

## Online Appendices for

“The Value of Multi-dimensional Rating Systems:  
Evidence from a Natural Experiment and Randomized Experiments”

## Appendix A: Additional Robustness Checks

It is possible that restaurant operations are affected by season. We control for seasonality and we do find restaurant ratings are higher in winter than in other seasons. However, the results of variables of interest still hold after we control for seasonality. Table A1 shows the results of Equation [1]. Table A2 shows the results of Equation [2] (in the main text) and Table A3 shows the results of Equations [4] to [6] when we control for seasonality. The coefficients of interest are the same signs and similar magnitudes before and after controlling for seasonality.

<b>Table A1. Downward Trend in the SD System (DV = Rating)</b>				
Sample:	Before System Change		After System Change	
	<i>Yelp</i>	<i>TripAdvisor</i>	<i>Yelp</i>	<i>TripAdvisor</i>
	Model 1	Model 2	Model 3	Model 4
Number of total reviews	-0.113***	-0.0507*	-0.0213**	0.0866***
	(0.0117)	(0.0202)	(0.00655)	(0.00970)
Season1	0.0256	0.0122	0.0143	-0.0109
	(0.0234)	(0.0395)	(0.00905)	(0.0129)
Season2	0.0201	-0.0154	0.0215*	0.00836
	(0.0236)	(0.0433)	(0.0103)	(0.0146)
Season3	0.0188	-0.0511	0.00401	0.0205
	(0.0237)	(0.0450)	(0.0103)	(0.0132)
Constant	4.104***	4.058***	3.762***	3.780***
	(0.0416)	(0.0506)	(0.0324)	(0.0442)
Restaurant FE	Yes	Yes	Yes	Yes
Prob>F	0	0	0	0
Observations	18,388	8,917	166,670	69,024

*Note:* Cluster-robust standard error in parentheses; \*\*\* p<0.001, \*\*p<0.01, \* p<0.05

<b>Table A2. DID Analysis (DV = Rating)</b>		
Sample:	All Data	Data of 2007-2010
<i>Post</i>	-0.126***(0.0169)	-0.0390*(0.0180)
<i>Treat</i>	0.0765***(0.0219)	0.0607*(0.0240)
<i>Post*Treat</i>	0.402***(0.0212)	0.153***(0.0269)
Number of total reviews	0.00125(0.00533)	-0.0450***(0.00995)
Season1	0.0156*(0.00696)	0.0343**(0.0122)
Season2	0.0176*(0.00760)	0.0366**(0.0134)

Season3	0.00387(0.00745)	0.0309*(0.0136)
Constant	3.784***(0.0217)	3.889***(0.0360)
Restaurant FE	Yes	Yes
Prob>F	0	0
Observations	262,999	79,826

Note: Cluster-robust standard error in parentheses; \*\*\* p<0.001, \*\*p<0.01, \* p<0.05

**Table A3. Estimation of Rating Deviation (DV=Rating Deviation)**

Sample:	<i>Yelp After System Change</i>	<i>TripAdvisor After System Change</i>	<i>Yelp and TripAdvisor After System Change</i>
	Model 1	Model 2	Model 3
Number of total reviews	0.0396***(0.00362)	-0.0592***(0.00567)	0.0152***(0.00327)
Treat			-0.00245(0.0207)
Number of total reviews*Treat			-0.0141**(0.00503)
Season1	-0.0242***(0.00561)	-0.00597(0.00790)	-0.0222***(0.00473)
Season2	-0.0213***(0.00637)	-0.000243(0.00836)	-0.0158**(0.00510)
Season3	-0.0141*(0.00615)	-0.0113(0.00821)	-0.0125*(0.00509)
Constant	0.672***(0.0178)	1.052***(0.0256)	0.790***(0.0160)
Restaurant FE	Yes	Yes	Yes
Prob>F	0	0	0
Observations	166,670	69,024	235,694

Note: Cluster-robust standard error in parentheses; \*\*\* p<0.001, \*\*p<0.01, \* p<0.05

Second, we used more than 50,000 observations in our main analysis. It is easier to obtain small  $p$  values with such a large sample (Lin et al 2013). To rule out large sample being the reason, we randomly subsample the data with 200 restaurants which leaves us fewer than 10,000 observations and the significant slopes persist. Tables A4, A5 and A6 show the results of Equations [1] to [6] when we use subsample data. The coefficients of interest are the same signs and similar magnitudes when we use random subsample.

**Table A4. Downward Trend in the SD System(DV = Rating)**

Sample:	Before System Change		After System Change	
	<i>Yelp</i>	<i>TripAdvisor</i>	<i>Yelp</i>	<i>TripAdvisor</i>
	Model 1	Model 2	Model 3	Model 4
Number of total reviews	-0.132***	-0.0342	-0.0301*	0.093***
	(0.029)	(0.044)	(0.014)	(0.024)

Constant	4.23*** (0.0935)	3.99*** (0.125)	3.84*** (0.068)	3.76*** (0.102)
Restaurant FE	Yes	Yes	Yes	Yes
Prob>F	0	0.5	0	0.02
Observations	3,359	1,460	30,779	11,550

Note: Cluster-robust standard error in parentheses; \*\*\* p<0.001, \*\*p<0.01, \* p<0.05

**Table A5. DID Analysis (DV = Rating)**

Sample:	All Data	Data of 2007-2010
Post	-0.163***(0.0377)	-0.0517(0.0435)
Treat	-0.015(0.05)	-0.013(0.05)
Post*Treat	0.503***(0.046)	0.202***(0.073)
Number of total reviews	-0.0004(0.012)	-0.0498*(0.022)
Constant	3.85***(0.049)	3.98***(0.07)
Restaurant FE	Yes	Yes
Prob>F	0	0
Observations	47,148	14,536

Note: Cluster-robust standard error in parentheses; \*\*\* p<0.001, \*\*p<0.01, \* p<0.05

**Table A6. Estimation of Rating Deviation (DV=Rating Deviation)**

Sample:	<i>Yelp After System Change</i>	<i>TripAdvisor After System Change</i>	<i>Yelp and TripAdvisor After System Change</i>
	Model 1	Model 2	Model 3
Number of total reviews	0.0253**(0.008)	-0.0627***(0.0136)	0.008(0.0076)
Treat			0.0464(0.0527)
Number of total reviews*Treat			-0.0255*(0.0126)
Constant	0.711***(0.04)	1.064***(0.058)	0.803***(0.037)
Restaurant FE	Yes	Yes	Yes
Prob>F	0	0.01	0
Observations	30,779	11,550	42,329

Note: Cluster-robust standard error in parentheses; \*\*\* p<0.001, \*\*p<0.01, \* p<0.05

Third, we use Tobit analysis to account for censoring of Equation [1] and Equation [2] where the dependent variable is the overall rating. And the results are shown in Table A7 and A8. The results are consistent to those of OLS regressions.

**Table A7. Downward Trend in the SD System (DV = Rating)**

Sample:	Before System Change		After System Change	
	<i>Yelp (SD)</i>	<i>TripAdvisor (SD)</i>	<i>Yelp (SD)</i>	<i>TripAdvisor (MD)</i>

	Model 1	Model 2	Model 3	Model 4
<b>Number of total reviews</b>	<b>-0.156***</b> <b>(0.012)</b>	-0.14	<b>-0.027**</b> <b>(0.006)</b>	<b>0.139***</b> <b>(0.012)</b>
Constant	4.97*** (0.588)	14.93	3.89*** (0.16)	3.94*** (0.26)
Restaurant FE	Yes	Yes	Yes	Yes
Prob>chi2	0		0	0
Observations	18,388	8,917	166,670	69,024

Note: \*\*\* p<0.001, \*\*p<0.01, \* p<0.05; Model 2 doesn't fit using Tobit analysis when control for restaurant fixed effect, but results of model 1, 3 and 4 are the same signs and similar magnitudes.

<b>Table A8. DID Analysis (DV = Rating)</b>		
Sample:	All Data	Two years before and after system change (2007-2010)
<i>Post</i>	-0.167*** (0.016)	-0.043* (0.018)
<i>Treat</i>	0.144*** (0.022)	0.108*** (0.022)
<b><i>Post*Treat</i></b>	<b>0.65*** (0.023)</b>	<b>0.266*** (0.029)</b>
Number of total reviews	0.005 (0.004)	-0.065*** (0.009)
Constant	3.89*** (0.13)	4.09*** (0.21)
Restaurant FE	Yes	Yes
Prob>Chi2	0	0
Observations	262,999	79,826

Note: \*\*\* p<0.001, \*\*p<0.01, \* p<0.05.

## Appendix B: Experiment Details

### Experiment 1

In this experiment, subjects are randomly divided into two groups, SD and MD. If subjects are in the SD group, he/she would be shown the following page.

Café Tempe



\$

Downtown Tempe

American, International, Contemporary, Healthy

**Dining options:** Breakfast, Lunch, Dinner, Late Night, Delivery, Reservations, Takeout

**Description:** Cafe Tempe Bistro is a charming art district eatery nestled among the galleries of downtown Scottsdale. Featuring New American Comfort Food, a fresh & healthy style of cooking delicately prepared and dedicated to the use of all natural locally grown produce & organic ingredients whenever possible. Established in 1996, open for lunch & dinner, reservations welcomed.

Consumer reviews:

*“Good food, good prices, pleasant staff”*

The food was good, the service was great, and the prices were good.

*“Convenient but that's about all”*

Food was mediocre and access was extremely limited by strip mall construction. Service was adequate. Price was inexpensive.

*“Good Quality and Service”*

The staff is always friendly and helpful. The food is fresh, tastes great, and is made the way I like it. If not, they'll make it right. I usually have a difficult time deciding- everything looks so good.

I got the slab of ribs with fries and coleslaw. The wife got fried shrimp (and a lot of them!). The ribs are excellent: smoky, fall of the bone, fork tender and moist. The sauce is tasty with mild heat. The shrimp were cooked well, not overdone or greasy.

Want to read more consumer reviews:

Yes  No

If the subject wants to read more reviews, following information will be shown.

***"Almost Perfect!"***

The food is so great, as is the cozy atmosphere. But...they don't have a full bar, wine and wine drinks only. I'm a martini girl so it didn't quite work for me. Great for lunch though!

***"Fun restaurant"***

We went twice and we saw them be extra involved with children - speaking kindly, making cute ice cream "face" desserts and bringing them right to the child. And despite the number of young children, it was quiet and we could talk to each other over dinner.

***"Iffy at the best of times."***

First time we went it was great onion soup and burgers. Food was good and served hot. One week later we went back for the same menu we got a poor waitress, cold soup and good burgers. I sent the soup back twice, waitress said "that's how we serve it. We did not go back again.

***"Great restaurant"***

You can count on Cafe Tempe for good food and good service. This location gives you the best of both. The food was prepared properly, served hot and with a smile. Our server Christopher is among the best we have had. He never let my drink glass get empty. All I can say is ask for Chris you won't be disappointed.

***"Great little place!"***

Lots of menu variety. Good value. Fresh and tasty. Try the mini apple pie for dessert!

***"Better than I expected"***

I was pleasantly surprised with the Fajitas. The steak was tender and tasty with deliciously flavored spices. If it wasn't for a gift card, I would not have eaten here.

***"Just unlucky"***

Firstly I must say that the owner reacted correctly when we complained and listened to what we thought was wrong. My wife ordered Tuna Sashimi which I have to say was of extremely poor quality. It was neither usual deep red color and had white veins through it, plus it was not soft in texture. I had chicken crusted in Pecans which was of a middle standard. All in all our experience was not good but the Restaurant is a pleasant setting with tables outside on the street side.

***"Very Nice Restaurant in downtown Tempe."***

This is the second visit to this family owned restaurant. I wasn't disappointed the first time, and I was once again pleased. They have a knowledgeable and friendly staff. The menu choices were more than adequate. The food was properly prepared and served fresh out of the kitchen. I would be more than pleased to visit this wonderful, little restaurant again.

***"Wonderful !!"***

This Cafe is a very quiet with a great atmosphere. The soup and salad is very good as well as the tuna salad was excellent. Our waiter was very attentive to our needs!! I would highly recommend if you are looking for a very quiet cafe inside or outside!!

If the subject is randomly selected into the MD group, then the following page would be shown. Similarly, more reviews would be shown if the subject chose to read more reviews. Note that the information provided in SD group and MD group is the same except for multi-dimensional ratings.

## Café Tempe

 55 Reviews

\$

Downtown Tempe

American, International, Contemporary, Healthy

**Dining options:** Breakfast, Lunch, Dinner, Late Night, Delivery, Reservations, Takeout

**Description:** Cafe Tempe Bistro is a charming art district eatery nestled among the galleries of downtown Scottsdale. Featuring New American Comfort Food, a fresh & healthy style of cooking delicately prepared and dedicated to the use of all natural locally grown produce & organic ingredients whenever possible. Established in 1996, open for lunch & dinner, reservations welcomed.

### Rating summary

Food 

Service 

Value 

Atmosphere 

### Consumer reviews:

#### *"Good food, good prices, pleasant staff"*

The food was good, the service was great, and the prices were good.

#### *"Convenient but that's about all"*

Food was mediocre and access was extremely limited by strip mall construction. Service was adequate. Price was inexpensive.

#### *"Good Quality and Service"*

The staff is always friendly and helpful. The food is fresh, tastes great, and is made the way I like it. If not, they'll make it right. I usually have a difficult time deciding- everything looks so good. I got the slab of ribs with fries and coleslaw. The wife got fried shrimp (and a lot of them!). The ribs are excellent; smoky, fall of the bone, fork tender and moist. The sauce is tasty with mild heat. The shrimp were cooked well, not overdone or greasy.

### Want to read more consumer reviews:

Yes  No

And after that, subjects were asked whether they want to go to the restaurant for lunch, preference matching and questions about whether their uncertainty has been reduced given the information provided.

I want to go to this restaurant for **lunch**.

Yes  No

Please choose which best represents your level of agreement or disagreement with the following statement

This restaurant would fit my preference.

Strongly Disagree      Disagree      Neither Agree nor Disagree      Agree      Strongly Agree

I am sure that this restaurant would fit my preference (Note that this question asks how confident you are in answering the previous question).

Strongly Disagree      Disagree      Neither Agree nor Disagree      Agree      Strongly Agree

This restaurant with these characteristics is what I am looking for.

Strongly Disagree      Disagree      Neither Agree nor Disagree      Agree      Strongly Agree

I am sure that this restaurant with these characteristics is what I am looking for (Note that this question asks how confident you are in answering the previous question).

Strongly Disagree      Disagree      Neither Agree nor Disagree      Agree      Strongly Agree

After that, subjects were asked to answer a list of some demographic questions, and then they were asked to answer a few manipulation questions.

Gender

Male



Female



Are you a native English speaker?

Yes



No



Age

How often do you check restaurant ratings online before you decide to go to a restaurant?

0%



25%



50%



75%



100%



I am familiar with restaurant ratings.

Strongly Disagree



Disagree



Neither Agree nor Disagree



Agree



Strongly Agree



Generally speaking, people can not be trusted.

Strongly Disagree



Disagree



Neither Agree nor Disagree



Agree



Strongly Agree



Generally speaking, it is difficult for me to make a decision in my daily life.

Strongly Disagree



Disagree



Neither Agree nor Disagree



Agree



Strongly Agree



All things considered, I am satisfied with my life as a whole these days.

Strongly Disagree



Disagree



Neither Agree nor Disagree



Agree



Strongly Agree



Do you like American foods?

Strongly Disagree



Disagree



Neither Agree nor Disagree



Agree



Strongly Agree



How often do you go to restaurants?

- Less than once a month
- Once a month
- 2-3 Times a Month
- Once a Week
- 2-3 Times a Week
- Daily

What kind of ratings are provided in the restaurant information page:

- Single average rating
- Ratings on different dimensions (service, food, etc.).

Ratings on different dimensions (service, food, ect.) are helpful to make a decision.

Strongly Disagree



Disagree



Neither Agree nor Disagree



Agree



Strongly Agree



## Experiment 2

Respondents were asked to read the reviews:

Please read all the following reviews carefully:

*"Very Nice Restaurant"*

This is the second visit to this family owned restaurant. I wasn't disappointed the first time; and I was once again pleased. They have a knowledgeable and friendly staff. The menu choices were more than adequate. The food was properly prepared and served fresh out of the kitchen. I would be more than pleased to visit this wonderful, little restaurant again.

*"It doesn't get much better than this!"*

What a beautiful setting in their patio. Very romantic. The food is very good, but not exceptional. But the setting and the staff really make it memorable. This is a special occasion place!

*"Lovely ambiance/average food"*

My husband and I took my 86-year-old mother for a special occasion. The food is overpriced. The service also was not on par with the price point. We were in a room with only one other seated table, and rarely saw our waiter.

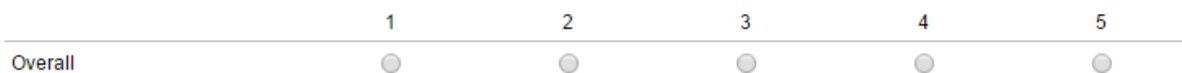
*"Truly one of the best meals I have had"*

I came here with my boyfriend for his birthday. WOW the service was cunning, the atmosphere is the most incredible part and the food paired with wine is so good it makes you want to scream. Gorgeous place inside and especially out. Everything has a place to go and every detail is thought out!

And then they were randomly divided into four groups: SD, SD with Priming, MD Overall First, and MD Dimen First, and then they were asked to indicate the month of the day as a screening test.

SD:

Please rate the restaurant ( 1 denotes extremely bad and 5 denotes extremely good)



Please indicate the month of today



SD with Priming:

Please think about different attributes of the restaurant ( for example, service, food, ambiance, etc) and then rate the restaurant( 1 denotes extremely bad and 5 denotes extremely good)

	1	2	3	4	5
Overall	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please indicate the month of today

August	September	July	October
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

MD Overall First:

Please rate the restaurant ( 1 denotes extremely bad and 5 denotes extremely good)

	1	2	3	4	5
Overall	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please rate different attributes of the restaurant( 1 denotes extremely bad and 5 denotes extremely good)

	1	2	3	4	5
Food	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Service	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Atomosphere	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Value	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please indicate the month of today

August	September	July	October
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

MD Dimen First:

Please rate different attributes of the restaurant( 1 denotes extremely bad and 5 denotes extremely good)

	1	2	3	4	5
Food	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Service	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Atomosphere	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Value	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please rate the restaurant ( 1 denotes extremely bad and 5 denotes extremely good)

	1	2	3	4	5
Overall	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please indicate the month of today

August	September	July	October
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## Appendix C: “Write a Review” Webpage on TripAdvisor (Taken in March, 2017)

**House of Tricks**  
114 E 7th St, Tempe, AZ 85281-3711

Your first-hand experiences really help other travelers. Thanks!

✓ Your overall rating of this restaurant Draft saved at 1:10 AM.

●●●●● Very Good

**Title of your review**  
Summarize your visit or highlight an interesting detail

**Your review** [Tips for writing a great review](#)  
Tell people about your experience: your meal, atmosphere, service?  
(100 character minimum)

**What sort of visit was this?**  
Couples Family Friends Business Solo

**Were you here for...**  
Select one

**When did you visit?**  
Select one

**Could you say a little more about it?** (optional)

Does this restaurant offer **highchairs for toddlers**? Yes No Not Sure

Does this restaurant offer **free wifi**? Yes No Not Sure

Can a **vegan** person get a good meal at this restaurant? Yes No Not Sure

Is this restaurant good for **lunch**? Yes No Not Sure

Is this restaurant good for **dinner**? Yes No Not Sure

Are the prices at this restaurant **mid-range / moderate**? Yes No Not Sure

**Click to select a rating**

Service ●●●●● Excellent

Food ●●●●● Very Good

Value ●●●●● Average

## Appendix D: Pairwise T Tests for Groups in Experiment 2

Table A9. Pairwise Group Comparisons

<i>Group</i>	<i>Contrast</i>	<i>Std. Err.</i>	<i>t</i>	<i>P&gt;t</i>	<i>[95% Conf.</i>	<i>Interval]</i>
2 vs 1	.0269836	.0328139	0.82	0.411	-.0373589	.0913261
3 vs 1	.0246268	.0327297	0.75	0.452	-.0395506	.0888042
4 vs 1	.0292214	.0326941	0.89	0.372	-.0348861	.093329
3 vs 2	-.0023568	.0328258	-0.07	0.943	-.0667225	.0620089
4 vs 2	.0022379	.0327903	0.07	0.946	-.0620582	.066534
4 vs 3	.0045946	.032706	0.14	0.888	-.0595363	.0687256