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The effect of individual online reviews on purchase likelihood
Article

Web Appendix: The Effect of Individual Online Reviews on Purchase Likelihood

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ABSTRACT

This web Appendix presents additional details and analyses to the ones presented in the paper.

Keywords: Online product reviews, electronic commerce, endogeneity

A1. Distribution of Star Ratings of Unique Reviews

Table A1 shows the distribution of the star ratings of the 43,388 unique reviews in the data. As can be seen, an overwhelming majority of new reviews added are positive with 81.28% of them being 4-, or 5-star and only 18.72% of them being 1-, 2-, or 3-star reviews.

A2. Unequal Bandwidths in Regression Discontinuity Design

In a typical RD design, the length of the windows (or bandwidths) on either side of the discontinuity is held constant and each observation within the window is assigned the same weight. Imbens and Lemieux (2008) refer to this as rectangular kernels. Our empirical setting, however, means that using constant bandwidths would result in the loss of a large number of observations and thus probably bias our results. In the rest of this section, we explain our RD design, the structure of our data, the need and validity of having unequal bandwidths in our RD design and some robustness checks for unequal bandwidths.

We use the RD approach to identify the effect of replacing a 1, 2, 3, or 4-star review in the first position with a 5-star review. The main identifying assumption of this approach is the continuity assumption (Lee and Lemieux 2010). This means that all variables of interest are continuous (i.e. experience little variation) within a small bandwidth on either side of the discontinuity. In our context, this implies that within a specific time window before and after the addition of a new review, all variables that may affect the purchase decision – other than the reviews displayed on the page – experience little variation. Any change observed in the probability to purchase between a session prior to the addition of a new review and a session thereafter can hence be attributed to the treatment, that is, the addition of a new review.

A2.1 Data Structure

Recall that to analyze the effect of an addition of a new 5-star review, we need to observe at least one session before the addition of that review and at least one session thereafter. We depict this scenario in Figure A1 where S_i is the ith session for a product in the data and R_j is the jth review added for the product. We focus on cases where R_2 is a 5-star review. In addition, we require both of these sessions to occur within the bandwidth of the windows (shaded grey around R_2 in Figure A1).

In order to have a time window, that is bandwidth, of equal length on either side of the addition of the 5-star review R_2, both the time gap between the addition of the preceding review R_1 as well as the time gap between the addition of R_2 and the succeeding review R_3 would need to be at least as long as this bandwidth. This is the case in Figure A1 but not in Figure A2 where review R_3 is added within the grey time window. As a result, if we were to require equal bandwidths, we would in Figure A2 need to discard all sessions associated with the addition of R_2 (i.e. sessions S_2 to S_4). Obviously, such a shortening of the bandwidth could occur on either side of the addition of review R_2.

In order to compute instances where the bandwidths may be shortened for a given focal review R_2, we would need to note the time when the preceding review R_1 as well as the succeeding review R_2 were added. Given that our data duration is only 60 days, there are instances where R_3, the review succeeding the focal review R_2 is not added yet. Hence, in all our RD analyses, we use only those sessions where we know the timing of all three reviews R_1 through R$_3$. The size of the data depends on the size of the bandwidth. For bandwidths of 14 days, which is our main estimation in Column (II) of Table 7 of the paper, we have 8,820 sessions in the data.

A2.2 Sessions with Unequal Bandwidths

In our data, we find many instances, such as in Figure A2, where the addition of new reviews falls into the bandwidth and thus "censors" the bandwidth. Table A2 below summarizes, for different bandwidths, the number of observations in our data where the bandwidths on both sides of the addition of R2 will remain uncensored, such as in Figure A1, as well as the number of sessions that we have on either side of the discontinuity. As can be seen, as we move to longer bandwidths, more reviews fall into the bandwidth, thus "censoring" the bandwidth. As a result, for 14-day windows, requiring identical 14-day bandwidths across all observations reduces our sample to roughly 10% of the number of observations. This, in turn, reduces significantly the statistical power of the analysis, especially given the conversion rates typically observed in online commerce.

Another concern with such an approach is that it implies a strong selection effect since for products that are infrequently purchased, reviews are more likely to be infrequently added. If we use only those sessions where the bandwidths are uncensored on either side of the discontinuity, our analysis would tend to leave out products that are frequently purchased, where reviews are added at a high frequency and, thus, more likely to fall into the window of the bandwidth. These, however, would, by definition, have less sessions and less purchases, making sample size a problem.

Table A2 illustrates that, depending on the bandwidth, using only sessions with equal bandwidths leaves us with about 800 – 2000 sessions (relative to 4000 to 9000 observations if we do not require even bandwidths) and 0 - 45 purchases, implying a maximum of 20 purchases on either side of the discontinuity. Table A3 summarizes results from our RD regressions using these samples. The results are

largely directionally consistent with those in Table 7 in the paper though due to the much smaller sample size they are mostly insignificant.[1]

A2.3 Potential Econometric Concerns Regarding the Use of Unequal Bandwidths

Using unequal bandwidths on either side of the discontinuity in our empirical setting would not invalidate the assumptions of the RD design as noted by Lee and Lemieux (2010). Notably, the key assumption that consumers who are planning to make a purchase should not be likely to manipulate, precisely or imprecisely the addition of a 5-star review (p.283 of Lee and Lemieux 2010) still holds. The reason is that it is unlikely that customers would time their purchases such that they are on one particular side of the discontinuity. Note that this assumption holds true regardless of whether we use consistently long bandwidths on either side of the discontinuity (such as in Figure A1) or curtail the bandwidth on either side (such as in Figure A2).

The question that may arise with our approach is whether allowing for bandwidths to be "censored", that is be shorter than the maximum bandwidth set by us leads to selection effects. Specially, this would be the case if consumers' purchase likelihood differed across different points within a bandwidth which would then imply that censoring a bandwidth could systematically under- or overestimate the average purchase probability in that bandwidth as estimated using a rectangular kernel. To illustrate this point, we use the potential outcomes notation from Imbens and Lemieux (2008). We let $Y(1)$ and $Y(0)$ denote the potential outcomes (i.e. purchase rate) when we have a treatment (5-star review in the first position) and control (1, 2, 3, or 4-star

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[1] We tried two other approaches using this data to increase the statistical power of the estimation. First, rather than having four dummy variables denoting the different star-ratings of *R1*, we used one variable, similar to the specification in Column (I) and Column (III) of Table 7 in the paper. Second, rather than discarding sessions from the estimation when the review *R3* falls within the bandwidth as in Figure 2, we include the sessions within the bandwidth with *R3* in the first position and R2 in the second position (such as session *S5* in Figure 2). In both cases, we still did not have sufficient statistical power and had mostly statistically insignificant coefficients.

review in the first position) respectively. Let X denote time and $X = c$ denote the moment of discontinuity (addition of a 5-star review). The continuity assumption is violated if:

$$\lim_{x \uparrow c} E[Y(0)|X = c] \neq \lim_{x \downarrow c} E[Y(0)|X = c]$$

or

$$\lim_{x \uparrow c} E[Y(1)|X = c] \neq \lim_{x \downarrow c} E[Y(1)|X = c]$$

Intuitively, this would be a problem in our approach if the purchase probability during a session was dependent on the time gap between a customer's session and the addition of a review. So, for example, all else being equal, the purchase likelihood for session S2 in Figure A1, which is farther away from the discontinuity, would be different from the purchase likelihood for session S3. This would imply that the purchase rate when calculated with equal bandwidths would be systematically different from that calculated by having irregular bandwidths, biasing our RD estimate.

A2.4 Robustness Checks for Unequal Bandwidths

We conduct several checks to see if the purchase rate indeed differs across different points of time within the bandwidth. First, we estimate whether the purchase probability varies within this time gap. We include in the analysis all sessions available in the data with additions of reviews of any star-rating (as opposed to just 5-star reviews as in our RD models) and all bandwidths on either side of the addition of reviews. We use the purchase probability as the dependent variable. The main independent variables are a set of dummy variables that represent the time gap between the session and the addition of the next review. Table A4 below demonstrates

that the purchase rate does not vary with the time gap between a purchase and the addition of the next review.

Second, we focus on the data used in the RD regression in the paper where the new review added has 5-stars and the previous review in the first position had either 1-, 2-, 3-, or 4-stars. First, in Column (I) of Table A5, we control for the time gap between each session and the addition of the 5-star review. Second, in Column (II), rather than using a linear specification as in Column (I), we use dummy variables for different windows as in Table A4. As can be seen, our results indicate that the purchase rate does not vary with the time gap.

Third, uneven bandwidths could be a problem if the shortening of bandwidths occurred selectively on one side of the window but not the other as shortening the bandwidth on only one side of the discontinuity might potentially lead to a biased estimation of the effect of adding a new 5-star review. We check this by including controls to capture factors specific to uneven bandwidths. Column (III) of Table A5 includes dummy variables that capture on which side of the discontinuity the window is censored and shows that we do not have selective shortening of bandwidths. Fourth, in Column (IV) of Table A5, we include both dummy variables for different windows as in Column (II) and dummy variables that capture which side of the discontinuity the window is censored as in Column (III). The results continue to hold. We report the specification of Column (IV) in all our RD estimations in the paper and this Appendix.

Note lastly that typically concerns related to the specification of the bandwidth focus on a bandwidth possibly being too long as observations further away from the event may be subject to greater noise and hence invalidate the continuity assumption (Imbens and Lemieux 2008). However, we in any case focus on those observations

that are closer to the discontinuity and in cases where we have shortening of bandwidths due to the addition of a review, observations that would be further away from the discontinuity are censored.

We feel that these considerations as well as the battery of checks support that allowing for censored bandwidths does not violate any of the key assumptions of an RD design.

A3. Potential Endogeneity due to the Interdependence of Review Position and Purchase Probability

We discuss here the possible endogeneity that may arise due to the interdependence between the position of a review and purchase probability. This may occur if a consumer made their purchase decision based on the reviews they saw on the page and the review they submit, which may depend on the existing reviews, is displayed immediately on top of the existing reviews.

We detail here the events that can occur between a customer buying the product and their review being displayed on the product page. The main implication of these events is that a new review may well not follow immediately the reviews displayed when the consumer purchased the product, which breaks the endogeneity of such interdependence. We also explain why even in instances when this order is not broken, this should not present a problem for our analysis.

We first evaluate whether indeed our data suggests that a new review follows immediately the reviews the consumer viewed prior to purchasing. For this purpose, we match purchase data with data on reviews. Note that this means we are looking at a small sample – not everyone who wrote a review during the period of our data purchased during this period (they may have purchased before) and not everyone who

purchased during the period submitted a review (they may have done this afterwards). Further, this process is complicated by the fact that our review dataset only notes the partial IP address (i.e. only 3 of the 4 blocks of numbers that constitute a unique IP address) from which the review was submitted and not the customer ID. Nonetheless, we match this partial IP with the partial IP addresses from our purchase data. In all, we identify 88 customers who both purchased and wrote reviews during our observation period.

For this data, we find that in two-thirds of cases (60/88), at least one intervening review is added between the time when a customer viewed reviews for a product and when their own review was displayed. On average, 5.63 intervening reviews were added. Note that because of the restriction of our time window, we likely underestimate the share of instances where an intervening review was posted between a customer viewing reviews and the customer posting reviews: if the intervening time was long, we are less likely to observe both the purchase and the posting of this customer's review.

At least three mechanisms can lead to other reviews being added between purchase and posting of this customer's review. First, there is generally a delay between a customer purchasing a product and the date when they submit a review for the product. For the 88 customers for whom we matched purchase and review data, the average time between purchase and a review being submitted is 14.11 days with a standard deviation of 9.25 days. The smallest and largest delays respectively are 0.60 and 46.71 days (these numbers are not whole numbers as we account for the exact time stamp). Again, given the restriction of our time window, we are likely to underestimate the intervening time relative to the full population.

Second, the third-party firm that handles reviews for our online retailer vets reviews for offensive or uninformative content before posting them. Our data notes the time when a customer submits a review as well as the time when the review is displayed on the page. The median of this time gap is 1.46 days and the mean is 14.01 days. The standard deviation of this gap is 102.95 days. The large variation in delays suggests that reviews are not always displayed in the same order in which they were submitted.

Third, the online retailer enables customers to modify their review after it is displayed on the page to encourage customers to add new information as they experience the product. When a customer modifies an existing review, it is again vetted and then removed from its previous position and displayed on top of the page, i.e. in position one. During our observation period, 4.57% of the reviews were modified but it is likely that a larger share of reviews that were visible to consumers during our observation period had changed their position as many such changes likely happened before our observation period. Again, in such cases, the review displayed on top of the page would be unrelated to the reviews below it.

Note also that not every customer visiting a product page reads reviews. In our data, customers do not read reviews in 18.58% of the sessions. Such customers who do not read reviews may still buy the product and write reviews. As a result, the new review such customers write would be independent of the reviews displayed during the customer's session since that customer did not read these reviews.

Finally, in the event that none of the abovementioned four cases applies, the new review added could be related to the other reviews displayed on the same page. It is also possible that the products that are purchased more frequently have higher

ratings. Even when this is the case, the simultaneity issue, that is, an inter-relationship between rank and purchase probability, does not affect our results due to two reasons.

First, our analysis controls for product fixed effects that control for product-specific factors such as differences in purchase frequencies. Second, if the purchase probability depends on the rank of a review, and vice versa, then we likely see more instances of particular reviews in position one and more instances of certain shifts (e.g., a 5-star review replaced by another 5-star review) than of others (e.g., a 5-star review replaced by a 1-star review). Such a relationship could perhaps imply fewer observations of shifts that are less likely to occur which could potentially affect the ability to identify significant effects. However, as our results indicate, we do find an effect when a 5-star review replaces a 1- or 2-star review suggesting that we have the statistical power to estimate such effects. In addition, recall that in our RD analysis we only focus on a short time window around a particular shift holding everything else constant.

A4. Robustness Checks for Regression Discontinuity Design

We discuss here robustness checks to the regression discontinuity design (RD) analysis that is discussed in Section 3.2 of the paper. The checks discussed here replicate the checks discussed in Section 3.3 of the paper that leverage an individual review's multiple shifts (MS) across the different positions on the product page.

Note that the first two checks discussed in Section 3.3 involve pruning the data. The first check excludes those sessions from the data where consumers spent less than five seconds in the reviews part of the product page. The second check excludes sessions where consumers browsed past the first page of reviews. Since, as discussed in Section 2.2 of the paper, the data used for the RD setup is already quite

restrictive, we are unable to conduct these two tests for the RD setup due to small sample sizes in the data. We discuss below the other three checks.

First, recall that the RD data includes sessions related to the addition of only those reviews where the data has at least one session before and one session after the addition of a review. We relax this requirement in the first check. The results are reported in Column (I) of Table A6 and are consistent with the main RD results in Column (II) of Table 7 in the paper.

Second, we examine whether the results hold with a quadratic specification for three control variables – average rating, average rating of the other four reviews on the page and the number of reviews. Column (II) of Table A6 demonstrates that this is the case.

Third, we include two variables that note the number of "thumbs up" and "thumbs down" votes received by the review in the first position as controls. The results in Column (III) of Table A6 are consistent with our main RD estimation results.

A5. When do Individual Reviews Matter: Regression Discontinuity Results

We discuss here results from the RD analysis that replicate the results discussed in Section 3.4 of the paper, which use the MS analysis. Recall that we suggest two types of settings when individual reviews matter.

First, individual reviews are likely to impact consumer purchase decision when these reviews resolve uncertainty around product quality. We suggest that consumer uncertainty is higher when the product description on the website provides little product information. We stratify our RD estimation by how much information the product description on the webpage provides. Table A7, Column (I) displays the

results using products where the description has a below-median number of words. Column (II) displays results for instances where the product description has an above-median number of words. We find strong effects of reviews when products have only a short description.

Another instance where consumers may have uncertainty involves products with high variance in prior ratings. This indicates a product which may appeal to a subset of consumers but not to everyone and for which consequently consumers are likely to have higher uncertainty. A low variance, on the other hand, indicates a product which appeals similarly to all consumers. Columns (III) and (IV) of Table A7 presents the results when we stratify products based on the variance of past ratings. They indicate stronger results when there is a large variance in reviews.

The second setting when individual reviews matter is when they contrast with inferences consumers make about products based on information otherwise available. We focus first on average rating, which is typically used as a signal for product quality. Column (I) and (II) of Table A8 stratify the data by average rating of the product. The results indicate that individual reviews matter when the average rating is low.

Another instance when individual reviews offer contrasting information is through price. We propose that for products that are priced low relative to others in the same category, reviews with 5- star ratings should impact purchases. Column (III) and (IV) of Table A8 stratify the data by whether the price of a product is above or below the median price of that category. The results indicate that individual reviews matter when the price of a product is low relative to the category.

Table A9 replicates the results of Table A7 with the data used for the RD analysis restructured at the level of a review impression to mirror the MS setup. As

can be seen, the results from Table A7 hold. Likewise, Table A10 replicates the

results from Table A8. Once again, the results hold.

References

Imbens, G. W., & Lemieux, T. (2008). Regression discontinuity designs: A guide to practice. *Journal of Econometrics*, 142(2), 615-635.

Lee, D. S., & Lemieux, T. (2010). Regression discontinuity designs in economics. *Journal of Economic Literature*, 48(2), 281-355.

Figure A1: Timeline of Sessions and Reviews with Uncensored Bandwidths

R_1
R_2
R_3

Timeline
S_1 S_2 S_3 S_4 S_5

S - session in data
R – Reviews added to product page
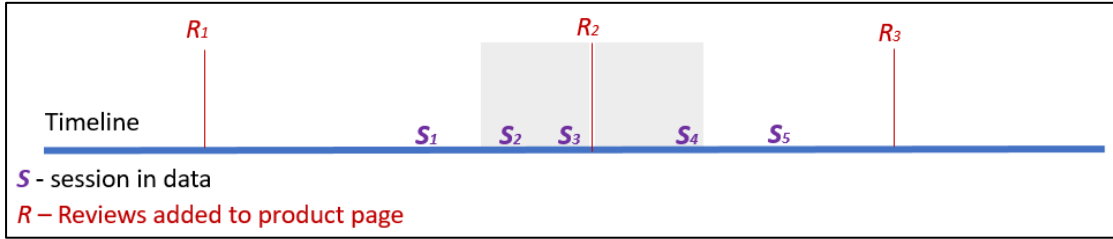
Figure A2: Timeline of Sessions and Reviews with Censored Bandwidths

R_1
R_2 R_3

Timeline
S_1 S_2 S_3 S_4 S_5

S - session in data
R – Reviews added to product page
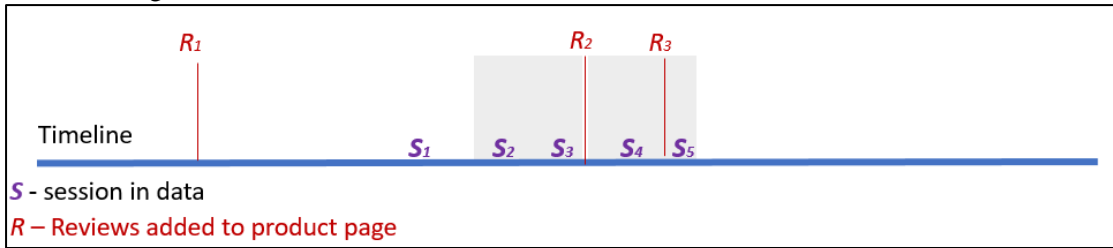
Table A1: Distribution of star rating of unique reviews

Star rating	Frequency	Percent	Cumulative percent
1-Star	3515	8.10%	8.10%
2-Star	1,386	3.19%	11.30%
3-Star	2,733	6.30%	17.59%
4-Star	11,735	27.05%	44.64%
5-Star	24,019	55.36%	100.00%
Total	43,388	100.00%	

Table A2: Number of Sessions and Purchases Using Equal Bandwidths on Either Side of Discontinuity

Bandwidth (days)	Sessions before discontinuity with uncensored bandwidth		Sessions after discontinuity with uncensored bandwidth		Total sessions with uncensored bandwidths	Total sessions in data without bandwidth restrictions	Percent of all sessions in data that are censored
	Purchases	Total	Purchases	Total			
1	4	184	5	143	327	626	47.76%
2	14	475	12	384	859	1,847	53.49%
3	11	653	15	550	1,203	2,980	59.63%
4	17	916	20	822	1,738	4,035	56.93%
5	22	1,009	23	958	1,967	4,974	60.45%
6	16	1,020	20	928	1,948	5,731	66.01%
7	10	685	20	680	1,365	6,405	78.69%
8	9	547	18	524	1,071	6,900	84.48%
9	11	566	18	527	1,093	7,331	86.89%
10	12	542	16	515	1,057	7,660	86.20%
11	12	588	15	544	1,132	8,010	85.87%
12	11	583	17	540	1,123	8,333	86.52%
13	11	552	16	503	1,055	8,629	87.77%
14	9	414	13	396	810	8,820	90.82%
15	7	357	15	338	695	9,012	92.29%
16	7	362	13	314	676	9,169	92.63%
17	8	344	11	277	621	9,336	93.35%
18	8	341	11	273	614	9,447	93.50%
19	7	338	11	280	618	9,580	93.55%
20	8	306	11	258	564	9,699	94.18%

Table A3: Regression Discontinuity Design with Uncensored Bandwidths on Both Sides of Discontinuity

	11- day windows		12- day windows		13- day windows		14- day windows		15- day windows		16- day windows		17- day windows	
	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Before star-rating														
1-star	0.0328	0.0386	0.0421	0.0373	0.1042	0.0622 *	0.0823	0.0537	0.0471	0.0643	0.0003	0.0494	0.0087	0.0450
2-star	-0.0099	0.0374	-0.0004	0.0366	0.0478	0.0579	0.0123	0.0475	-0.0034	0.0478	-0.0254	0.0363	-0.0121	0.0340
3-star	0.0470	0.0358	0.0500	0.0335	0.1179	0.0637 *	0.0887	0.0740	0.1504	0.1075	0.1263	0.0829	0.0999	0.0865
4-star	0.0008	0.0133	0.0083	0.0139	0.0736	0.0450	-0.0021	0.0290	0.0054	0.0355	0.0205	0.0305	0.0088	0.0334
Average rating of the product	-0.0636	0.1374	-0.0818	0.1307	-0.0597	0.1191	-0.0342	0.1238	-0.0779	0.1297	-0.0449	0.1166	-0.1240	0.1302
Average rating of other four reviews on the page	0.0174	0.0322	0.0341	0.0353	0.0394	0.0410	0.1034	0.0665	0.0501	0.0878	-0.0378	0.0634	-0.0115	0.0631
Number of reviews of the product	0.0012	0.0016	0.0010	0.0016	-0.0616	0.0432	0.0108	0.0201	0.0097	0.0272	-0.0154	0.0149	-0.0070	0.0163
Mobile platform fixed effect	0.0154	0.0123	0.0192	0.0128	0.0183	0.0130	0.0050	0.0129	0.0103	0.0151	0.0230	0.0140	0.0218	0.0151
Weekend fixed effect	0.0117	0.0122	0.0170	0.0124	0.0198	0.0123	0.0274	0.0145 *	0.0274	0.0171	0.0261	0.0167	0.0239	0.0154
Number of words in the five positions	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Product fixed effect	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Products	209		196		178		135		111		104		97	
N	1,132		1,123		1,055		810		695		676		621	
R^2	0.24		0.23		0.25		0.26		0.24		0.22		0.22	

*=p<0.1, **=p<0.05, ***=p<0.001
Standard errors clustered at the product level in all estimations.

Table A4: Robustness Check for Invariance of Purchase Probability within a Regression Discontinuity (RD) Bandwidth

	All sessions in data		
	Estimate	SE	
Session within...			
5-8 days of review addition	0.0018	0.0028	
9-12 days of review addition	-0.0049	0.0038	
13-16 days of review addition	-0.0025	0.0042	
17-20 days of review addition	-0.0032	0.0051	
21+ days of review addition	0.0011	0.0050	
Bandwidth censored before the addition of review	-0.0051	0.0048	
Bandwidth censored after the addition of review	0.0001	0.0045	
Star rating of review in position...			
One	0.0022	0.0014	
Two	0.0012	0.0016	
Three	0.0048	0.0016	***
Four	0.0030	0.0018	*
Five	0.0032	0.0014	**
Average rating of the product	-0.0163	0.0273	
Number of reviews of the product	-0.0001	0.0001	
Mobile platform fixed effect	0.0347	0.0034	***
Weekend fixed effect	0.0039	0.0029	
Number of words in the five positions	Yes		
Product fixed effect	Yes		
Products	3,076		
N	45,415		
R^2	0.13		

*=p<0.1, **=p<0.05, ***=p<0.001
Standard errors clustered at the product level in all estimations.

Table A5: Regression Discontinuity (RD) Robustness Checks for Unequal Bandwidths

	(I) Estimate	SE		(II) Estimate	SE		(III) Estimate	SE		(IV) Estimate	SE	
Before star-rating												
1-star	0.0271	0.0142	*	0.0269	0.0142	*	0.0273	0.0143	*	0.0272	0.0143	*
2-star	0.0369	0.0153	**	0.0371	0.0154	**	0.0378	0.0153	**	0.0380	0.0153	**
3-star	0.0148	0.0169		0.0147	0.0169		0.0149	0.0169		0.0148	0.0169	
4-star	0.0140	0.0068	**	0.0138	0.0068	**	0.0140	0.0069	**	0.0138	0.0069	**
Average rating of the product	-0.1174	0.0749		-0.1179	0.0751		-0.1176	0.0755		-0.1183	0.0757	
Average rating of other four reviews on the page	0.0240	0.0111	**	0.0240	0.0111	**	0.0244	0.0112	**	0.0245	0.0112	**
Number of reviews of the product	0.0000	0.0006		0.0000	0.0006		0.0000	0.0006		0.0000	0.0006	
Mobile platform fixed effect	0.0357	0.0058	***	0.0355	0.0058	***	0.0357	0.0058	***	0.0355	0.0058	***
Weekend fixed effect	0.0002	0.0054		0.0011	0.0053		0.0002	0.0054		0.0011	0.0053	
Bandwidth controls...												
Time gap between time of session review addition (days)	0.0004	0.0008										
Session within 5-8 days of review addition				0.0021	0.0059					0.0021	0.0059	
Session within 9-12 days of review addition				-0.0034	0.0078					-0.0033	0.0079	
Session within 13-16 days of review addition				0.0111	0.0135					0.0112	0.0135	
Bandwidth censored before the addition of review							0.0018	0.0163		0.0013	0.0162	
Bandwidth censored after the addition of review							0.0122	0.0293		0.0119	0.0293	
Number of words in the five positions	Yes			Yes			Yes			Yes		
Product fixed effect	Yes			Yes			Yes			Yes		
Products	1,182			1,182			1,182			1,182		
N	8,820			8,820			8,820			8,820		
R^2	0.18			0.18			0.18			0.18		

*=p<0.1, **=p<0.05, ***=p<0.001
Standard errors clustered at the product level in all estimations.

Table A6: Regression Discontinuity: Further Robustness Checks

	(I)		(II)		(III)	
	Including sessions where there were not at least one session before and after the addition of a review		Quadratic effect of average rating and number of reviews		Including controls for "thumbs up" and "thumbs down" votes	
	Estimate	SE	Estimate	SE	Estimate	SE
Before star-rating						
1-star	0.0231	0.0128 *	0.0288	0.0147 *	0.0325	0.0167 *
2-star	0.0311	0.0144 **	0.0359	0.0154 **	0.0407	0.0159
3-star	0.0120	0.0163	0.0131	0.0170	0.0177	0.0167
4-star	0.0151	0.0067 **	0.0123	0.0072 *	0.0137	0.0070 **
Number of "thumbs up" votes					-0.0057	0.0041
Number of "thumbs down" votes					0.0023	0.0040
Average rating of the product	-0.0996	0.0636	-0.7547	0.6138	-0.1333	0.0764 *
Average rating of the product^2			0.0836	0.0761		
Average rating of other four reviews on the page	0.0247	0.0101 **	0.0581	0.0499	0.0265	0.0112 **
Average rating of other four reviews on the page^2			-0.0046	0.0068		
Number of reviews of the product	0.0001	0.0005	-0.0004	0.0007	-0.0001	0.0006
Number of reviews of the product^2			0.0000	0.0000		
Mobile platform fixed effect	0.0363	0.0056 ***	0.0354	0.0058 ***	0.0356	0.0058 ***
Weekend fixed effect	0.0034	0.0051	0.0010	0.0053	0.0010	0.0053
Bandwidth controls+	Yes		Yes		Yes	
Number of words in all five positions	Yes		Yes		Yes	
Product fixed effect	Yes		Yes		Yes	
Products	1,443		1,182		1,182	
N	10,134		8,820		8,820	
R^2	0.1963		0.1827		0.1827	

*=p<0.1, **=p<0.05, ***=p<0.001

Standard errors clustered at the product level in all estimations.

+Bandwidth controls include the following variables: Session within 5-8 days of review addition, session within 9-12 days of review addition, session within 13-16 days of review addition, bandwidth censored before the addition of review, and bandwidth censored after the addition of review.

Table A7: Regression Discontinuity (RD) Results by Product Description and Review Variance

	(I) Product description <=66 words		(II) Product description > 66 words		(III) High review variance		(IV) Low review variance	
	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Before star-rating								
1-star	0.0512	0.0202 **	0.0099	0.0211	0.0414	0.0129 ***	-0.0026	0.0423
2-star	0.0590	0.0229	0.0206	0.0213	0.0454	0.0217 **	0.0350	0.0212 *
3-star	0.0487	0.0275 *	-0.0107	0.0218	0.0110	0.0190	0.0291	0.0307
4-star	0.0158	0.0113	0.0149	0.0086 *	0.0101	0.0095	0.0169	0.0105
Average rating of the product	-0.4280	0.1897 **	0.0287	0.0540	-0.2043	0.0988 **	-0.0314	0.0955
Average rating of other four reviews on the page	0.0322	0.0184 *	0.0212	0.0141	0.0314	0.0105 ***	0.0187	0.0249
Number of reviews of the product	-0.0008	0.0009	0.0001	0.0007	0.0006	0.0009	-0.0004	0.0007
Mobile platform fixed effect	0.0383	0.0085 ***	0.0317	0.0080 ***	0.0307	0.0075 ***	0.0401	0.0089 ***
Weekend fixed effect	-0.0025	0.0079	0.0039	0.0071	-0.0050	0.0065	0.0061	0.0083
Bandwidth controls[+]	Yes		Yes		Yes		Yes	
Number of words in the five positions	Yes		Yes		Yes		Yes	
Product fixed effects	Yes		Yes		Yes		Yes	
Products	666		511		581		594	
N	4,415		4,370		4,403		4,397	
R^2	0.1867		0.1803		0.1707		0.1902	

*=p<0.1, **=p<0.05, ***=p<0.001
Standard errors clustered at the product level in all estimations.
[+]Bandwidth controls include the following variables: Session within 5-8 days of review addition, session within 9-12 days of review addition, session within 13-16 days of review addition, bandwidth censored before the addition of review, and bandwidth censored after the addition of review.

Table A8: Regression Discontinuity (RD) Results by Average Rating and Price within Category

	(I)			(II)			(III)			(IV)		
	Average Rating <= 4.3077			Average Rating > 4.3097			Price below category median			Price above category median		
	Estimate	SE		Estimate	SE		Estimate	SE		Estimate	SE	
Before star-rating												
1-star	0.0319	0.0172	*	0.0278	0.0292		0.0479	0.0360		0.0355	0.0399	
2-star	0.0354	0.0201	*	0.0529	0.0281	*	0.0505	0.0299	*	0.1255	0.0761	
3-star	0.0277	0.0231		-0.0004	0.0305		0.0087	0.0442		0.0329	0.0504	
4-star	0.0171	0.0095	*	0.0152	0.0117		0.0239	0.0141	*	0.0269	0.0236	
Average rating of the product	-0.2082	0.1142	*	-0.0795	0.2425		-0.0964	0.1203		-0.3139	0.2927	
Average rating of other four reviews on the page	0.0208	0.0097	**	0.0360	0.0284		0.0326	0.0234		0.0431	0.0306	
Number of reviews of the product	-0.0001	0.0012		0.0001	0.0007		-0.0003	0.0008		0.0005	0.0008	
Mobile platform fixed effect	0.0267	0.0074	***	0.0441	0.0089	***	0.0686	0.0133	***	0.0530	0.0152	***
Weekend fixed effect	-0.0034	0.0064		0.0054	0.0086		-0.0183	0.0116		0.0308	0.0169	*
Bandwidth controls[+]	Yes			Yes			Yes			Yes		
Number of words in the five positions	Yes			Yes			Yes			Yes		
Product fixed effects	Yes			Yes			Yes			Yes		
Products	611			601			343			182		
N	4,408			4,412			2,993			1,706		
R^2	0.1819			0.1833			0.1641			0.1616		

*=p<0.1, **=p<0.05, ***=p<0.001
Standard errors clustered at the product level in all estimations.
[+]Bandwidth controls include the following variables: Session within 5-8 days of review addition, session within 9-12 days of review addition, session within 13-16 days of review addition, bandwidth censored before the addition of review, and bandwidth censored after the addition of review.

Table A9: MS Analysis Using the Same Sessions as in RD: Product Description & Review Variance

		(I) Product Description <= 66 words		(II) Product Description > 66 words		(III) High review variance		(IV) Low review variance	
Position of the review	Star rating	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
One	1-Star								
	2-Star	-0.0040	0.0105	-0.0008	0.0136	-0.0016	0.0114	-0.0114	0.0187
	3-Star	0.0110	0.0142	0.0150	0.0128	0.0258	0.0083 ***	-0.0062	0.0219
	4-Star	0.0319	0.0115 ***	0.0042	0.0128	0.0280	0.0083 ***	-0.0017	0.0227
	5-Star	0.0441	0.0156 ***	0.0110	0.0173	0.0357	0.0098 ***	0.0063	0.0286
Two	1-Star	0.0025	0.0102	0.0044	0.0150	0.0068	0.0086	-0.0116	0.0262
	2-Star	0.0001	0.0121	0.0013	0.0131	0.0092	0.0084	-0.0245	0.0207
	3-Star	0.0183	0.0115	0.0078	0.0153	0.0131	0.0093	0.0030	0.0234
	4-Star	0.0337	0.0127 ***	0.0116	0.0156	0.0294	0.0082 ***	0.0029	0.0253
	5-Star	0.0376	0.0153 **	0.0124	0.0174	0.0360	0.0106 ***	0.0024	0.0287
Three	1-Star	0.0044	0.0093	-0.0103	0.0116	0.0028	0.0072	-0.0243	0.0158
	2-Star	0.0175	0.0145	0.0009	0.0136	0.0132	0.0094	-0.0051	0.0251
	3-Star	0.0212	0.0126 *	-0.0178	0.0150	0.0174	0.0100 *	-0.0273	0.0238
	4-Star	0.0310	0.0132 **	0.0066	0.0143	0.0274	0.0082 ***	-0.0014	0.0254
	5-Star	0.0408	0.0161 **	0.0072	0.0176	0.0329	0.0106 ***	0.0014	0.0296
Four	1-Star	-0.0019	0.0097	-0.0075	0.0106	-0.0034	0.0081	-0.0068	0.0175
	2-Star	-0.0084	0.0119	-0.0275	0.0141 *	-0.0195	0.0090 **	-0.0134	0.0219
	3-Star	0.0242	0.0129 *	0.0083	0.0146	0.0237	0.0108 **	-0.0057	0.0226
	4-Star	0.0311	0.0126 **	0.0001	0.0153	0.0180	0.0092 **	0.0019	0.0254
	5-Star	0.0342	0.0156 **	0.0115	0.0161	0.0293	0.0098 ***	0.0041	0.0279
Five	1-Star	-0.0046	0.0093	-0.0090	0.0128	0.0042	0.0067	-0.0301	0.0228
	2-Star	0.0310	0.0127 **	0.0092	0.0171	0.0324	0.0106 ***	-0.0131	0.0237
	3-Star	0.0050	0.0107	0.0025	0.0158	0.0053	0.0079	-0.0026	0.0250
	4-Star	0.0290	0.0124 **	0.0111	0.0149	0.0340	0.0085 ***	-0.0064	0.0246
	5-Star	0.0362	0.0150 **	0.0076	0.0170	0.0313	0.0095 ***	-0.0019	0.0285
Average rating of the product		-0.3734	0.1734 **	0.0079	0.0490	-0.1923	0.0902 **	0.0501	0.0731
Average rating of other four reviews on the page		0.0399	0.0150 ***	0.0139	0.0140	0.0316	0.0092 ***	0.0185	0.0226
Number of reviews of the product		-0.0007	0.0009	-0.0005	0.0009	0.0007	0.0007	-0.0012	0.0009
Mobile platform fixed effect		0.0373	0.0080 ***	0.0319	0.0073 ***	0.0298	0.0069 ***	0.0389	0.0084 ***
Weekend fixed effect		-0.0073	0.0076	-0.0012	0.0071	-0.0095	0.0063	0.0020	0.0086
Number of words in the five positions		Yes		Yes		Yes		Yes	
Product fixed effects		Yes		Yes		Yes		Yes	
Week specific fixed effects		Yes		Yes		Yes		Yes	
Products		588		433		492		506	
N		21,675		21,540		21,680		21,535	
R^2		0.18		0.18		0.16		0.19	

*=p<0.1, **=p<0.05, ***=p<0.001, standard errors clustered at the product level in all estimations.

24

Table A10: MS Analysis Using the Same Sessions as in RD: Average Rating & Category Price

Position of the review	Star rating	(I) Average rating <= 4.3077 Estimate	SE		(II) Average rating > 4.3077 Estimate	SE		(III) Price below category median Estimate	SE		(IV) Price above category median Estimate	SE	
One	1-Star												
	2-Star	-0.0007	0.0111		-0.0132	0.0153		0.0021	0.0212		-0.0612	0.0429	
	3-Star	0.0121	0.0112		0.0176	0.0170		0.0321	0.0247		-0.0065	0.0256	
	4-Star	0.0168	0.0108		0.0159	0.0185		0.0330	0.0203		0.0020	0.0248	
	5-Star	0.0281	0.0130	**	0.0237	0.0251		0.0416	0.0247	*	0.0239	0.0330	
Two	1-Star	0.0038	0.0117		-0.0007	0.0168		0.0145	0.0247		-0.0025	0.0229	
	2-Star	0.0013	0.0117		-0.0065	0.0140		-0.0011	0.0216		0.0078	0.0523	
	3-Star	0.0126	0.0125		0.0105	0.0162		0.0232	0.0236		0.0089	0.0273	
	4-Star	0.0220	0.0120	*	0.0190	0.0199		0.0354	0.0230		0.0207	0.0252	
	5-Star	0.0213	0.0126	*	0.0246	0.0256		0.0482	0.0265	*	0.0054	0.0313	
Three	1-Star	0.0006	0.0080		-0.0236	0.0144		-0.0007	0.0187		-0.0339	0.0244	
	2-Star	0.0050	0.0109		0.0151	0.0228		0.0251	0.0234		-0.0127	0.0366	
	3-Star	0.0051	0.0123		-0.0047	0.0193		0.0066	0.0238		-0.0266	0.0355	
	4-Star	0.0169	0.0111		0.0180	0.0207		0.0310	0.0230		0.0090	0.0265	
	5-Star	0.0245	0.0137	*	0.0199	0.0261		0.0369	0.0267		0.0163	0.0332	
Four	1-Star	-0.0021	0.0087		-0.0131	0.0151		0.0048	0.0165		-0.0300	0.0248	
	2-Star	-0.0135	0.0094		-0.0362	0.0289		-0.0100	0.0182		-0.1097	0.0516	**
	3-Star	0.0199	0.0125		0.0083	0.0180		0.0159	0.0222		0.0095	0.0266	
	4-Star	0.0152	0.0120		0.0130	0.0206		0.0265	0.0233		0.0015	0.0270	
	5-Star	0.0187	0.0119		0.0224	0.0258		0.0439	0.0235	*	-0.0012	0.0319	
Five	1-Star	-0.0063	0.0086		-0.0036	0.0241		-0.0030	0.0176		-0.0374	0.0292	
	2-Star	0.0205	0.0114	*	0.0111	0.0244		0.0344	0.0254		0.0217	0.0279	
	3-Star	-0.0008	0.0111		0.0092	0.0191		0.0135	0.0219		-0.0253	0.0283	
	4-Star	0.0217	0.0116	*	0.0151	0.0197		0.0445	0.0228	*	-0.0053	0.0272	
	5-Star	0.0212	0.0125	*	0.0190	0.0246		0.0292	0.0254		0.0209	0.0316	
Average rating of the product		-0.1830	0.0969	*	-0.0547	0.2249		-0.0759	0.0966		-0.1803	0.2852	
Average rating of other four reviews on the page		0.0251	0.0096	***	0.0287	0.0263		0.0378	0.0187	**	0.0383	0.0331	
Number of reviews of the product		-0.0002	0.0012		-0.0005	0.0007		-0.0012	0.0011		0.0004	0.0013	
Mobile platform fixed effect		0.0252	0.0070	***	0.0440	0.0083	***	0.0683	0.0123	***	0.0546	0.0145	***
Weekend fixed effect		-0.0086	0.0060		0.0008	0.0085		-0.0308	0.0111	***	0.0299	0.0161	*
Number of words in the five positions		Yes			Yes			Yes			Yes		
Product fixed effects		Yes			Yes			Yes			Yes		
Week specific fixed effects		Yes			Yes			Yes			Yes		
Products		542			518			305			177		
N		21,540			21,675			14,780			8,500		
R^2		0.17			0.18			0.17			0.16		

*=p<0.1, **=p<0.05, ***=p<0.001, standard errors clustered at the product level in all estimations.