# Wintertime for Deceptive Advertising?[*]

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ABSTRACT

Casual empiricism suggests that deceptive advertising about product quality is prevalent, and several classes of theories explore its causes and consequences. We provide some unusually sharp empirical evidence on the extent, mechanics, and dynamics of deceptive advertising. Ski resorts self-report substantially more natural snowfall on weekends. Resorts that plausibly reap greater benefits from exaggerating—those that have expert terrain and those that do not offer money back guarantees— exaggerate more. We find little evidence that competition restrains or encourages exaggeration.

Other keywords: false advertising, misleading advertising, bait and switch, search costs, quality disclosure, product information

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Casual empiricism suggests that deceptive advertising about product quality is prevalent, and several classes of theories explore its causes and consequences.[1] Yet there is little sharp empirical evidence that speaks to such theories. This gap is due in part to formidable measurement challenges; in most settings, measuring deceptive advertising requires detailed, high-frequency information (on ads, product quality, and inventories) that is difficult to observe.

We test for deceptive advertising by examining a critical component of product quality at ski resorts: *new*, *natural* (or "fresh") snowfall in the past 24 hours. Ski resorts issue "snow reports" on their websites roughly once a day. These reports are also collected by aggregators and then rebroadcast over the Internet and via print and broadcast media. A skier wishing to ski on new, natural snow can use these snow reports to help decide whether and where to ski on a particular day. In principle, snow reports provide skiers with location-specific information on fresh snowfall that is not necessarily captured by third-party weather websites.

The dynamics of customer acquisition by ski resorts suggest that the optimal (deceptive) advertising strategy may vary at high frequencies. Resorts only benefit from exaggerating snow reports when skiers condition purchase decisions on them. The cost of exaggeration is angering or losing credibility with skiers, including those who have already pre-committed (e.g., as part of a multi-day vacation) but use the snow report to help plan their day.

Several factors suggest that resort snow reporting behavior could differ on weekends vs. weekdays. Customer traffic tends to be much heavier on weekends, so resorts may tend to

[1] Lazear (1995) models firms taking advantage of high consumer search costs by "baiting" consumers with a high quality good that is not actually in-stock, and then "switching" consumers to a lower quality good that is in-stock. In signal-jamming models (e.g., Holmstrom (1999)), agents engage in costly effort to upwardly bias signals of their quality, but rational recipients of these signals anticipate these efforts and no information is lost. Other models focus on deception more generally, with motivating examples from advertising; e.g., Ettinger and Jehiel (2010). See also footnote 10 below.

exaggerate more on weekends if the benefits of exaggeration scale with demand while the cost-- which we suspect is primarily reputational-- scales less. Likewise, resorts may exaggerate more on weekends if there is a larger (potential) share of non-precommitted customers on weekends than on weekdays, when many skiers are constrained by work schedules and hence less likely to condition resort choice on snow conditions. Of course there may also be factors pushing toward greater exaggeration on weekdays; e.g., if there are more expert and hence fresh snow-elastic skiers during the week (a "ski bum" effect, if you will). We lack the requisite demand-side data to formulate a sharp hypothesis about whether exaggeration is more likely on weekends or weekdays, and hence conduct nonparametric and two-sided tests for whether and how much snow reporting varies over the week.

We estimate that resorts report 23 percent more new natural snow on Saturday and Sunday mornings (1.59 inches vs. 1.29 inches, p-value = 0.025). This "weekend effect" is substantial in absolute as well as percentage terms. New natural snow only falls during about 30% of the resort-days in our sample, and our results also suggest that many resorts report accurately. Overall then, our results suggest that, when reporting any new snow at all, resorts *report* an inch or more of additional fresh snow on weekends.[2]

To be fair, there is a small literature in climatology suggesting that day of week effects in pollution affect precipitation and temperature, and thus may affect snowfall. But the effects estimated in that literature are quite small (relative to the 23 percent difference in resort-reported snow we find) and of mixed sign.[3] Nevertheless, we control for government-

[2] In addition to reporting new natural snow, resorts also report other aspects of snow quantity and quality, such as base depth, number of trails open, and surface conditions (e.g., powder, packed powder). These other aspects can be influenced by manmade snow and hence we do not examine them.

[3] Cerveney and Balling (1998) find higher CO and $O_3$ levels and higher precipitation on Fridays and Saturdays. Effects are primarily in areas downwind of the U.S. Eastern seacoast. Forster and Solomon (2003) find that nighttime low temperatures are 0.2 to 0.4 degrees Celsius higher on weekends in the middle of the United States

reported snow in all of our key empirical specifications. We find that doing this cuts the weekend effect by one-quarter to one-third but improves the precision of estimates, leaving them statistically and economically significant.

Having found some evidence that deceptive advertising varies *within* resorts over time along with payoffs, we next explore whether deceptive advertising varies *across* resorts with plausibly different payoffs. Weekend effects in resort reporting are larger for resorts with more expert terrain and for those that do not offer a money back guarantee.[4] This is consistent with expert skiers valuing fresh snow more highly, and with guarantees and deception being substitutes (rather than, e.g., guarantees giving skiers a false sense of confidence in resort reports). We do not find any statistically significant differences in deceptive advertising across density of competition, population within 150 miles, or resort ownership type (government, privately held firm, or publicly-traded), although these null effects are imprecisely estimated.

In all, our results suggest that deceptive advertising about product quality responds sharply to incentives, both within-resort over time—as evidenced by the weekend effect—and across resorts with different characteristics.

Our finding of significant product quality exaggeration builds on Jin and Kato (2006), who audit claims about the quality of baseball cards being auctioned on eBay and find evidence of exaggeration.[5] Jin and Kato's analysis focuses on the effect of deceptive claims on

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but are 0.1 to 0.2 degrees lower in the Southeast and Southwest (weekend effects in the Northeast and West, where most of our resorts are located, are smaller).

[4] Guarantees, when offered, typically offer the skier a 100% refund on that's day lift ticket so long as the skier does not take more than one run.

[5] See also Ellison and Ellison (2009) for evidence of firm practices that "frustrate consumer search or make it less damaging to firms" in the Pricewatch shopping engine for computer parts. Luca and Zervas (2013) and Mayzlin et al (2014) identify and analyze review fraud in restaurants and hotels; in their settings, unlike ours, the sender of the (deceptive) message about product quality is not readily identifiable.

demand and auction prices, whereas our focus is more on the supply of deception.[6] Our work is related to literature on how customer feedback on product/service quality affects firm behavior and equilibrium.[7] It also complements prior work showing that third-party quality disclosure can change firm behavior.[8]

Although our findings provide unusually sharp evidence on the nature and dynamics of deceptive advertising, our setup can only identify a subset of the behaviors of interest for modeling and policy analysis. We lack any high-frequency data on prices or quantities sold, and hence cannot measure the demand responses to snow reports.[9] This prevents us from sharply testing across the models discussed at the outset or measuring the welfare implications of (changes in) advertising practices. Moreover, as with any study of a single industry, the external validity of our findings to other markets is uncertain.

Our findings nevertheless have potentially broad applicability, as the market for skiers does not seem uniquely suited to deceptively advertising. There are many other markets where search and switching costs loom large.[10] And many of the other conditions that contribute to deception in theory do *not* seem to prevail in our setting. Ski area customers get immediate and visceral feedback on the accuracy of snow reports. The potential for repeat play and

[6] Another related literature considers whether, how, and why entities "game" mandated reporting re: product quality; see, e.g Forbes et al (2013) on airline reporting of on-time performance, and Chen et al (2012) on air pollution data in China.

[7] This literature has focused to a great extent on eBay; see, e.g., Cabral and Hortascu (2010) and cites therein. See also Hubbard (2002) on auto repair and Luca (2011) on restaurants.

[8] See, e.g., Sauer and Leffler (1990), Dranove and Jin (2010), and Luca and Smith (2014). Beales et al (1981) provide an overview of legal limitations on deceptive advertising. Jolls and Sunstein (2006) discuss behavioral motives for government regulation of advertising.

[9] We conducted this study without industry cooperation, and hence our data on resorts is limited to what we could gather from other sources. Nearly all resorts are privately held so publicly available financial information on them is scarce, particularly at the daily frequency.

[10] In our setting, on a one-shot basis, driving times are substantial even between "neighboring" resorts. On a longer-term basis, some consumers may find it costly to coordinate with peers on alternative destinations or to learn how to navigate the terrain and ancillary services (parking, rentals, dining, lodging) of a new mountain.

learning is high.[11] And the entry and exit rates of ski areas are low: there are few if any "fly-by-night" players with incentives to commit outright fraud. So we speculate that there are many other markets where conditions are ripe for deceptive advertising that varies sharply with advertiser incentives.

The paper proceeds as follows. Section II details our data on snowfall and on resort characteristics. Section III details our identification strategy and results. Section IV concludes.

## II. Snowfall and Resort Data

Our data for measuring product quality and its reporting consist of resort-provided snow reports, government snow data, and resort characteristics.

Resort-reported snow is measured by the resorts themselves, and reported, typically daily, on individual resort websites. Our discussions with industry participants suggest that snow measurement practices vary across resorts: some take multiple measurements up-and-down the mountain, while others measure from a single spot. One commonality seems to be that there is a division of labor: measurements are usually taken by ski patrol (who are also responsible for opening and closing trails and assisting injured skiers) and then called/radioed in to the marketing department. Marketing is then responsible for reporting snow conditions on the resort's website and disseminating them to aggregators. These practices suggest that resorts have several potential production functions for exaggerating fresh snowfall, and doing so selectively on weekends. Measurement-takers might be more likely to exaggerate or aggressively round up on the weekend (e.g., reporting 3 inches instead of 2, or 2 inches

[11] The immediate feedback stands in contrast to the examples (e.g., tobacco use, investment advice) that motivate Glaeser and Ujelyi (2010) and Kartik et al (2007). The visceral feedback (and high stakes) contrasts with the "low involvement situations" (e.g.,. voting, cheap products) that can make consumers susceptible to persuasion in Mullainathan et al (2008).

instead of 1.4). Marketers might be more likely to exaggerate or aggressively round up numbers, reported to them by measurement-takers, on the weekend. Marketers could instead/also take a higher number from among the many provided by measurement-takers from different parts of the resort on weekends; e.g., marketers could report a mid-mountain number during the week, and a summit number on the weekend. We test the hypothesis that resorts report more snow on weekends, without being able to identify the exact production function of any exaggeration.

We collect resort-provided reports from the websites of two popular aggregators: *SkiReport.com* and *OnTheSnow.com*. These websites do not supply archives of ski reports and thus we are forced to assemble our data from different sources. From February 15, 2008 until the end of our sample, we collected snow reports once per day from *SkiReport.com*.[12] We collected snow reports from earlier time periods from two private Internet archives. Since these archives had better coverage of *OnTheSnow.com*, we used archived reports from this website. In the data collected from Internet archives, we are limited to collecting data for days on which the relevant web page was archived. We collect snow reports from archived pages that summarize all reports from a given state or province, so an entire state's data is either archived or not on a given day. The frequency of data collection in these archives increases over time. In the 2004-5 and 2005-6 seasons, snow reports are available for only about 10 percent of resort-days between December and March. This ratio rises to 30 percent in the 2006-7 season and 65 percent in the 2007-8 season.

The archiving process is Internet-wide, so it seems reasonable to assume that the archiving of data for a resort should be exogenous to actual or reported snow. We test this assumption in

[12] Since we circulated the first draft of this paper in mid-2009, both *Skireport.com* and Mountain News Corporation, the owner of *Onthesnow.com*, have been purchased by Vail Resorts. Skireport.com now redirects to Onthesnow.com.

three ways. First, we test whether reports were more likely to be archived on certain days of the week, and find that weekends account for almost exactly two sevenths of our resort reports (28.4%, p-value of difference from 2/7 = 0.945). Second, we simply examine the timing of the reports, finding that in one of our archives it increased from once every ten days, to once every five days, to once every three days, to essentially every day. Archiving frequencies were higher for states with more resorts (e.g., Colorado vs. Missouri), suggesting that the archiving of a page containing a state's snow reports responded to that webpage's popularity, but the regular sampling frequencies suggested that this response was not happening at high enough frequency to contribute to a weekend effect. Third, we test whether the availability of a report is correlated with an interaction of government-reported snow (which we can measure on days when resort-reported snow is missing from the archives) and a weekend indicator variable, and find no evidence that it is (results discussed below, and reported in Online Appendix Table A1).

Our government data on snowfall, which we use to control for any true weekend effect, comes from two sources: actual reported snowfall from nearby government weather stations, and estimated snowfall from the Snow Data Assimilation System (SNODAS), a U.S. National Weather Service model that provides estimated snowfall from satellite, ground station, and airborne weather data collection.[13] SNODAS data are available for any point in the continental United States on a 30-arc-second grid.[14] We take the largest of the 25 SNODAS estimates from the 5x5 grid surrounding the main resort mountain as the estimate of actual snowfall that we match to the resort snow report.[15]

[13] SNODAS data are described and available at http://nsidc.org/data/g02158.html.
[14] Thirty arc seconds are roughly 930 meters North-South and 660 meters East-West (at 45 degrees latitude).
[15] We collect data on the latitude and longitude of resort mountains primarily from the U.S. Geological Survey, and supplement this data with hand-collected information from Google Maps.

For the government weather stations, we match each resort with to up to 20 National Oceanographic and Atmospheric Administration (NOAA) or National Operational Hydrologic Remote Sensing Center (NOHRSC) weather stations within 100 miles horizontally and at elevations within 1000 feet of the resort summit.[16] We match each resort snow report to mean reported snow from the surrounding stations that meet these criteria.

In matching the resort and government snow data, we match time periods as closely as possible. Resorts can issue and update snow reports on aggregator websites at any time, but they usually issue a report early in the morning local time. This report is timed to capture as much overnight snowfall as possible while still being available in time to affect that day's skier purchasing decisions. Saturday's snow report issued at 7 AM local time would therefore reflect snowfall from 7 AM Friday to 7 AM Saturday, and so we attempt to match the Saturday resort report with SNODAS and government data from this time period. NOHRSC reports typically cover a 24-hour period beginning at 7 AM local time, so this matches the timing of resort reports well. NOAA stations aggregate their data into 24-hour periods beginning at midnight Coordinated Universal Time (UTC), which corresponds to 7 PM Eastern Standard Time (EST) and 4 PM Pacific Standard Time (PST) in winter months. Since NOHRSC reports provide a better match with the timing of the resort reports, we match with NOAA reports only if matched NOHRSC stations are not available. SNODAS aggregates its data into 24-hour periods that begin at 6 AM (UTC), or 1 AM EST and 10 PM PST. Our analysis accounts for this asynchronicity.

[16] NOAA station data is described at http://www.ncdc.noaa.gov/oa/climate/ghcn-daily/. NOHRSC station data is described at http://www.nohrsc.noaa.gov/nsa/reports.html. We match weather stations using a loss function of the distance in miles plus 0.1 times the difference between summit and station elevation in feet. The average matched station is 26 miles away and 160 feet below the summit for Eastern resorts and 52 miles away and 280 feet below the summit for Western resorts. Twenty-eight out of 437 resorts do not have matching weather stations due to the elevation restriction (19 of these are in Western Canada).

Table 1 provides statistics on the distribution of our resort and snowfall observations across region and time period. We include resorts in the U.S. and Canada in our sample. We distinguish between Eastern and Western resorts, defining Eastern as states and provinces that are entirely east of the Continental Divide. Eastern mountains have lower elevations, and we are able to match more Eastern mountains to government weather stations that are within 1000 feet of summit elevation. SNODAS forecasts are not available in Canada, but are available for essentially all U.S. resorts. As mentioned above, the frequency of resort snow reports increases later in the sample, from about 12-13 reports per resort*year in 2004-5 and 2005-6, to 39 in 2006-7, to 70-75 in 2007-8. Our analysis of the weekend effect will focus on the 2004-8 seasons.

Table 2, Panel A describes some additional characteristics of the resorts in our sample. Eastern and Western resorts differ on many of these characteristics, and so we report separate summary statistics for each group. Western resorts classify a larger share of their terrain as Expert (double black diamond), Advanced (black diamond) or, Intermediate (blue square), whereas Eastern resorts have a higher share of Beginner (green circle) terrain. Eastern mountains have lower base and summit elevations and vertical drops that are 60 percent smaller. Eastern resorts have roughly similar numbers of lifts, but less than half as many runs and one-ninth as many skiable acres. Eastern resorts have greater proximity to skiers who might be most influenced by snow reports in deciding whether and where to make a day- or weekend-trip (as measured by the population living in postal codes within 150 miles of the resort using U.S. and Canadian census data). Eastern resorts also face more competitors (as measured by the number of non-co-owned resorts within 50 miles).

Table 2, Panel B provides summary statistics for resort snow reports and snowfall data from government weather stations and SNODAS. Average reported snowfall from resort reports is 23 percent higher on weekends than during the week (1.59 vs. 1.29 inches, p-value of difference = 0.025). Resorts are 14 percent more likely to report at least some snow on weekend days (32.3 vs. 28.3 percent, p-value 0.016) and report 8 percent more snow conditional on reporting a positive amount (p-value 0.222).[17] Resorts report more snow than is reported in government weather data on both weekdays and weekends, although this could be the result of resort being located on specific mountains that receive more snow than neighboring locations.[18] There is also more snow on weekends in government weather data, but the differences are smaller and statistically insignificant (p-values 0.316 and 0.184 in Table 2 Panel B, more below in Table 3).

## III. Results

In this section, we identify a weekend effect in resort snow reports, and explore the reporting behaviors and types of resorts that drive the weekend effect.

### *A. Main Results*

Our starting point for testing for weekend effects is the OLS specification:

$$s_{rt} = \beta * w_t + a_w + n_r + e_{rt} \qquad (1)$$

where $s_{rt}$ is natural new (or "fresh") snowfall reported by resort r on day t, $w_t$ is an indicator variable for whether t is a weekend day, $a_w$ is a fixed effect for a specific calendar week

[17] The p-values given, like the standard errors in the regressions that follow, allow for two-dimensional clustering of error terms within days and resorts.

[18] Although the SNODAS model estimates snowfall for precise locations, it does so partly by interpolating between government weather stations. Thus strategic ski resort location decisions might exploit mountain-by-mountain variation in snowfall that SNODAS does not fully capture.

(Wednesday-Tuesday), $n_r$ is a fixed effect for a resort, and $e_{rt}$ is an error term. The fixed effects control for any bias arising from the proportion of snow reports on weekends varying between more and less snowy weeks of the year (e.g., if resorts were open only on weekends at the beginning and end of the season) or between more and less snowy resorts. Point estimates actually change very little when these fixed effects are dropped (Online Appendix Table A2), so these potential omitted variable biases do not appear important in practice. But the fixed effects do improve the efficiency of estimation by absorbing variation that would otherwise be captured by the error term. Table A2 also shows that the results are qualitatively similar if we use Tobit instead of OLS.[19]

Since actual and reported snowfall may be correlated across resorts on the same day, we allow for clustering within day when calculating our standard errors. Since snow reports may be serially correlated, we also allow for clustering within resorts, using the two-dimensional clustering procedure in Petersen (2009). Allowing for clustering within days does meaningfully affect standard errors, while clustering within resort has essentially no effect. Clustering at other levels, or allowing for spatial correlation in the error term, tends to produce slightly smaller standard errors than our preferred method of clustering on resort x day (Online Appendix Table A3).

Table 3 presents estimates of day of the week effects, and of weekend effects for different definitions of weekend (Sat-Sun, Fri-Sun), over the 2004-2008 seasons. In resort-reported snow (column 1), we find that the largest day of the week effects are for Saturday, Sunday,

[19] We also estimate specifications with resort*week fixed effects. This reduces degrees of freedom by about a third and increases the standard errors accordingly. The weekend effect point estimate is not statistically (or economically) significantly different from the specifications in Table 3, and the additional fixed effects are not collectively significant. See Table A2 for details.

Friday, and Monday. Regardless of our definition of weekend, we find that resorts report 0.20-0.25 more inches of new natural snow on weekends

In contrast, we do not find statistically significant evidence of a weekend effect in weather station or SNODAS data (columns 2-4). Point estimates of a weekend effect are positive for the sample of days for which we have a resort report, with magnitudes between 0.06 and 0.10 inches (Columns 3 and 4), or between 23 and 43 percent of the weekend effect in resort-reported snow. In contrast to the weekend effects in resort reports, the weekend effects in government reports are far from statistically significant (p-values range from 0.22 to 0.53), and they are not present to any meaningful extent when we examine the full sample of resort*days from the 2004-2008 seasons (Column 2). Nevertheless we control for government-reported snow in our tests below, to err on the side of estimating smaller weekend effects.

Table 4 examines the effect of adding controls for government weather data to our models of resort-reported weekend effects over the 2004-2008 seasons.[20] The first column presents our result from Table 3, Column 1 (Specification 2) for reference. Column 2 restricts the sample to resort-days with a good match to government weather stations. Column 3 restricts the sample to resort-days with a good match to SNODAS. Columns 4-7 add controls for various functional forms of weather station snowfall: Column 4 includes same-day weather station snowfall and restricts its coefficient to be 1 (a difference-in-difference approach); Column 5 removes the coefficient restriction but continues to impose linearity (see below for more flexible fuctional forms); Column 6 restricts the sample to observations with data for prior and next-day weather station snowfall; Column 7 adds controls for these leads and lags

[20] Online Appendix Table A4 presents estimates of the weekend effect for various sub-periods (by year, by month, and by holiday vs. non-holiday). We do not have sufficient power to draw any firm inferences.

(longer leads and lags do not have statistically significant coefficients). Regardless of specification, adding these weather station controls reduces both the standard error and the point estimate on the weekend effect but leaves it economically and statistically significant. When we control for SNODAS estimates by differencing (Column 8), we use a weighted average of current and next-day reported snowfall, where the weights are derived from the overlaps of time periods with a 7am-7am local time window in the resort's time zone. This yields weights that are fairly similar to the coefficients estimated in Column 9. Regardless of the approach, controlling for SNODAS instead of weather station estimates of snowfall produces weekend effect estimates between the unconditional (Column 3) and weather station (Column 4-7) specifications. In subsequent analysis, we focus on the specifications using differences between resort-reported and weather station or SNODAS snowfall estimates (Columns 4 and 8).

Online Appendix Table A1 examines whether our results are affected by either selective reporting by resorts or by the selection of reports captured in our archives. Selective reporting could be due to (possibly also deceptive) practices by resorts or aggregators that are subtly different than reporting more snow than has actually fallen. For example, resorts with no new snow might prefer to leave up a stale report rather than report no new snow, and the optimality of this strategy might vary over the week (Columns 4-6). Similarly, we might be concerned that archiving was related to interest in a webpage, and thus might be related to snow in a way that varied over the week (Columns 1-3). In practice we find some evidence that reporting and archiving frequencies are very slightly higher when there is more actual snow (Columns 2, 5, and 8). But these effect sizes are tiny (compared to the dependent variable mean in the last row), and they disappear once we include our usual set of fixed

effects for weeks and resorts (Columns 3, 6, and 9).[21] More importantly, there is no evidence that selectivity differs on weekends (this key result is shown in the "Gov snow*Weekend" row). [22]

*B. Margins and functional form of exaggeration*

Next we explore resort reporting behaviors explore reporting behaviors vis a vis the functional form of exaggeration. Figure 1 simply sorts resort-days into integer amounts of resort-reported snow—resorts report integer amounts in 99.8% of cases-- and counts the frequencies of these amounts on weekdays and weekends.

Resorts are less likely to report no new snow on weekends: 28% of weekend days, vs. 32% of weekdays (Figure 1). Table 5 probes this further by cross-tabbing resort reports of any positive amount of resort-reported snow against fine categories of weather station snow. Resorts are more likely to report a positive amount of snow, when government reports are at levels < ½ of an inch, on weekends than on weekdays. This is likely due to resorts being more likely to round up fractional amounts on weekends, since we never observe a resort reporting a non-integer amount of snow in the (0, 1) interval.

Figure 1 also suggests that resort are more likely to report large amounts of fresh snowfall (6 inches, and >12 inches) on the weekends. Table 6 probes this further by estimating weekend effects for different levels of government snow. Here we find resorts reporting an

[21] In particular, it is the inclusion of resort fixed effects that causes the relationship between snow and both reporting and archiving frequencies to disappear, suggesting that this relationship reflects snowier resorts reporting more frequently and snowier states being archived more frequently.

[22] We were also be concerned that resorts may issue updated snow reports on days when snow is falling, and that this updating may be more common on weekends. In practice, however, updated snow reports are quite rare. Of the 1504 times our third-party archives captured the same resort twice on one day, on only 62 times (4.5 percent) had the resort report been updated, and these instances were not disproportionately on weekends or weekdays. If same-day decisions about where to ski are largely made early in the morning, there may be limited incentive to update mid-day.

additional 1.6"-2.5" of snow on weekend days with > 6 inches in the government weather data, relative to weekend days with no or lesser new snowfall in the government data. This pattern of results holds whether we condition on positive resort-reported snow (Columns 3 and 4) or not (Columns 1 and 2). Table 6 also shows a weekend effect for inflating fractional amounts of government snow that is consistent with our findings on the extensive margin in Table 5 and Figure 1.

All told, these results suggest the weekend effect is due to at least two distinct types of exaggeration. First, resorts seem more likely to round a fractional inch of snow up to a single inch on weekends (Figure 1, Tables 5 and 6). Second, resorts inflate amounts by more when a large amount of snow falls on weekends (Figure 1, Table 6).

### *C. The weekend effect and resort characteristics: Which resorts exaggerate?*

Next we estimate cross-resort differences in weekend effects. Figure 2 plots the distribution of resort-level weekend effect estimates, with the resort count on the y-axis. The blue line (with the larger mass near zero) comes from a Bayesian posterior mixed (random coefficients) model; the red line comes from a noisier model that interacts the weekend indicator with resort fixed effects.[23] Both models suggest that the modal weekend effect is close to zero, and that a substantial number of resorts (perhaps 10 to 15 percent) exaggerate by 0.5 inches or more on the weekends.

Table 7 tests whether the weekend effect is larger for resorts with characteristics that proxy for payoffs to exaggeration. (We report specifications that difference resort-reported and weather station snowfall; results are similar if we control for snowfall or difference with

[23] We estimate the mixed model using the Generalized Linear Latent and Mixed Model (GLLAMM) procedure described in Rabe-Hesketh et al (2004). Both the GLLAMM model and the fixed effects model reject the null hypothesis of a constant weekend effect across resorts (with a p-value less than 0.0001 in both cases).

SNODAS instead). We find that resorts with expert terrain report 0.24 inches more fresh snow on weekdays (bottom panel) and an *additional* 0.17 extra inches of fresh snow on weekends (top panel).[24] The main (weekday) effect could be due to resorts with expert terrain being especially well located, but the interaction (weekend) effect suggests that resorts with more expert terrain exaggerate their snowfall more on weekends because fresh snow is especially appealing to expert skiers. We also find some evidence of larger weekend effects for resorts that do not offer money-back guarantees (i.e., the interactions between weekend and no guarantee are positive and significant).[25] The finding that exaggeration and guarantees are not complementary suggest that guarantees increase the expected cost of exaggeration (by inducing consumers to exercise guarantees) more than they increase the expected benefit of exaggeration (by, e.g., giving consumers a false sense of security).

In contrast, we do not find a significant relationship between weekend effects and the number of neighboring (competing) resorts, or the number of people living within 150 miles driving distance from the resort, although our estimates here are quite noisy.[26] Likewise, the differences in the weekend effect between resorts with different types of owners (publicly traded, private, or government), and between West vs. East, are insignificant and imprecisely estimated.

[24] We also estimate specifications that interact the share of terrain that is Intermediate, Advanced, and Expert with the weekend indicator (with Beginner terrain as the omitted category). These regressions find slightly positive but insignificant coefficients for Intermediate and Advanced terrain, and a positive and significant coefficient for Expert terrain. A regression including an indicator variable for any Expert terrain and a continuous variable for the share of Expert terrain suggests that the weekend effect is mostly associated with the former. This is consistent with resorts needing Expert terrain to be in expert skiers' choice sets, but with the exact amount being less important (or imprecisely measured).

[25] Guarantees, when offered, typically offer the skier a 100% refund on that's day lift ticket so long as the skier does not take more than one run

[26] We define two resorts as competitors if they are within 50 miles (as the crow flies), are not under common ownership, and either both or neither have expert terrain. Permuting the definition does not change the results. Nor does changing the mileage-filter or functional form of population.

The results on expert terrain in particular raise further questions about the functional form of the weekend effect, since expert resorts have a substantially higher level of snowfall. One might think to do this exercise using resort/government snow as an outcome variable in a regression, but this would be problematic given the many resort-days with trace amounts of snow in the government data because resorts report integer amounts of snow in 99.8% of cases, and never report non-integer values less than one. So instead Table 8 reports simple weekend/weekday ratios for resort reports, government reports, and resort/government (i.e., a ratio of weekend/weekday ratios). Consistent with our regression results, Table 8 shows a positive weekend/weekday ratio of ratios for each of the four key groups of resorts—expert, non-expert, guarantee, non-guarantee—with the largest for expert and guarantee.

### *D. Postscript: The rise of cheap monitoring technology and the fall of the weekend effect?*

Finally, we explore the effects of changes to the information environment on exaggeration. On January 8, 2009, *SkiReport.com* introduced a feature in its popular iPhone application that makes it easier for users to file "first-hand" reports, in real time (e.g., from the chair lift). These reports are then posted below the resort's official snow report (Online Appendix Figure A1). Online Appendix Table A5 adds data from the 2008-9 season to the sample and shows that exaggeration disappears following the app launch, with some evidence that the effect is driven by resorts with better iPhone reception. We caution that these results are merely suggestive, since there may be other differences between resorts with better and worse iPhone reception, and/or other contemporaneous technology shocks (e.g., slopeside webcams).

## IV. Conclusion

We provide some unusually sharp empirical evidence on the extent, mechanics, and dynamics of deceptive advertising.

Ski resorts self-report significantly and substantially more natural snowfall on weekends; there is no significant weekend effect in government snowfall data gleaned from three different sources. There is some evidence that resorts with greater benefits from exaggerating-those with expert terrain and those without money-back guarantees-- do it more. The evidence on whether competition restrains or encourages exaggeration is inconclusive. In all, the results suggest that deceptive advertising about product quality varies sharply with incentives, both within resorts (over time, at high-frequencies), and across resorts.

Although our setting may be unusual with its high-frequency variation in product quality, we speculate that our findings are broadly applicable. They relate to many classes of models on signaling, deception, obfuscation, and search costs. Search and information costs loom large in many other markets where product availability and pricing vary at high frequencies. Some of these markets presumably have conditions that are even more ripe for deceptive advertising than ours, with, for example, purchase decisions that are lower-stakes, have quality realizations with longer lags, or embed fewer opportunities for repeat play and learning.

A particularly important direction for future research is to combine evidence on the nature and dynamics of deceptive advertising with richer evidence on consumer responses. This is critical for examining whether and how consumers pierce the veil of deception, and for measuring the welfare effects of deceptive advertising and innovations that amplify or discourage it.

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**Table 1. Descriptive Statistics: Resorts and Reports by Region and Year**

| | Ski resorts | | | Daily snow reports | | |
|---|---|---|---|---|---|---|
| | Total | w/Weather Station | w/SNODAS | All | w/Weather Station | w/SNODAS |
| Region | | | | | | |
| Eastern U.S. | 232 | 227 | 195 | 24,390 | 21,883 | 18,808 |
| Western U.S. | 135 | 131 | 125 | 24,825 | 18,554 | 21,112 |
| Eastern Canada | 41 | 41 | 0 | 3,132 | 2,046 | 0 |
| Western Canada | 29 | 10 | 0 | 4,055 | 636 | 0 |
| Total | 437 | 409 | 320 | 56,402 | 43,119 | 39,920 |
| Season | | | | | | |
| 2004-5 | 354 | 223 | 268 | 4,054 | 1,544 | 2,829 |
| 2005-6 | 363 | 310 | 277 | 4,807 | 2,566 | 3,714 |
| 2006-7 | 393 | 359 | 299 | 15,376 | 12,812 | 11,354 |
| 2007-8 | 429 | 399 | 315 | 32,165 | 26,197 | 22,023 |
| Total | 437 | 409 | 320 | 56,402 | 43,119 | 39,920 |

We define Eastern resorts as those located in states and provinces that are entirely east of the Continental Divide

**Table 2. Descriptive Statistics: Resort and Snow (Report) Characteristics**

| | All resorts (437) | | Eastern resorts (273) | | Western resorts (164) | |
|---|---|---|---|---|---|---|
| **Panel A. Resort characteristics** | Mean | SD | Mean | SD | Mean | SD |
| Terrain type (%) | | | | | | |
| Beginner | 27 | 11 | 29 | 11 | 22 | 10 |
| Intermediate | 41 | 12 | 41 | 12 | 42 | 11 |
| Advanced | 25 | 13 | 25 | 12 | 26 | 13 |
| Expert | 7 | 11 | 5 | 9 | 10 | 15 |
| % with any expert terrain | 42 | | 40 | | 46 | |
| Base elevation | 3132 | 2946 | 1157 | 901 | 6419 | 2111 |
| Summit elevation | 4373 | 3580 | 1922 | 1178 | 8455 | 2266 |
| Vertical drop | 1242 | 1004 | 764 | 620 | 2036 | 1019 |
| Lifts | 7.8 | 5.1 | 7.1 | 3.7 | 8.8 | 6.7 |
| Runs | 41 | 35 | 29 | 24 | 63 | 42 |
| Acres | 671 | 1114 | 155 | 168 | 1461 | 1438 |
| LN(Population within 150 mile radius) | 15.5 | 1.2 | 16.1 | 1.0 | 14.6 | 1.0 |
| Competing resorts within 50 miles | 5.9 | 4.8 | 6.3 | 5 | 5.2 | 4.3 |
| % Offering money-back guarantee | 3.9 | | 4.8 | | 2.4 | |
| % with iPhone coverage | 66.8 | | 65.2 | | 69.5 | |
| Type of ownership (%) | | | | | | |
| Publicly traded | 3.2 | | 1.8 | | 5.5 | |
| Private | 89.9 | | 91.6 | | 87.2 | |
| Government | 6.9 | | 6.6 | | 7.3 | |

| **Panel B. Natural Snowfall** | Resort-reported | | Weather station | | SNODAS | |
|---|---|---|---|---|---|---|
| % of days with snowfall in range | Weekday | Weekend | Weekday | Weekend | Weekday | Weekend |
| 0" | 71.7 | 67.7 | 51.2 | 49.0 | 50.3 | 46.5 |
| 0.01 to 0.49 | | | 14.2 | 14.7 | 15.1 | 14.9 |
| 0.50 to 1.49 | 6.7 | 7.7 | 14.1 | 14.8 | 11.3 | 12.7 |
| 1.50 to 2.49 | 5.2 | 5.7 | 6.9 | 6.8 | 5.9 | 6.6 |
| 2.50 to 3.49 | 3.4 | 4.1 | 4.3 | 3.9 | 4.2 | 4.3 |
| 3.50 to 4.49 | 3.1 | 3.4 | 2.6 | 2.8 | 2.9 | 3.0 |
| 4.50 to 5.49 | 1.9 | 2.0 | 1.8 | 2.3 | 2.8 | 3.3 |
| 5.50 or more | 8.0 | 9.4 | 5.0 | 5.8 | 7.5 | 8.7 |
| Mean snowfall | 1.29 | 1.59 | 1.05 | 1.15 | 1.17 | 1.32 |
| SD snowfall | 3.16 | 4.13 | 2.27 | 2.38 | 2.11 | 2.20 |
| Observations | 40,398 | 16,004 | 34,065 | 13,676 | 28,308 | 11,612 |
| % on weekend | 28.4% | | 28.6% | | 29.1% | |
| P-value (H0: % weekend = 2/7) | 0.94 | | 0.978 | | 0.845 | |

States and provinces that are entirely east of the Continental Divide are considered Eastern. Resorts are considered to have iPhone coverage if they received 10 or more iPhone first-hand reports about subjects other than snow quality. P-values reported are for a test of the null hypothesis that the proportion of snow reports on a weekend day (Saturday or Sunday) is 2/7. These tests allow for clustering of observations on days. Data in Panel B is for the 2004-8 seasons.

**Table 3. Day of week effects in reported snowfall, 2004-2008**

Dependent variable: Inches of new natural snowfall reported

| | Resorts | Weather stations | | SNODAS |
|---|---|---|---|---|
| | | All | w/Resort report | w/Resort report |
| | (1) | (2) | (3) | (4) |
| Specification 1. Day of week indicator variables (Sunday omitted) | | | | |
| Monday | -0.145 | 0.074 | 0.147 | -0.005 |
| | (0.166) | (0.056) | (0.157) | (0.144) |
| Tuesday | -0.389*** | 0.016 | -0.264** | -0.092 |
| | (0.149) | (0.054) | (0.121) | (0.154) |
| Wednesday | -0.231 | 0.032 | -0.048 | 0.0439 |
| | (0.162) | (0.055) | (0.152) | (0.160) |
| Thursday | -0.388** | 0.001 | -0.237* | 0.128 |
| | (0.165) | (0.052) | (0.137) | (0.168) |
| Friday | -0.131 | 0.043 | 0.000 | 0.101 |
| | (0.156) | (0.051) | (0.144) | (0.165) |
| Saturday | -0.006 | 0.007 | -0.027 | 0.242 |
| | (0.161) | (0.055) | (0.139) | (0.157) |
| F-test p-value | 0.0550 | 0.2413 | 0.136 | 0.356 |
| R^2 | 0.123 | 0.0403 | 0.166 | 0.133 |
| Specification 2. Two-day weekend indicator variable (Sat&Sun) | | | | |
| Weekend | 0.246** | -0.029 | 0.057 | 0.096 |
| | (0.099) | (0.033) | (0.090) | (0.092) |
| R^2 | 0.123 | 0.0403 | 0.163 | 0.131 |
| Specification 3. Three-day weekend indicator variable (Fri-Sun) | | | | |
| Weekend | 0.238*** | -0.014 | 0.086 | 0.102 |
| | (0.089) | (0.030) | (0.084) | (0.083) |
| R^2 | 0.123 | 0.0401 | 0.163 | 0.131 |
| Observations | 56,402 | 231,952 | 47,741 | 39,920 |
| Unique days | 752 | 1,026 | 709 | 707 |

OLS with fixed effects for weeks (Wed-Tues) and resort. Column 2 includes every weather station reading taken from October-May from a station that is matched with a ski resort, regardless of whether a resort report is available for that day or not. Standard errors allow for clustering within both day and resort.

**Table 4. Weekend effect regressions 2004-2008, controlling for actual snowfall per government data**

Dependent variable: Inches of new natural snowfall reported by resort

| Dependent variable | Resort | | | Resort, controlling for weather station snow | | | | Resort, controlling for SNODAS | |
|---|---|---|---|---|---|---|---|---|---|
| Observations include | | w/Station data | w/SNODAS | w/Station data (t+1, t, t-1) | | | | w/SNODAS (t+1, t, t-1) | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Weekend (Sat&Sun) | 0.246** | 0.203** | 0.242** | 0.146** | 0.164*** | 0.131** | 0.125** | 0.173* | 0.183** |
| | (0.099) | (0.099) | (0.117) | (0.060) | (0.062) | (0.062) | (0.059) | (0.093) | (0.089) |
| Gov (t+1) | | | | | | | 0.053** | .25 to .375 | 0.359*** |
| | | | | | | | (0.024) | | (0.025) |
| Gov (t) | | | | 1 | 0.684*** | 0.736*** | 0.672*** | .625 to .75 | 0.621*** |
| | | | | | (0.047) | (0.051) | (0.048) | | (0.029) |
| Gov (t-1) | | | | | | | 0.180*** | | 0.104*** |
| | | | | | | | (0.025) | | (0.020) |
| Observations | 56,402 | 47,741 | 39,920 | 47,741 | 47,741 | 43,119 | 43,119 | 39,920 | 39,920 |
| Unique days | 752 | 692 | 707 | 692 | 692 | 692 | 692 | 707 | 707 |
| R^2 | 0.123 | 0.117 | 0.141 | 0.093 | 0.294 | 0.303 | 0.317 | 0.084 | 0.351 |

OLS with fixed effects for weeks (Wed-Tues) and resort. Columns 4 constrains the coefficient on current-day snow to be one; column 7 constrains the coefficients on current and future-day SNODAS snow to sum to one, with the proportions determined by the number of hours in the 7AM-to-7AM local time window that overlap with the SNODAS observation window in question (weights are 0.75 on t and 0.25 on t+1 for the Eastern time zone; and 0.625 and 0.375 respectively for the Pacific time zone). Columns 2-9 are restricted to observations with either weather station or SNODAS data for days t-1 to t+1. Standard errors allow for clustering within both day and resort.

**Table 5. Probability of a resort reporting positive amount of snow**

| | Weekday | Weekend | Difference | SE of difference | Observations |
|---|---|---|---|---|---|
| NOAA reported snow | (1) | (2) | (3) | (4) | (5) |
| None | 0.033 | 0.047 | 0.014* | (0.007) | 12,072 |
| Less than 0.25" | 0.096 | 0.128 | 0.032** | (0.015) | 10,204 |
| 0.25-0.49" | 0.227 | 0.296 | 0.068*** | (0.022) | 4,112 |
| 0.5-0.74" | 0.303 | 0.343 | 0.040 | (0.025) | 2,903 |
| 0.75-0.99" | 0.374 | 0.374 | 0.000 | (0.032) | 2,028 |
| 1.0-1.49" | 0.430 | 0.464 | 0.034 | (0.028) | 3,167 |
| 1.5-1.99" | 0.538 | 0.528 | -0.010 | (0.030) | 2,088 |
| 2-2.99" | 0.581 | 0.559 | -0.022 | (0.028) | 2,541 |
| 3" or more | 0.702 | 0.701 | -0.001 | (0.027) | 4,004 |

This table reports the probability that a resort will report a positive amount of snow, conditional on the level of government-reported snowfall and whether it is a weekend day (Saturday or Sunday). Government snow fall is an average the NOAA/NOHRSC reports from days T-1, T and T+1, weighted by the coefficients in Table 4, Column 6. Mean resort-reported snow is estimated for different levels of NOHRSC/NOAA-reported snow on weekdays and weekends (Saturday and Sunday) using a single regression. The regression is identical to that in Table 4, column 2, except that the single weekend indicator variable is replaced by an interaction of indicator variables for different levels of snowfall and the weekend indicator. Standard errors allow for clustering on day and resort.

**Table 6. More on the functional form of weekend effects in resort-reported snow**

| Sample: | Full | | Resort snow > 0 | |
|---|---|---|---|---|
| Dependent variable: | Resort | Resort-Gov | Resort | Resort-Gov |
| | (1) | (2) | (3) | (4) |
| Weekend*(Gov snow = 0) | 0.011 | 0.026 | 0.441 | 0.395 |
| | (0.052) | (0.053) | (0.374) | (0.368) |
| Weekend*(Gov snow = 0.01 to 1") | 0.242*** | 0.230*** | 0.228 | 0.237 |
| | (0.077) | (0.072) | (0.178) | (0.172) |
| Weekend*(Gov snow = 1.01 to 3") | -0.144 | -0.109 | -0.306* | -0.266 |
| | (0.147) | (0.135) | (0.177) | (0.168) |
| Weekend*(Gov snow = 3.01 to 6") | -0.025 | -0.260 | -0.234 | -0.304 |
| | (0.406) | (0.415) | (0.391) | (0.381) |
| Weekend*(Gov snow = 6.01+) | 1.643 | 1.934* | 2.065** | 2.476*** |
| | (1.165) | (1.156) | (0.830) | (0.890) |
| N | 43,119 | 43,119 | 12,612 | 12,612 |

This table reports the results of regressions that are identical to those in Table 4, columns 2 and 4, except for the fact that a single weekend indicator is replaced by interactions of that variable with indicator variables for different levels of government-reported snowfall. Government snow fall is an average the NOAA/NOHRSC reports from days T-1, T and T+1, weighted by the coefficients in Table 4, Column 6. Regressions also include the 5 indicator variables and resort and week fixed effects as in Table 4. Standard errors allow for clustering on day and resort.

**Table 7. Variation in weekend effects by resort characteristics, 2004-8 seasons**

Dependent variable: Resort - NOHRSC/NOAA snow

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Weekend (Sat&Sun) | 0.146** | 0.061 | -0.012 | -0.093 | -0.103 | -0.062 | -0.088 |
| | (0.060) | (0.068) | (0.082) | (0.089) | (0.097) | (0.105) | (0.089) |
| Interaction effects with weekend | | | | | | | |
| Expert terrain > 0 | | 0.169** | 0.170** | 0.171** | 0.173** | 0.173** | 0.168** |
| | | (0.075) | (0.074) | (0.074) | (0.073) | (0.074) | (0.072) |
| West | | | 0.140 | 0.139 | 0.162 | 0.138 | 0.135 |
| | | | (0.150) | (0.150) | (0.189) | (0.150) | (0.151) |
| No money back guarantee | | | | 0.196*** | 0.191*** | 0.193*** | 0.194*** |
| | | | | (0.073) | (0.070) | (0.072) | (0.072) |
| 1/(1+number of competitors within 50 miles) | | | | | 0.019 | | |
| | | | | | (0.065) | | |
| Ln(Population within 150 miles), normalized | | | | | | -0.084 | |
| | | | | | | (0.150) | |
| Publicly traded owner | | | | | | | 0.064 |
| | | | | | | | (0.217) |
| Government owner | | | | | | | -0.051 |
| | | | | | | | (0.116) |
| Main effects | | | | | | | |
| Expert terrain > 0 | | 0.240*** | 0.235*** | 0.236*** | 0.232*** | 0.238*** | 0.234*** |
| | | (0.039) | (0.039) | (0.039) | (0.039) | (0.039) | (0.039) |
| West | | | 0.540*** | 0.540*** | 0.499*** | 0.538*** | 0.537*** |
| | | | (0.082) | (0.082) | (0.103) | (0.082) | (0.082) |
| No money back guarantee | | | | 0.039 | 0.049 | 0.037 | 0.038 |
| | | | | (0.033) | (0.033) | (0.033) | (0.033) |
| 1/(1+number of competitors within 50 miles) | | | | | -0.035 | | |
| | | | | | (0.034) | | |
| Ln(Population within 150 miles), normalized | | | | | | -0.095 | |
| | | | | | | (0.070) | |
| Publicly traded owner | | | | | | | 0.067 |
| | | | | | | | (0.122) |
| Government owner | | | | | | | -0.001 |
| | | | | | | | (0.055) |
| Observations | 47,741 | 47,741 | 47,741 | 47,741 | 47,741 | 47,741 | 47,741 |
| Unique days | 692 | 692 | 692 | 692 | 692 | 692 | 692 |
| R^2 | 0.310 | 0.316 | 0.326 | 0.327 | 0.327 | 0.327 | 0.333 |

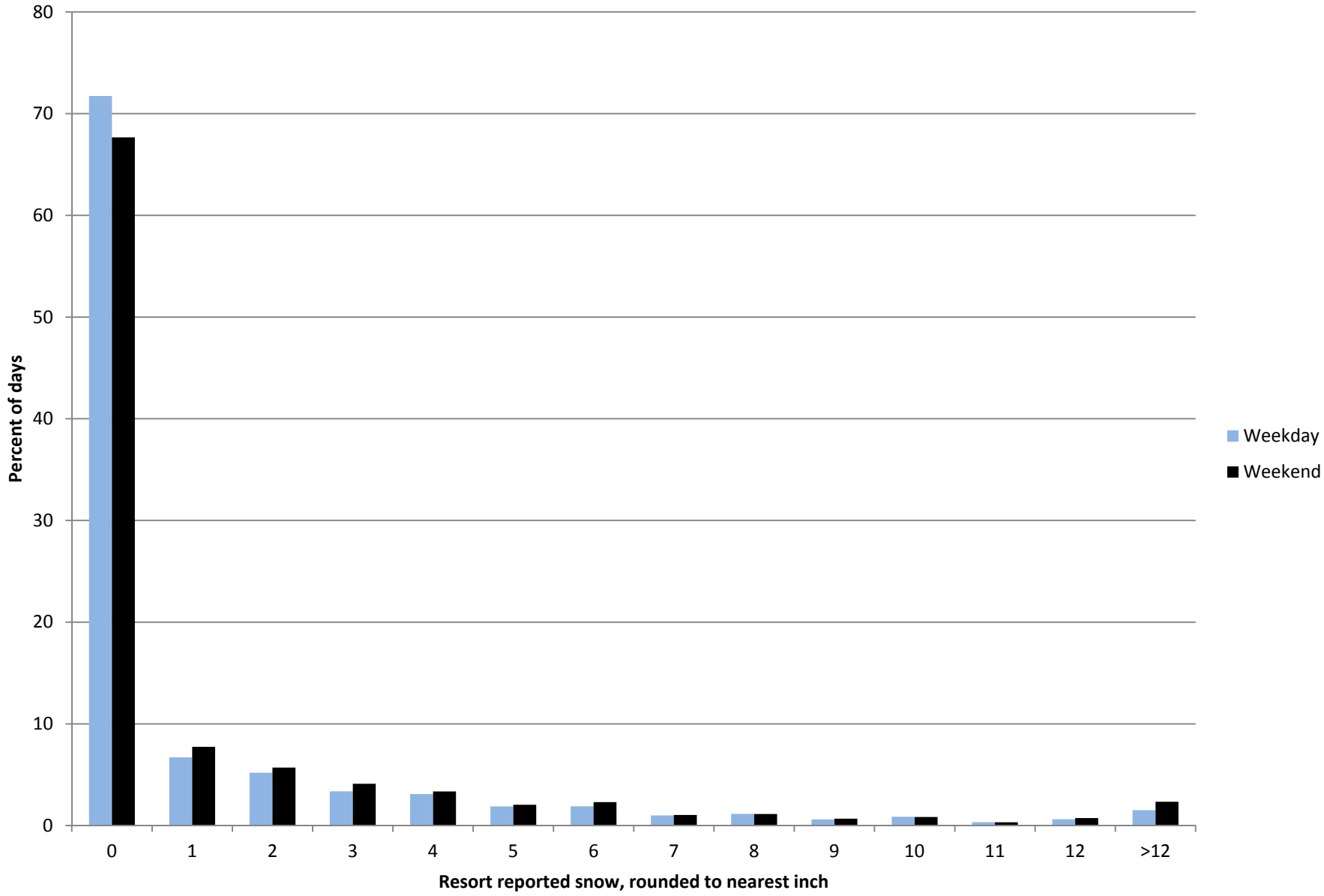
OLS with fixed effects for weeks (Wed-Tues) and resort. Standard errors allow for clustering within both day and resort. Two resorts are considered competitors if they are within 50 miles, are not under common ownership, and either both or neither have expert terrain. Sample size drops in the last two columns because we were not able to find data for many resorts on guarantees and ownership.

**Table 8. Average resort-reported and government-reported snowfall by weekday/weekend and resort characteristic**

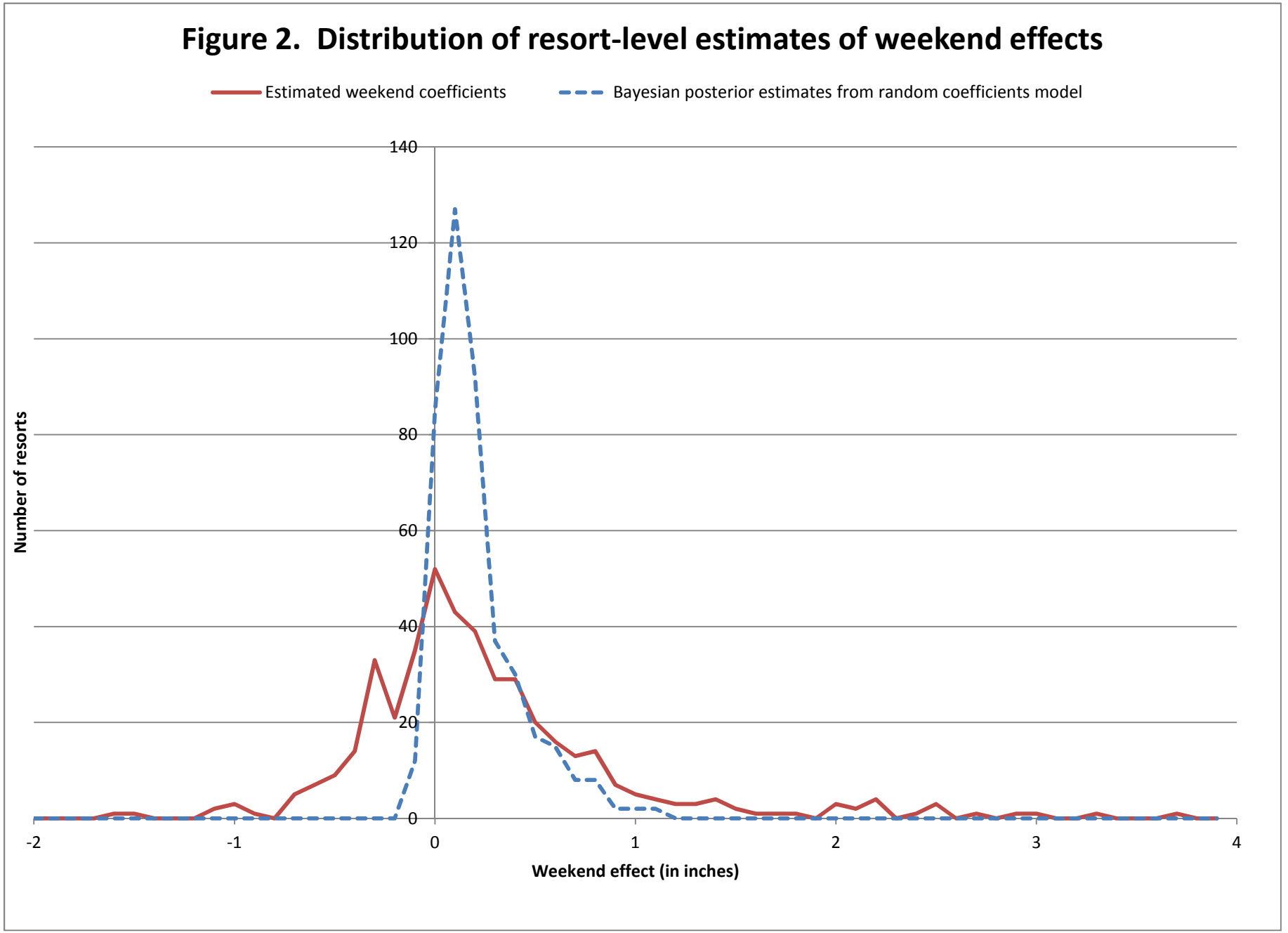
| | Weekday snow | Weekend snow | Weekend/Weekday ratio |
|---|---|---|---|
| Expert terrain resorts | | | |
| Resort reports | 1.45 | 1.72 | 1.19 |
| Gov. weather station | 1.07 | 1.12 | 1.05 |
| Resort/Gov | 1.36 | 1.54 | **1.14** |
| N resort-days | 16,289 | 6,479 | |
| No expert terrain resorts | | | |
| Resort reports | 1.18 | 1.41 | 1.19 |
| Gov. weather station | 1.04 | 1.19 | 1.14 |
| Resort/Gov ratio | 1.13 | 1.18 | **1.04** |
| N resort-days | 17,776 | 7,197 | |
| Money-back guarantee resorts | | | |
| Resort reports | 1.40 | 1.75 | 1.24 |
| Gov. weather station | 1.13 | 1.19 | 1.05 |
| Resort/Gov | 1.24 | 1.47 | **1.18** |
| N resort-days | 14,563 | 5,738 | |
| No-guarantee resorts | | | |
| Resort reports | 1.24 | 1.42 | 1.14 |
| Gov. weather station | 1.00 | 1.13 | 1.13 |
| Resort/Gov | 1.24 | 1.25 | **1.01** |
| N resort-days | 19,502 | 7,938 | |

The figures in bold are the ratio of the ratios (i.e. the ratio of the resort-to-government ratio on weekends to that on weekdays).

## Figure 1. Distribution of resort snow reports, weekends and weekdays



# Figure 2. Distribution of resort-level estimates of weekend effects



**Online Appendix Figure 1. Example of first-hand reports**

**Online Appendix Table A1. Tests for selection biases in resort snow reports**

Dependent variable: = 1 if observation is archived and/or resort issued snow report

| | Was state*day page archived? | | | Did resort issue a fresh report? (conditional on page being archived) | | | Is report in dataset? (page archived & resort issued report) | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Weekend (Sat or Sun) | -0.0099 | -0.0180 | -0.0389 | 0.0068 | 0.0044 | 0.0116 | -0.0020 | -0.0106 | -0.0132 |
| | (0.0320) | (0.0327) | (0.0663) | (0.0091) | (0.0104) | (0.0421) | (0.0285) | (0.0289) | (0.0532) |
| Gov snow (NOHRSC/NOAA) | | 0.0079* | -0.0048 | | 0.0040*** | -0.0095 | | 0.0066* | -0.0052 |
| | | (0.0042) | (0.0108) | | (0.0016) | (0.0070) | | (0.0037) | (0.0088) |
| Gov snow*Weekend | | 0.0095 | 0.0063 | | 0.0032 | 0.0163 | | 0.0101 | 0.0116 |
| | | (0.0074) | (0.0195) | | (0.0031) | (0.0129) | | (0.0062) | (0.0150) |
| Fixed effects | | | | | | | | | |
| Week (Wed-Tues)? | | | yes | | | yes | | | yes |
| State or resort? | | | state | | | resort | | | resort |
| Observations | 20,603 | 19,886 | 19,841 | 59,737 | 57,488 | 54,105 | 154,556 | 152,307 | 149,515 |
| Dependent variable mean | | 0.42 | | | 0.86 | | | 0.37 | |

The table reports marginal effects from probit regressions predicting whether a state's page was archived on a given day, and whether a resort snow report is available for a specific day (conditional on the page being archived and unconditional). The sample includes every day in the 2004-2008 seasons (October 1 to May 31) for every resort between the resort's opening and closing date (as determined by the first and last day a resort snow report is issued). Since the variation in the regressions in the first three columns is at the state*day level, they include one data point for each state*day, but observations are weighted by the number of resorts in the state. Actual snow is measured using the average snowfall reported by the NOAA stations matched to the state's resorts. Standard errors adjust for clustering within day.

**Online Appendix Table A2. Alternative specifications for 2004-2008 -- fixed effects and tobit**

Dependent variable: Inches of new natural snowfall reported by resort

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Specifications without actual snow controls | Table 4, Col 1 | No FEs | Resort FEs | Week FEs | Resort*week FEs | Tobit |
| Weekend (Sat&Sun) | 0.246** | 0.297** | 0.277** | 0.274*** | 0.230* | 0.994** |
| | (0.099) | (0.133) | (0.134) | (0.100) | (0.135) | (0.397) |
| Constant | 1.229*** | 1.297*** | 1.302*** | 1.303*** | 1.316*** | -5.063*** |
| | (0.077) | (0.0665) | (0.0665) | (0.0491) | (0.0598) | (0.335) |
| Ln(Sigma) | | | | | | 8.341*** |
| | | | | | | (0.301) |
| Observations | 56,402 | 56,402 | 56,402 | 56,402 | 56,402 | 56,402 |
| Unique days | 755 | 755 | 755 | 755 | 755 | 755 |
| R^2 | 0.123 | 0.001 | 0.064 | 0.060 | 0.453 | N/A |
| Resort-reported - weather station snow | Table 4, Col 4 | No FEs | Resort FEs | Week FEs | Resort*week FEs | Tobit |
| Weekend (Sat&Sun) | 0.146** | 0.146* | 0.136* | 0.155** | 0.137* | 0.694** |
| | (0.060) | (0.082) | (0.079) | (0.062) | (0.076) | (0.276) |
| Constant | 0.403*** | 0.377*** | 0.337*** | 0.403*** | 0.333*** | -6.033*** |
| | (0.0476) | (0.0455) | (0.0497) | (0.0476) | (0.0781) | (0.367) |
| Ln(Sigma) | | | | | | 6.976*** |
| | | | | | | (0.304) |
| Observations | 47,741 | 47,741 | 47,741 | 47,741 | 47,741 | 47,741 |
| Unique days | 692 | 692 | 692 | 692 | 692 | 692 |
| R^2 | 0.093 | 0.000 | 0.070 | 0.025 | 0.425 | N/A |
| Resort-reported - SNODAS snow | Table 4, Col 8 | No FEs | Resort FEs | Week FEs | Resort*week FEs | Tobit |
| Weekend (Sat&Sun) | 0.173* | 0.189* | 0.180 | 0.185** | 0.154 | 0.692** |
| | (0.085) | (0.114) | (0.112) | (0.093) | (0.131) | (0.323) |
| Constant | -0.034 | -0.0239 | -0.0249 | 0.0343 | 0.0843 | -6.941*** |
| | (0.050) | (0.0431) | (0.0462) | (0.0533) | (0.0862) | (0.343) |
| Ln(Sigma) | | | | | | 6.866*** |
| | | | | | | (0.229) |
| Observations | 39,920 | 39,920 | 39,920 | 39,920 | 39,920 | 39,920 |
| Unique days | 707 | 707 | 707 | 707 | 707 | 707 |
| R^2 | 0.3434 | 0.2859 | 0.323 | 0.3075 | 0.5848 | N/A |

Note: Regressions are estimated by OLS or Tobit and include the indicated fixed effects. Standard errors allow for clustering within both date and resort. Week fixed effects are for Wednesday-Tuesday weeks (to include a weekend and the immediately surrounding weekdays). Tobit models control for rather than difference weather station and SNODAS snow.

**Online Appendix Table A3. Robustness of standard errors to alternative assumptions about clustering**

| | | | | Approach in paper ↓ | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Dependent variable: Resort snow (Table 4, Col 2) | | | | | | | | | |
| | 0.203*** | 0.203*** | 0.203** | 0.203** | 0.203** | 0.203** | 0.203** | 0.203* | 0.203** |
| | (0.038) | (0.041) | (0.098) | (0.099) | (0.082) | (0.089) | (0.094) | (0.105) | (0.090) |
| Dependent variable: Resort snow - NOAA snow (Table 4, Col 4) | | | | | | | | | |
| | 0.146*** | 0.146*** | 0.146** | 0.146** | 0.146*** | 0.146** | 0.146** | 0.146*** | 0.146** |
| | (0.035) | (0.038) | (0.058) | (0.060) | (0.048) | (0.070) | (0.062) | (0.051) | (0.059) |
| Clustering scheme | | | | | | | | | |
| X-section | | Resort | | Resort | Resort | State | | | Spatial HAC |
| Time | | | Day | Day | Month | Month | | | Spatial HAC |
| X-section*Time | | | | | | | State*Month | Census div*Month | |

This table presents versions of the specifications in Table 4, Columns 2 and 4 with alternative approaches to calculating standard errors. All regressions have 47,741 observations and all standard errors allow for heteroskedasticity. Columns 2-9 allow for one or two-dimensional clustering as described. The "Spatial HAC" standard errors in column 9 allow for geographically and serially correlated errors, using the method described in Conley (2008) and code provided by Hsiang (2010) (available at http://www.fight-entropy.com/2010/06/standard-error-adjustment-ols-for.html). Our spatial HAC standard errors allow for 7 daily lags of serial correlation, a 300 kilometer limit for spatial correlations, and a Bartlett linear kernel (results are very insensitive to these choices).

**Online Appendix Table A4. Weekend effect estimates for sub-periods, 2004-2008**

Dependent variable: Inches of new natural snowfall reported by resort

| | No weather controls | | | Resort - weather station | | | Resort - SNODAS | | |
|---|---|---|---|---|---|---|---|---|---|
| | Obs. | Coef. | SE | Obs. | Coef. | SE | Obs. | Coef. | SE |
| All observations | 56,402 | 0.246** | (0.097) | 47,741 | 0.146** | (0.058) | 39,920 | 0.173* | (0.088) |
| 2004-5 Season | 4,054 | 0.152 | (0.410) | 2,218 | 0.772* | (0.393) | 2,829 | 0.107 | (0.331) |
| 2005-6 Season | 4,807 | 0.571 | (0.367) | 3,463 | 0.327 | (0.277) | 3,714 | 0.223 | (0.280) |
| 2006-7 Season | 15,376 | 0.248 | (0.184) | 13,518 | -0.034 | (0.090) | 11,354 | 0.210* | (0.111) |
| 2007-8 Season | 32,165 | 0.219* | (0.130) | 28,542 | 0.152** | (0.076) | 22,023 | 0.157 | (0.133) |
| November | 2,581 | 0.591 | (0.357) | 1,811 | 0.347 | (0.351) | 2,051 | 0.147 | (0.306) |
| December | 10,271 | -0.029 | (0.194) | 8,720 | 0.111 | (0.125) | 7,140 | 0.182 | (0.159) |
| January | 12,247 | 0.521* | (0.290) | 10,611 | 0.368** | (0.143) | 8,495 | 0.479 | (0.296) |
| February | 11,932 | 0.088 | (0.201) | 10,304 | 0.159 | (0.142) | 9,137 | -0.037 | (0.200) |
| March | 14,653 | 0.372* | (0.190) | 12,623 | 0.032 | (0.121) | 9,704 | 0.157 | (0.131) |
| April and May | 4,718 | -0.054 | (0.207) | 3,672 | -0.032 | (0.164) | 3,393 | 0.044 | (0.168) |
| Christmas holiday | 3,683 | -0.056 | (0.277) | 3,157 | -0.047 | (0.224) | 1,746 | -0.298 | (0.202) |
| President's day week | 2,395 | 0.509 | (0.301) | 2,119 | 0.307* | (0.167) | 1,841 | 0.019 | (0.207) |
| Other periods | 50,324 | 0.254** | (0.106) | 42,465 | 0.132** | (0.062) | 36,333 | 0.189** | (0.094) |
| West | 28,880 | 0.385** | (0.172) | 21,686 | 0.281*** | (0.108) | 21,112 | 0.332** | (0.141) |
| East | 27,522 | 0.092 | (0.126) | 26,055 | 0.041 | (0.057) | 18,808 | 0.003 | (0.105) |
| U.S. | 49,215 | 0.234** | (0.106) | 44,318 | 0.168*** | (0.058) | | | |
| Canada | 7,187 | 0.315** | (0.130) | 3,423 | -0.212 | (0.216) | | | |

This table repeats the specifications in Table 4 (columns 1, 4, and 8) for subsamples of the data.

**Online Appendix Table A5. First-hand reporting (via iPhones) and the weekend effect**
Dependent variable: Resort - NOHRSC/NOAA snow

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Weekend (Sat&Sun) | 0.042 | | | | | |
| | (0.076) | | | | | |
| Interaction effects with weekend | | | | | | |
| Post-Jan8 (1/8 or later in any season) | | 0.076 | | 0.069 | | |
| | | (0.185) | | (0.177) | | |
| Post-launch (1/8/2009 or later) | 0.209* | 0.253* | | 0.215 | | |
| | (0.119) | (0.139) | | (0.139) | | |
| iPhone coverage at resort | 0.118* | | | | | |
| | (0.069) | | | | | |
| iPhone coverage*post-Jan8 | | -0.174 | -0.159 | -0.091 | 0.037 | -0.095 |
| | | (0.163) | (0.159) | (0.156) | (0.075) | (0.108) |
| **iPhone coverage*post-launch** | **-0.239**** | **-0.214**** | **-0.216**** | **-0.204*** | **-0.172*** | **-0.193**** |
| | **(0.097)** | **(0.108)** | **(0.106)** | **(0.112)** | **(0.098)** | **(0.080)** |
| Main effects | | | | | | |
| iPhone coverage*post-Jan8 | | 0.111 | 0.110 | | | |
| | | (0.078) | (0.078) | | | |
| iPhone coverage*post-launch | 0.187*** | 0.186*** | 0.188*** | | | |
| | (0.067) | (0.065) | (0.065) | | | |
| Fixed effects | | | | | | |
| Resort | X | | | | | |
| Week | X | | | | | |
| Month | | X | | | | |
| Resort*Weekend | | X | X | X | | X |
| Month*Weekend | | | X | | X | X |
| Resort*Month | | | | X | X | X |
| Observations | 72,569 | 72,569 | 72,569 | 72,569 | 72,569 | 72,569 |
| Unique days | 813 | 813 | 813 | 813 | 813 | 813 |
| R^2 | 0.091 | 0.086 | 0.088 | 0.220 | 0.217 | 0.223 |

Here we add the 2008-2009 ski season to the sample. As in earlier tables, weeks run from Wednesday to Tuesday. To keep month and week fixed effects synchronized with the post-launch and post-Jan 8 variables, Post-Jan 8/Launch refers to weeks (Wed-Tues) beginning after January 7, and months by the number of days needed to make January entirely post-Jan 8/launch. The main effects for post-Jan 8 and post-launch are therefore absorbed by either week or month fixed effects and the interactions of these effects and the weekend effect are absorbed by month*weekend effects. Likewise, the main effect for iPhone coverage at resort is absorbed by the resort fixed effect, and resort*month fixed effects absorb interactions of iPhone coverage and post-Jan8/Launch. Standard errors allow for clustering within both day and resort. We classify a resort as covered if it was the subject of 10 or more first-hand reports after January 8, 2009 that did not mention snow quality.

Coverage maps from AT&T (the sole network provider for the iPhone in the United States during our sample period) do not account well for topography, so we classify a resort as covered (and hence more-affected) if it was the subject of 10 or more first-hand reports after January 8, 2009 that did *not* mention snow quality.