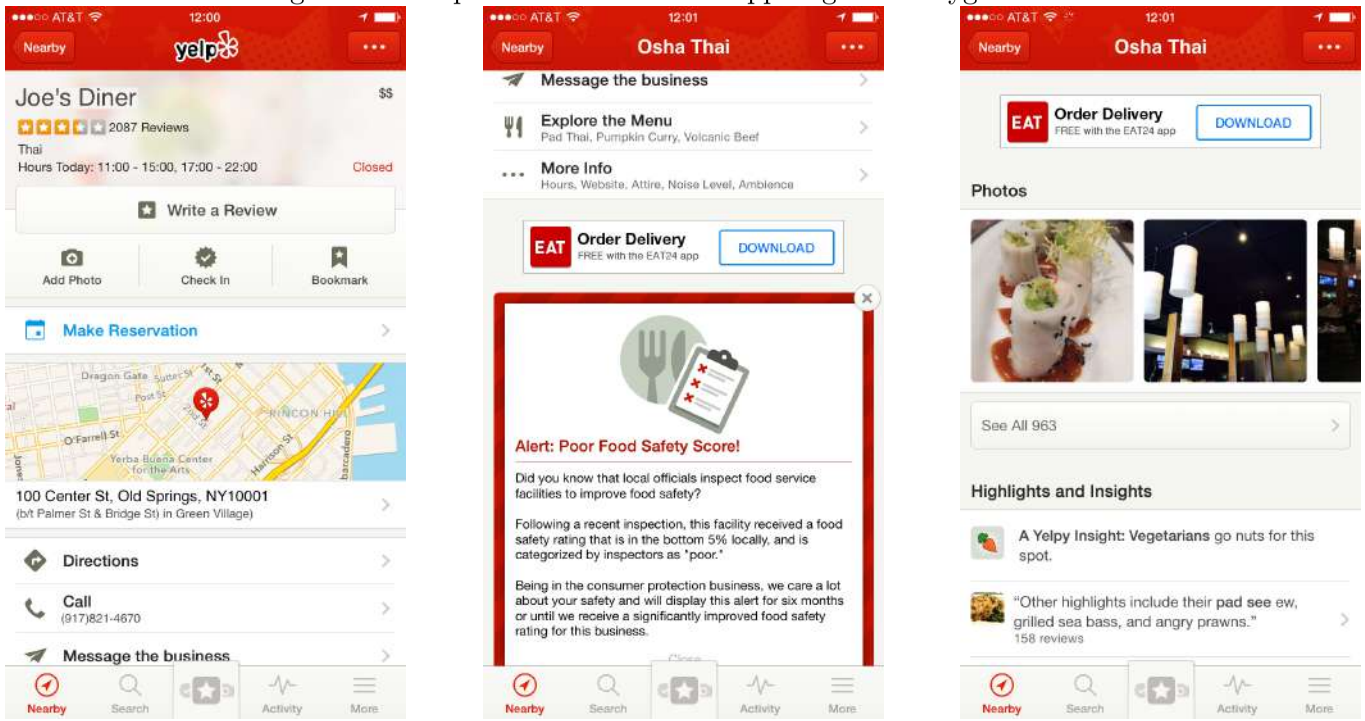
Appendix

Figure A2: Baseline Correlation Between Hygiene Scores and Restaurant Attributes



Note: The figures show scatter plots of restaurant hygiene score and displayed rating, and hygiene score and price, fitted with quadratic curves. Restaurant characteristics are captured before the hygiene alert posting period.

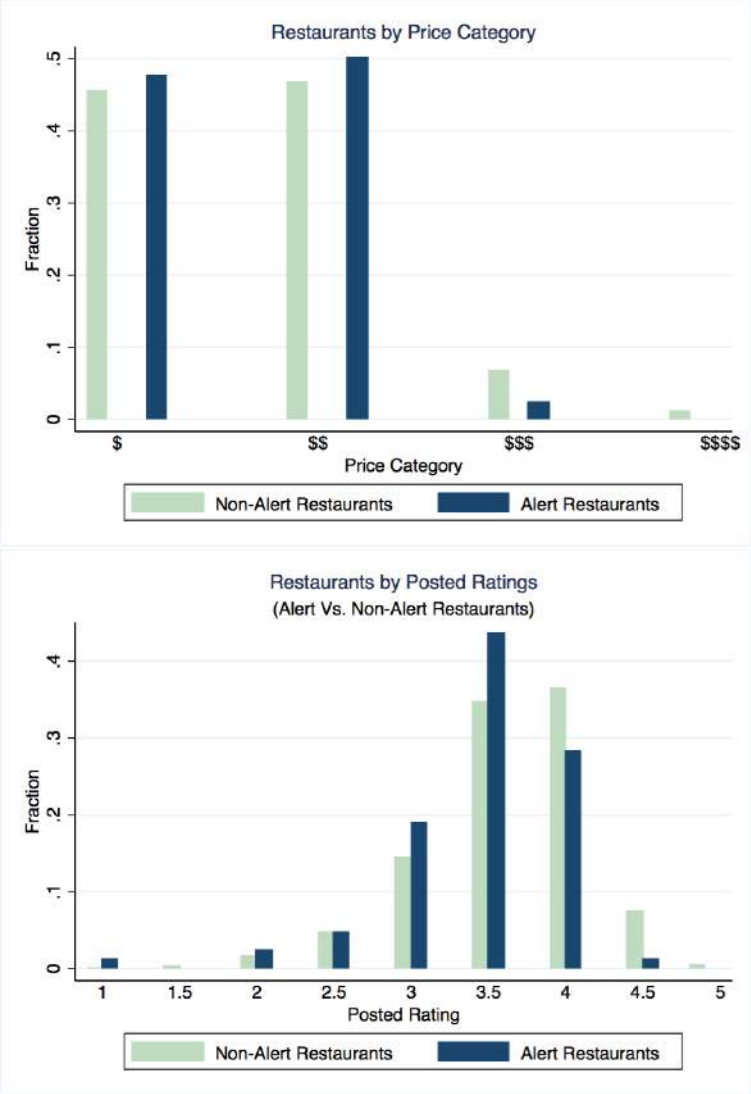
Figure A1: Yelp Restaurant Mobile App Page with Hygiene Alert



A. Top of the App Screen B. Scrolling Down the App Screen C. After Closing the Hygiene Alert Box

Note: In the mobile app, the hygiene alert blocks the photos and reviews section. The alert is not visible to the consumers who do not scroll down the page.

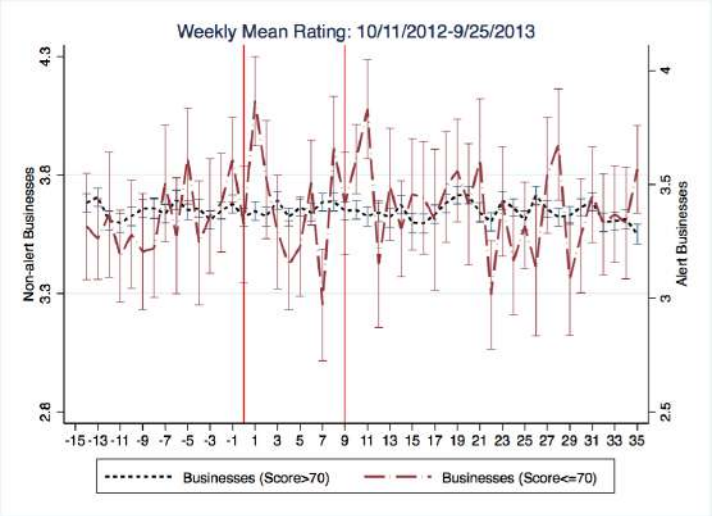
Figure A3: Baseline Restaurant Attributes with and without Alerts



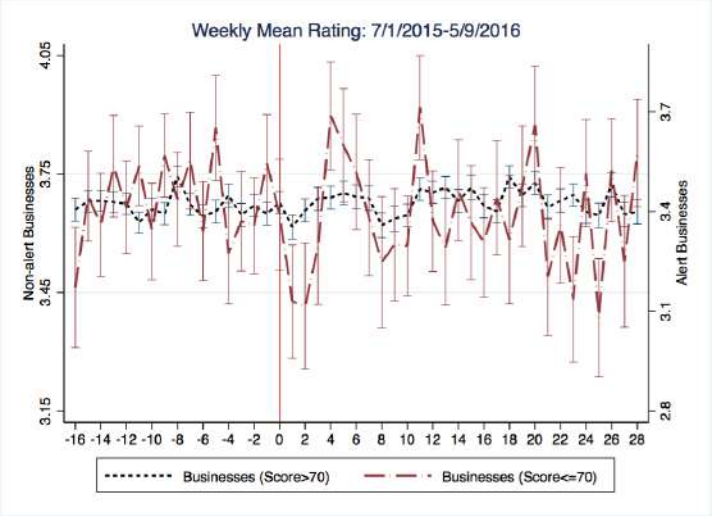
Note: **1** The figures compare observed restaurant attributes between alert restaurants (hygiene score$\leq$70) and non-alert restaurants (hygiene score$>$70). There are 151 alert restaurants and 4,471 non-alert restaurants. All attributes are captured before the implementation of hygiene alert.

Figure A4: The Impact on Yelp Ratings

A. *Effects of score posting*



B. *Effects of hygiene alerts*



Note: **1** The figures plot the weekly average rating of new reviews left on the restaurants and the average trustworthiness of these reviews with standard error bars separately for businesses with scores of 70 and below and businesses with scores above 70. **2** The two vertical lines in the top figures represents the week that hygiene score posting is launched in the trial period (1/17/2013) and officially (3/25/2013). The vertical line in the bottom figures represents the week that the hygiene alert is implemented (10/20/2015).

Table A1: Two Interventions in San Francisco and the Population of Restaurants Directly Affected

	Intervention	Effective Time	Yelp Efforts and Restaurants Affected
1	Hygiene scores are posted on Yelp	(Trial Period) 2013/1/17– 2013/3/25	• Yelp publicly announces the hygiene score posting program on its official blog and on various media outlets • Hygiene scores are posted on the Yelp pages of San Francisco restaurants matched with SFDPH records
		(Official Posting Period) 2013/3/25–present	• Hygiene scores are posted on the Yelp pages of all San Francisco restaurants matched with SFDPH records
2	A hygiene alert is issued for restaurants with "poor" operating conditions	2015/10/20–present	• Consumer alerts are posted on 151 restaurants identified as having "poor" operating condition by the SFDPH in the most recent inspection within 6 months (hygiene score$\leq$70).

Table A2: Hygiene Score Categories and Interpretations

- High Risk: Violations that directly relate to the transmission of foodborne illnesses, the adulteration of food products ,and the contamination of food-contact surfaces.
- Moderate Risk: Violations that are of a moderate risk to the public health and safety.
- Low Risk: Violations that are low risk or have no immediate risk to the public health and safety.

Score	**Operating Condition Category**	**Inspection Findings**
>90	Good	• Typically, only lower-risk health and safety violations observed • May have high-risk violations
86-90	Adequate	• Several violations observed • May have high-risk violations
71-85	Needs Improvement	• Multiple violations observed • Typically, several high-risk violations
Less than or equal to 70	Poor	• Multiple violations observed • Typically, several high-risk violations

Note: The above table is replicated from the website of the San Francisco Department of Public Health (https://www.sfdph.org/dph/EH/Food/Score/default.asp)

Table A3: Pre-trend Tests Before Interventions

Panel A. *Pre-trend tests before the hygiene score posting intervention*

	(1) Standardized # of Leads	(2) Standardized # of Reviews	(3) Rating
$t \times \ln(Score)$	0.0418	-0.129	0.0689
	(0.0432)	(0.0854)	(0.151)
t	-0.179	0.618	-0.301
	(0.192)	(0.385)	(0.679)
$\ln(Score)$	0.480**	-0.0909	1.127***
	(0.238)	(0.301)	(0.358)
N	6,149	5,806	4,400

Panel B. *Pre-trend tests before the hygiene alert intervention*

	(1) Standardized # of Leads	(2) Standardized # of Reviews	(3) Rating	(4) Standardized #Orders
$t \times (Score \leq 70)$	0.00620	-0.0330	0.0462	0.0165
	(0.0135)	(0.165)	(0.0569)	(0.0334)
t	-0.0273***	-0.422***	-0.000478	0.103***
	(0.00197)	(0.0307)	(0.0112)	(0.0110)
$(Score \leq 70)$	0.0116	0.0622	-0.0807	0.0330
	(0.0818)	(0.421)	(0.134)	(0.194)
N	13,600	12,262	9,780	2,529

Standard errors in parentheses, clustered at the business level. * p<0.10, ** p<0.05, *** p<0.01

Note: **1** This table reports linear regression results investigating the differential pre-trends before the hygiene score posting intervention (Table A) and the hygiene alert intervention (Table B). **2** The samples for the regressions in Table A are monthly observations at the business level during the three months before the hygiene score posting trial period started on 1/17/2013. The samples for Table B are monthly observations at the business level during the three months before the hygiene alert program started on 10/20/2015.

Table A4: The Impact of Score Posting (Log Vs. Negative Binomial, Effects on Ratings)

Panel A. *Differential effects by Ln(Score)*

	(1) Ln(# of Leads)	(2) # of Leads	(3) Ln(# of Reviews)	(4) # of Reviews	(5) Rating
Trial Period× Ln(Score)	0.383***	0.368***	0.247**	0.333***	0.0841
	(0.108)	(0.0778)	(0.109)	(0.125)	(0.198)
Posting Period× Ln(Score)	0.427***	0.389***	0.192**	0.281**	-0.0636
	(0.125)	(0.0684)	(0.0931)	(0.115)	(0.172)
N	16,409	16,409	15,499	15,499	11,838
Fixed Effects	Business	Business	Business	Business	Business
Model	Linear	Negative Binomial	Linear	Negative Binomial	Linear

Panel B. *Differential effects by the 70 score cutoff*

	(1) Ln(# of Leads)	(2) # of Leads	(3) Ln(# of Reviews)	(4) # of Reviews	(5) Mean Rating
Trial Period× (Score≤70)	-0.106	-0.121***	-0.0661	-0.103	0.00312
	(0.0676)	(0.0466)	(0.0651)	(0.0699)	(0.107)
Posting Period× (Score≤70)	-0.124*	-0.158***	-0.0797	-0.122*	0.0779
	(0.0658)	(0.0409)	(0.0548)	(0.0639)	(0.0875)
N	16,409	16,409	15,499	15,499	11,838
Fixed Effects	Business	Business	Business	Business	Business
Model	Linear	Negative Binomial	Linear	Negative Binomial	Linear

a. Standard errors in parentheses, clustered at the business level. * p<0.10, ** p<0.05, *** p<0.01

b. All regressions have controlled for period dummies, a linear time trend, and attribute-specific linear time trends. The results are similar without controlling for the time trends.

Note: **1** Panel A reports regression results examining the differential effects of the hygiene score posting on consumer activities based on log-levels of hygiene scores, and Panel B reports results based on the 70 score cutoff. **2** The regressions use the same sample as the ones reported in Table 1. Results of the alternative negative binomial specification are reported.

Table A5: The Impact of Hygiene Alerts (Log Vs. Negative Binomial, Effects on Ratings and Orders)

Panel A. *Effects on leads and reviews.*

	(1) Ln(# of Leads)	(2) # of Leads	(3) Ln(# of Reviews)	(4) # of Reviews	(5) Mean Rating
Alert Period× (Score≤70)	-0.0738**	-0.0943***	-0.113***	-0.144***	-0.101
	(0.0360)	(0.0205)	(0.0370)	(0.0403)	(0.0721)
Alert Period	-0.0329***	-0.00945	-0.0505***	-0.0597***	-0.0114
	(0.00895)	(0.00741)	(0.0123)	(0.0151)	(0.0268)
N	26,911	26,911	24,359	24,359	18,999
Fixed Effects	Business	Business	Business	Business	Business
Model	Linear	Negative Binomial	Linear	Negative Binomial	Linear

Panel B. *Effects on take-out orders.*

	(1) Ln(# of Orders)	(2) # of Orders	(3) Value per Order ($)
Alert Period× (Score≤70)	-0.128	-0.147**	0.480
	(0.120)	(0.0656)	(0.722)
Alert Period	0.0216	0.0525	0.581
	(0.0303)	(0.0375)	(0.804)
N	5,011	5,011	4,179
Fixed Effects	Business	Business	Business
Model	Linear	Negative Binomial	Linear

a. Standard errors in parentheses, clustered at the business level. * p<0.10, ** p<0.05, *** p<0.01

b. All the regressions have controlled for period dummies, a linear time trend, and attribute-specific linear time trends. The results are similar without controlling for the time trends.

Note: **1** The regressions use the same sample as the ones reported in Table 2. Results of the alternative negative binomial specification are reported. **2** This table shows that the hygiene alert has no effect on the mean rating of trustworthiness of new reviews left for the restaurant or on the value of the orders consumers placed.

Table A6: Falsification Exercises: Analysis with Alternative Sample and Alert Threshold

A. Use sample of restaurants above the alert threshold. Test impacts on restaurants with score (70,75] and (75,100].

	(1) Standardized # of Leads	(2) Standardized # of Reviews	(3) Standardized # or Orders
Alert Period ×(Score≤75)	0.0117	0.0118	0.0603
	(0.0216)	(0.0305)	(0.144)
Alert Period	0.00957***	-0.0388***	0.0411
	(0.00310)	(0.00871)	(0.0254)
N	26116	23518	4697
Fixed Effects	Business	Business	Business
Model	Linear	Linear	Linear

B. Compare the impact on restaurants restaurants just above (70,80] and just below (60,70]the alert threshold.

	(1) Standardized # of Leads	(2) Standardized # of Reviews	(3) Standardized # of Orders
Alert Period ×(Score≤70)	-0.0893***	-0.0992***	-0.167
	(0.0293)	(0.0345)	(0.104)
Alert Period	0.0104	-0.0341*	0.0886
	(0.00979)	(0.0204)	(0.0595)
N	3329	3088	878
Fixed Effects	Business	Business	Business
Model	Linear	Linear	Linear

C. Use the sample of restaurants above the alert threshold. Test differential impacts on restaurants with respect to hygiene scores.

	(1) Standardized # of Leads	(2) Standardized # Reviews	(3) Standardized # Orders
Alert Period ×Ln(Score)	0.0103	-0.0845	-0.438
	(0.0115)	(0.0644)	(0.282)
Alert Period	0.00902***	0.343	2.010
	(0.00321)	(0.290)	(1.265)
N	26116	23518	4697
Fixed Effects	Business	Business	Business
Model	Linear	Linear	Linear

Standard errors in parentheses, clustered at the business level. * p<0.10, ** p<0.05, *** p<0.01

Note: The regressions use the same sample as the ones reported in Table 2. In this section, we conduct robustness and placebo tests using alternative samples and placebo cutoffs for hygiene alert.

Table A7: Do Alerts Improve Future Scores?

	(1) (Score≤70)	(2) (Score≤70)
(LagScore≤70)×1st Inspection after Alert	-0.114**	-0.233***
	(0.0527)	(0.0757)
(70<LagScore≤85)×1st Inspection after Alert	0.0140	0.0248
	(0.0136)	(0.0187)
(LagScore≤70)	-0.182***	0.0424
	(0.0257)	(0.0495)
(70<LagScore≤85)	-0.00138	-0.00739
	(0.00598)	(0.0137)
Ist Inspection after Alert	-0.000282	-0.00573
	(0.00449)	(0.0145)
Month Dummies	x	x
Linear Time Trend (by month)	x	x
Business Fixed Effects	x	x
	15,754	8,209

Standard errors in parentheses, clustered at the business level. * p<0.10, ** p<0.05, *** p<0.01

Note: **1** The table reports panel regression results that investigate hygiene score changes for restaurants that had a score of 70 or below in the previous inspection. **2** The sample in Columns (1) consists of all inspections before the alert period and the first inspection after the alert. The sample in Columns (2) only includes the last inspection before the alert period and the first inspection after the alert.