

SOCIAL NETWORK INTEGRATION AND USER CONTENT GENERATION: EVIDENCE FROM NATURAL EXPERIMENTS

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Appendix A

Assessing Pretreatment Trends Using a Dynamic Difference-in-Differences Model

A key identifying assumption of the DID specification is the existence of parallel trends between the treatment and control group, leading up to the treatment. Under a dynamic difference-in-differences specification, it is possible to test the assumption of parallel trends explicitly. In particular, by interacting the treatment indicator with time dummies, we can explore relative changes in the trends of our dependent variables across the treatment and control groups around the time of treatment. Our aim in doing so is to assess whether the treatment effects recovered in the traditional DID analyses were plausibly due to a preexisting dynamic, which began before the treatment took place (i.e., a failure of the parallel trends assumption). Specifically, the DID's assumption of parallel trends would be violated if we were to observe a pretreatment trend in the same direction as the post-treatment effect; such an observation would imply that the effect began to manifest prior to the treatment.

As we discuss in the main text of the paper, TripAdvisor's Instant Personalization is an opt-out feature and the effect is presumably more salient than Yelp's Facebook Connect (an opt-in feature), therefore we use the time window around TripAdvisor's exogenous shock to examine the relative difference in differences in our dependent variables, between TripAdvisor and Yelp, across multiple periods of time, both before and after the treatment event. We implement the approach suggested by Angrist and Pishke (2009), interacting our platform dummy, *Trip*, with our time (monthly) dummies. Notably, this sort of approach has seen extensive use in recent IS work (Burtch et al. 2016; Chan and Ghose 2014; Greenwood and Wattal 2017).

We estimate a platform fixed effect, *Trip*, a set of absolute time (monthly) dummies τ_t (e.g., January 2011, February 2011), their interactions, and a vector of restaurant fixed effects. Our econometric specification is thus as detailed in Equation A1. We plot the coefficients associated with each month**Trip* interaction, omitting the month of integration (December 2010) from the estimation (i.e., the coefficients reflect difference-in-differences estimates relative to the month of treatment).

$$DV_{ipt} = Trip_p + \tau_t + Trip_p * \tau_t + \gamma_1 \ln(words_{ipt}) + \gamma_2 rating_{ipt} + \alpha_i + \varepsilon_{ipt} \quad (A1)$$

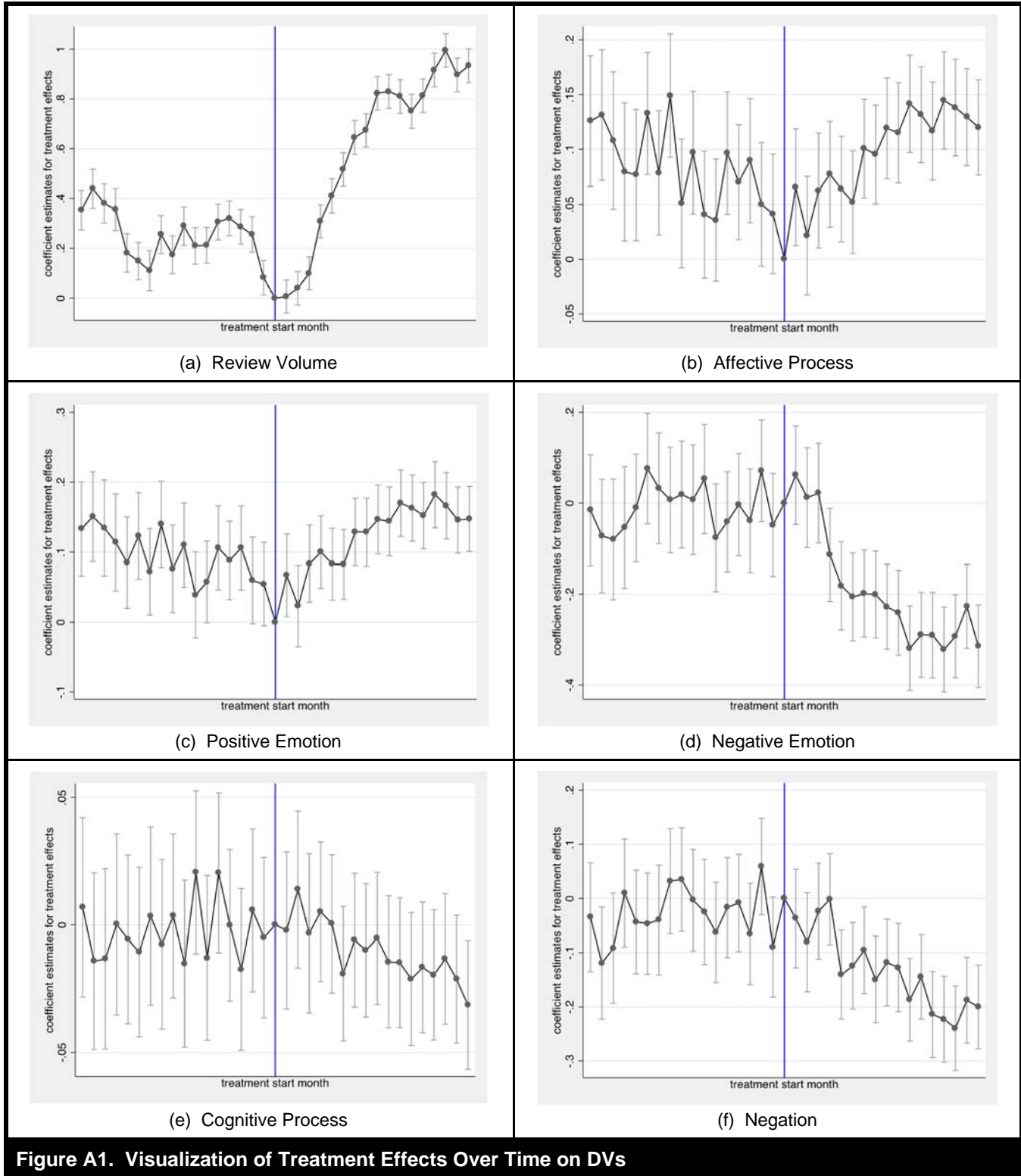


Figure A1. Visualization of Treatment Effects Over Time on DVs

In the above equation, i denotes restaurants, p indexes platforms and t indicates months. Figure A1 presents visualizations the coefficient estimates associated with our time dummy interactions for our DVs. As shown, we observe no evidence of pre-treatment trends (i.e., trends

beginning prior to the date of treatment that lie in the same direction as the post-treatment trend). Accordingly, although the pre-treatment trends are not strictly parallel, the fact that the treatment drives a near immediate reversal in the difference in differences suggest that we have identified the true treatment effect. Moreover, over our period of study, we do not observe a peak in any of the treatment effects, suggesting that the effects continue to progress in magnitude beyond our window of observation.

Beyond the above, to further rule out the possibility that some other significant event (e.g., system changes) confounded the Instant Personalization treatment, we scoured TripAdvisor's press releases¹ and Google News for articles related to Yelp. We found no mention of any significant changes to the TripAdvisor or Yelp interfaces between December 2010 and April 2011, indicating that our results are unlikely driven by spurious relationships

References

- Angrist, J. D., and Pischke, J. S. 2008. *Mostly Harmless Econometrics: An Empiricist's Companion*, Princeton, NJ: Princeton University Press.
- Burtch, G., Carnahan, S., and Greenwood, B. N. 2016. "Can You Gig It? An Empirical Examination of the Gig-Economy and Entrepreneurial Activity," Working Paper, Carlson School of Management, University of Minnesota.
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- Greenwood, B. N., and Wattal, S. 2017. "Show Me the Way to Go Home: An Empirical Investigation of Ride-Sharing and Alcohol Related Motor Vehicle Fatalities," *MIS Quarterly* (41:1), pp. 163-187.

¹http://www.tripadvisor.com/PressCenter-i4470-c1-Press_Releases.html.

Appendix B

Separate DID Analyses

As an additional robustness check, we report separate/single-shock DID analyses for the two exogenous shocks, to evaluate the robustness of our main findings, which were obtained via a double DID specification. We estimate the following models, where the parameter of interest (i.e., the DID estimate) is β_2

$$\ln(\text{ReviewVolume})_{ipt} = \beta_0 \text{Trip}_p + \beta_1 \text{Trip_Change}_t + \beta_2 \text{Trip}_p * \text{Trip_Change}_t + \beta_3 \ln(\text{words}_{ipt}) + \beta_4 \text{rating}_{ipt} + \alpha_i + \varepsilon_{ipt} \tag{1}$$

$$\text{ReviewVolume}_{ipt} = \beta_0 \text{Trip}_p + \beta_1 \text{Trip_Change}_t + \beta_2 \text{Trip}_p * \text{Trip_Change}_t + \beta_3 \ln(\text{words}_{ipt}) + \beta_4 \text{rating}_{ipt} + \alpha_i + \varepsilon_{ipt} \tag{2}$$

$$\ln(\text{ReviewVolume})_{ipt} = \beta_0 \text{Yelp}_p + \beta_1 \text{Yelp_Change}_t + \beta_2 \text{Yelp}_p * \text{Yelp_Change}_t + \beta_3 \ln(\text{words}_{ipt}) + \beta_4 \text{rating}_{ipt} + \alpha_i + \varepsilon_{ipt} \tag{3}$$

$$\text{ReviewVolume}_{ipt} = \beta_0 \text{Yelp}_p + \beta_1 \text{Yelp_Change}_t + \beta_2 \text{Yelp}_p * \text{Yelp_Change}_t + \beta_3 \ln(\text{words}_{ipt}) + \beta_4 \text{rating}_{ipt} + \alpha_i + \varepsilon_{ipt} \tag{4}$$

$$\ln(\text{Linguistic Characteristic})_{ipt} = \beta_0 \text{Trip}_p + \beta_1 \text{Trip_Change}_t + \beta_2 \text{Trip}_p * \text{Trip_Change}_t + \beta_3 \ln(\text{words}_{ipt}) + \beta_4 \text{rating}_{ipt} + \alpha_i + \varepsilon_{ipt} \tag{5}$$

$$\text{Linguistic Characteristic}_{ipt} = \beta_0 \text{Trip}_p + \beta_1 \text{Trip_Change}_t + \beta_2 \text{Trip}_p * \text{Trip_Change}_t + \beta_3 \ln(\text{words}_{ipt}) + \beta_4 \text{rating}_{ipt} + \alpha_i + \varepsilon_{ipt} \tag{6}$$

$$\ln(\text{Linguistic Characteristic})_{ipt} = \beta_0 \text{Yelp}_p + \beta_1 \text{Yelp_Change}_t + \beta_2 \text{Yelp}_p * \text{Yelp_Change}_t + \beta_3 \ln(\text{words}_{ipt}) + \beta_4 \text{rating}_{ipt} + \alpha_i + \varepsilon_{ipt} \tag{7}$$

$$\text{Linguistic Characteristic}_{ipt} = \beta_0 \text{Yelp}_p + \beta_1 \text{Yelp_Change}_t + \beta_2 \text{Yelp}_p * \text{Yelp_Change}_t + \beta_3 \ln(\text{words}_{ipt}) + \beta_4 \text{rating}_{ipt} + \alpha_i + \varepsilon_{ipt} \tag{8}$$

First, we report the separate DID analyses results for review volume in Table B1 and Table B2, where we observe that, compared with Yelp, the review volume of TripAdvisor increased by 38.8% after implementing Instant Personalization. Similarly, compared to TripAdvisor, the review volume of Yelp increased by 18.2% after integrating Facebook Connect.

Second, we present the separate DID results for mental processes. Based on Tables B3 and Table B4, we observe that, compared with Yelp, affective processes on TripAdvisor increased by 1.8%, whereas cognitive processes decreased by 0.9% after implementing Instant Personalization. Additionally, positive emotion on TripAdvisor increased by 3% while negative emotion decreased by 21%. According to Table B5 and Table B6, compared with TripAdvisor, affective processes on Yelp increased by 6.4%, while cognitive processes declined by 2.4% after implementing Facebook Connect. Further, positive emotion on Yelp increased by 7.8% but negative emotion decreased by 10.2%.

Third, we show separate DID analyses results for the inhibition effect in Table B7 and Table B8. We observe that, compared with Yelp as the baseline control group, the use of negations on TripAdvisor decreased by 11.9% after implementing Instant Personalization. Similarly, compared with TripAdvisor, language references to negation on Yelp decreased by 8.1% after integrating with Facebook Connect.

Variables	(1) ln(Review Volume)	(2) Review Volume
Trip	-0.841***(0.018)	-3.482***(0.132)
Trip_Change	0.257***(0.006)	1.210***(0.037)
Trip * Trip_Change	0.388***(0.014)	1.377***(0.116)
ln(words)	0.247***(0.005)	0.952***(0.027)
Rating	0.014***(0.003)	0.082***(0.015)
Constant	-0.124***(0.026)	-0.353*(0.143)
Observations	112,262	112,262
R-squared	0.220	0.140
Number of restaurants	3,964	3,964
Restaurant Fixed Effect	Yes	Yes

Notes: Cluster-robust standard errors in parentheses. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$

Table B2. Yelp DID Volume Effect

Variables	(1) ln(Review Volume)	(2) Review Volume
Yelp	0.612***(0.021)	2.117***(0.119)
Yelp_Change	0.006(0.015)	-0.010(0.067)
Yelp * Yelp_Change	0.182***(0.016)	0.858***(0.078)
ln(words)	0.149***(0.006)	0.573***(0.029)
Rating	0.006(0.003)	0.026*(0.013)
Constant	-0.462***(0.041)	-1.570***(0.231)
Observations	47,151	47,151
R-squared	0.195	0.150
Number of restaurants	3,178	3,178
Restaurant Fixed Effect	Yes	Yes

Notes: Cluster-robust standard errors in parentheses. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$

Table B3. TripAdvisor DID Affective and Cognitive Processes

Variables	(1) ln(Affective Process)	(2) Affective Process	(3) ln(Cognitive Process)	(4) Cognitive Process
Trip	-0.160***(0.006)	-0.967***(0.033)	0.051***(0.003)	0.739***(0.056)
Trip_Change	0.042***(0.002)	0.294***(0.017)	0.004***(0.001)	0.067***(0.022)
Trip * Trip_Change	0.018***(0.006)	0.095*(0.037)	-0.009*(0.003)	-0.115+(0.059)
ln(words)	-0.235***(0.003)	-1.797***(0.017)	0.039***(0.002)	0.855***(0.028)
Rating	0.094***(0.002)	0.593***(0.009)	-0.012***(0.001)	-0.198***(0.015)
Constant	2.745***(0.015)	13.971***(0.096)	2.571***(0.009)	11.860***(0.154)
Observations	110,337	110,669	108,368	110,669
R-squared	0.152	0.143	0.015	0.020
Number of restaurants	3,958	3,961	3,953	3,961
Restaurant Fixed Effect	Yes	Yes	Yes	Yes

Notes: Cluster-robust standard errors in parentheses. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$

Table B4. TripAdvisor DID Positive and Negative Affective Processes

Variables	(1) ln(Positive Emotion)	(2) Positive Emotion	(3) ln(Negative Emotion)	(4) Negative Emotion
Trip	-0.196***(0.006)	-1.016***(0.043)	0.225***(0.014)	0.025(0.015)
Trip_Change	0.047***(0.003)	0.292***(0.018)	-0.044***(0.005)	0.006(0.007)
Trip * Trip_Change	0.030***(0.007)	0.096*(0.047)	-0.210***(0.015)	-0.053***(0.016)
ln(words)	-0.270***(0.003)	-2.154***(0.024)	-0.300***(0.007)	-0.020*(0.008)
Rating	0.188***(0.002)	1.101***(0.011)	-0.295***(0.003)	-0.436***(0.006)
Constant	2.410***(0.016)	12.815***(0.126)	2.425***(0.033)	2.656***(0.054)
Observations	109,966	110,669	86,307	110,669
R-squared	0.236	0.228	0.129	0.128
Number of restaurants	3,958	3,961	3,929	3,961
Restaurant Fixed Effect	Yes	Yes	Yes	Yes

Notes: Cluster-robust standard errors in parentheses. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$

Table B5. Yelp DID Affective and Cognitive Processes

Variables	(1) ln(Affective Process)	(2) Affective Process	(3) ln(Cognitive Process)	(4) Cognitive Process
Yelp	0.076***(0.011)	0.083(0.089)	-0.013*(0.006)	-0.389***(0.087)
Yelp_Change	-0.035**(0.012)	-0.443***(0.098)	0.025***(0.007)	0.346***(0.104)
Yelp * Yelp_Change	0.064***(0.013)	0.650***(0.100)	-0.024***(0.007)	-0.354***(0.107)
ln(words)	-0.193***(0.004)	-1.620***(0.030)	0.063***(0.003)	0.646***(0.036)
Rating	0.076***(0.002)	0.474***(0.015)	-0.011***(0.001)	-0.172***(0.021)
Constant	2.498***(0.024)	13.174***(0.181)	2.458***(0.015)	13.151***(0.206)
Observations	46,767	46,821	46,807	46,821
R-squared	0.103	0.114	0.022	0.015
Number of restaurants	3,174	3,174	3,174	3,174
Restaurant Fixed Effect	Yes	Yes	Yes	Yes

Notes: Cluster-robust standard errors in parentheses. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$

Table B6. Yelp DID Positive and Negative Affective Processes

Variables	(1) ln(Positive Emotion)	(2) Positive Emotion	(3) ln(Negative Emotion)	(4) Negative Emotion
Yelp	0.097***(0.012)	0.063(0.088)	-0.052*(0.022)	0.036(0.022)
Yelp_Change	-0.040**(0.013)	-0.433***(0.096)	0.049*(0.024)	0.038(0.023)
Yelp * Yelp_Change	0.078***(0.014)	0.662***(0.098)	-0.102***(0.025)	-0.047+(0.026)
ln(words)	-0.226***(0.005)	-1.622***(0.029)	-0.231***(0.009)	-0.024***(0.009)
Rating	0.171***(0.003)	0.862***(0.014)	-0.253***(0.005)	-0.434***(0.006)
Constant	2.118***(0.027)	10.768***(0.178)	2.054***(0.050)	2.650***(0.048)
Observations	46,670	46,821	38,299	46,821
R-squared	0.191	0.175	0.112	0.101
Number of restaurants	3,173	3,174	3,108	3,197
Restaurant Fixed Effect	Yes	Yes	Yes	Yes

Notes: Cluster-robust standard errors in parentheses. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$

Table B7. TripAdvisor DID Inhibition Effect

Variables	(1) ln(Negation)	(2) Negation
Trip	0.509***(0.010)	0.576***(0.018)
Trip_Change	-0.018***(0.005)	0.026***(0.007)
Trip * Trip_Change	-0.119***(0.011)	-0.068***(0.019)
ln(words)	-0.265***(0.006)	-0.006(0.009)
Rating	-0.200***(0.003)	-0.351***(0.005)
constant	1.993***(0.030)	2.355***(0.053)
Observations	93,870	110,669
R-squared	0.143	0.093
Number of restaurants	3,937	3,961
Restaurant Fixed Effect	Yes	Yes

Notes: Cluster-robust standard errors in parentheses. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$

Table B8. Yelp DID Inhibition Effect		
Variables	(1) In(Negation)	(2) Negation
Yelp	-0.389***(0.017)	-0.543***(0.030)
Yelp_Change	0.061***(0.017)	0.042(0.033)
Yelp * Yelp_Change	-0.081***(0.018)	-0.038+(0.024)
ln(words)	-0.231***(0.008)	-0.047***(0.012)
rating	-0.170***(0.004)	-0.285***(0.007)
constant	2.138***(0.044)	2.855***(0.071)
Observations	40,877	46,821
R-squared	0.121	0.098
Number of restaurants	3,139	3,174
Restaurant Fixed Effect	Yes	Yes

Notes: Cluster-robust standard errors in parentheses. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$

Appendix C

Additional Analyses

Table C1 reports changes in user-level monthly reviewing volumes and language characteristics over the two year period surrounding TripAdvisor's social network integration (12 months before and after the event). This simple pre/post user-level data enables us to gain some sense of whether behavior appeared to change within users as a result of the treatment. For review volumes, we estimate the effect of TripAdvisor social network integration on users' average monthly number of reviews. For the linguistic features, due to limited scalability of the LIWC software to process large amounts of textual data, we randomly sampled a subset of users who jointly authored a total of approximately 750,000 reviews. Amongst these reviews, 96,356 were authored within our two year time window. Considering the results in Table C1, we observe that the social network integration is significantly associated with changes in all of our outcome variables, suggesting that our results may be attributable to within-user changes in behavior. One caveat of this analysis, however, is that we are unable to account for underlying time trends and other factors, because there is no true control group (all data comes from a single platform). Thus, this evidence is merely correlational, and thus circumstantial. Future work might therefore explore the relative roles of selection versus within-user changes in behavior.

Table C2 reports an additional analysis using a continuous measure (number of months since the user registered on the platform) of user tenure. This analysis yields similar results for the binary user tenure variable.

Table C3 reports robustness checks of our main analyses (log-transformed DVs) while controlling for seasonal trends (with 11 dummy variables, i.e. February, March, April, ..., December). These results are largely consistent with our main findings.

Table C1. Effect of Social Network Integration on Within User Review Volume and Language Characteristics

Variables	(1) Review Volume	(2) Affective Process	(3) Positive Emotion	(4) Negative Emotion	(5) Cognitive Process	(6) Negation
Trip_Change	0.792*** (0.017)	0.103* (0.044)	0.139*** (0.041)	-0.033* (0.013)	-0.165** (0.219)	-0.036* (0.014)
Constant	2.288*** (0.012)	6.480*** (0.036)	5.501*** (0.034)	0.748*** (0.010)	7.927*** (0.044)	1.304*** (0.011)
Observations	244,978	96,356	96,356	96,356	96,356	96,356
F-Statistic	2164.85***	5.44*	11.34***	6.64**	7.05***	6.63**
Number of Users	70,450	5,174	5,174	5,174	5,174	5,174
User Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Cluster-robust standard errors in parentheses. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Table C2. Effects of Continuous User Tenure on Review Language Characteristics

Variables	(1) Affective Process	(2) Positive Emotion	(3) Negative Emotion	(4) Cognitive Process	(5) Negation
ln(tenure)	0.019 (0.016)	0.029 (0.016)	-0.008 (0.005)	0.030 (0.019)	0.010 (0.006)
ln(words)	-3.065*** (0.047)	-3.081*** (0.048)	0.010 (0.012)	0.935*** (0.043)	0.045** (0.014)
Rating	0.634*** (0.020)	1.036*** (0.021)	-0.406*** (0.011)	-0.185*** (0.026)	-0.444*** (0.010)
Constant	18.270*** (0.249)	15.883*** (0.245)	2.386*** (0.093)	12.053*** (0.293)	3.088*** (0.100)
Observations	46,341	46,341	46,341	46,341	46,341
R-squared	0.259	0.290	0.088	0.022	0.064
Number of Restaurants	2,755	2,755	2,755	2,755	2,755
Restaurant Fixed Effect	Yes	Yes	Yes	Yes	Yes
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes

Notes: Cluster-robust standard errors in parentheses. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Table C3. Estimation with Adjustment for Seasonality (Log-Transformed Outcomes)

Variables	(1) ln(Review Volume)	(2) ln(Affective Process)	(3) ln(Positive Emotion)	(4) ln(Negative Emotion)	(5) ln(Cognitive Process)	(6) ln(Negation)
Trip	-0.647*** (0.019)	-0.083*** (0.007)	-0.101*** (0.008)	0.087*** (0.017)	0.007 (0.005)	0.394*** (0.014)
Trip_change	0.238*** (0.006)	0.041*** (0.002)	0.046*** (0.003)	-0.040*** (0.005)	0.008*** (0.002)	-0.016*** (0.005)
Trip * Trip_Change	0.379*** (0.014)	0.025*** (0.005)	0.040*** (0.006)	-0.200*** (0.012)	-0.004 (0.003)	-0.114*** (0.010)
Yelp_change	0.059*** (0.014)	-0.035*** (0.007)	-0.042*** (0.008)	0.057** (0.019)	0.033*** (0.005)	0.078*** (0.015)
Yelp * Yelp_Change	0.195*** (0.015)	0.076*** (0.008)	0.094*** (0.009)	-0.123*** (0.020)	-0.031*** (0.005)	-0.106*** (0.016)
ln(words)	0.182*** (0.004)	-0.220*** (0.002)	-0.255*** (0.002)	-0.257*** (0.005)	0.077*** (0.001)	-0.234*** (0.004)
Rating	0.014*** (0.003)	0.090*** (0.001)	0.183*** (0.001)	-0.283*** (0.003)	-0.012*** (0.001)	-0.192*** (0.002)
Constant	0.001 (0.024)	2.655*** (0.012)	2.311*** (0.013)	2.254*** (0.027)	2.377*** (0.008)	1.855*** (0.024)
Observations	139,239	137,158	136,760	109,450	137,272	118,205
R-squared	0.224	0.146	0.234	0.125	0.030	0.135
Number of Restaurants	3,968	3,963	3,963	3,936	3,962	3,944
Restaurant Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Seasonality	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Cluster-robust standard errors in parentheses. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$