Hedonic Price Model of New England Ski Areas

Alex Klein, 2019

Keywords

New England, Hedonic Price Model, Ski Area Characteristics, Price Analysis, Value Ranking

Abstract

Using a database of 60 New England ski areas, the correlation between several primary resort characteristics and the 2018-2019 adult day ticket prices is analyzed. A hedonic price model is used to run an OLS regression on the data and determine the importance and significance of 13 variables. This study determines that ski area size (including number of trails, skiable acres, and vertical drop), the snowmaking capabilities of the mountain, the number of nearby restaurants, and the proximity of a ski area to local residents and population centers have the greatest positive influence on ticket price. The hedonic model is also used to form a ranked list of ski areas in New England by their expected ticket price, representing resort quality, and how this compares to their actual ticket price, representing resort value. This study can provide valuable information to ski area management and tourism offices across New England, who can better understand the motivations for alpine skiing customers in the region.

Author Profile

Alex Klein is a Mechanical Engineering student in the class of 2022 at Johns Hopkins University. As a resident of New England, he enjoys many outdoor activities that the region has to offer, including skiing and hiking. Alex also has passions for photography and astronomy.

Disclosure

The author of this paper, Alex Klein, is a frequent skier of Killington Mountain Resort (VT), as well as several other nearby ski areas. This connection did not affect the integrity of the statistical analysis or writing of this paper in any way. All ski areas were treated the same, no matter the author's previous thoughts on them or whether he has skied there in the past.

§1: Introduction

1.1: The New England Ski Market

Skiing in New England has grown increasingly popular over the past one hundred years. What started as several small private ski areas with single rope tows has now expanded to 135 alpine ski areas, some of which rival the size and snowfall of resorts in the Rocky Mountains (Beaudin and Ju-Chin Huang, 2014). New England resorts draw both local customers and residents of nearby cities including Boston, Hartford, Portland, Providence, Manchester, New York, and Montreal. Along with steady industry growth, ski lift ticket prices have increased significantly over time. With new mergers and capital investment, ski ticket price records are consistently broken. This study will look at the influences that different factors have on ski area ticket pricing; how much do mountain size, snowfall, nearby activities, distance, and terrain affect the amount an average buyer is willing to pay? Other studies have used similar methods to answer the same question, but this is the first that focuses specifically on New England ski areas. Creating a model for ticket prices, a ranking of ski areas based on certain characteristics can be made, and the value of each ski area will be analyzed.

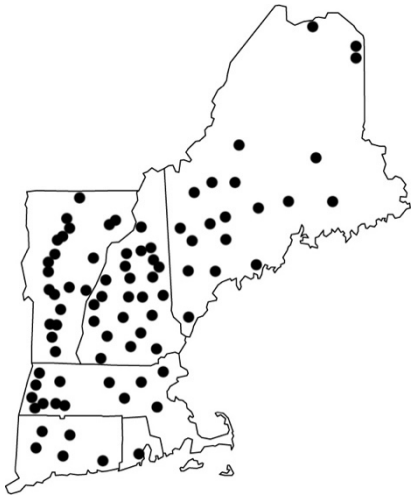

Figure 1: Map of Ski Areas in Study

1.2: Similar Analysis of Other Regions

Other studies have been conducted using similar methods and data to find certain characteristics' influence on ski ticket prices for other regions of the world. These are outlined below.

Author	Region	Variables with Positive Correlation to Ticket Pricing
Alessandrini (2012)	Italy	Length of the ski slopes, vertical drop, capacity of the lifts, and length of the season.
Falk (2008)	Austria	Lift capacity, lift speed, length of ski runs, vertical drop, ski season length, percentage of slopes with snowmaking, and being part of a ski network covered by the same lift pass.
Fonner and Berrens (2014)	United States	Vertical drop, base elevation, number of trails, lift capacity, lift speed, gondolas, snowmaking, nearby lodging.
Malasevska (2018)	Norway	Vertical drop, proportion of intermediate ski slopes, terrain parks, and nearby competition.
Nowacki (2016)	Poland, Slovakia, Czech Republic	Proportion of modern detachable chairlifts, the peak elevation, and ski season length.
Pawlowski (2011)	Central and Western Europe	Peak elevation, snow cover, congestion, availability of a free shuttle service, and proportion of gondolas to regular ski lifts.
Rosson and Zirulia (2018)	Northeast Italy	Proportion of high-speed lifts, snowmaking capabilities, availability of activities and entertainment, and reputation.
Wolff (2014)	France	Number of ski slopes, size of ski area, and number of ski lifts.

§2: Statistical Model

2.1: The Hedonic Price Model

Through the use of a regression analysis, a hedonic price model reveals the relative importance of certain variables on the pricing of a good. The model is based off of Lancaster's (1966) and Rosen's (1974) work on consumer theory and implicit prices (Man Chan, 2014). Often, hedonic models are used in the real estate market to determine a reasonable valuation of a property. Homes prices are regressed with variables such as number of bedrooms, land size, and neighborhood crime rates (Monson, 2009). In the case of ski areas, ticket pricing is based on a multitude of variables and characteristic of the resort. The ones used in this study are explained in section 3.2. In this study, ski ticket prices will be estimated using an ordinary least squares (OLS) and a classic linear regression model (De Haan and Diewert, 2013). The equation for the hedonic model is show below in section 2.2. The natural logarithm (ln) is in place to reduce the problem of heteroscedasticity, where the ticket price plot will widen as the independent variables increase (Ramalho and Ramalho, 2011). Note that no dummy variables are used in this study.

2.2: Equation for the Hedonic Price Model

$$\begin{aligned}\ln(\text{DayTicket}) = {} & \alpha + \beta_1\ln(\text{Vertical}) + \beta_2\ln(\text{Acres}) + \beta_3\ln(\text{Trails}) + \beta_4\ln(\text{Variety}) \\ & + \beta_5\ln(\text{SnowMaking}) + \beta_6\ln(\text{LiftAge}) + \beta_7(\text{NightSkiing}) \\ & + \beta_8(\text{Parks}) + \beta_9\ln(\text{Snowfall}) + \beta_{10}\ln(\text{Hotels}) + \beta_{11}\ln(\text{Restaurants}) \\ & + \beta_{12}\ln(\text{Competition}) + \beta_{13}\ln(\text{People}) + \varepsilon_0\end{aligned}$$

Where α is the intercept; β_x is the coefficients of each variable, identifying the impact of each price factor on ticket price; and ε_1 is the error term, representing the unexplained part of the ticket price. Note the natural logarithm is not taken of the variables NightSkiing and Parks as they contain zero values in the dataset.

§3: Variables

3.1: Categories of Ski Area Characteristics

Through the exploration of characteristics of a ski area, we can see similarities arise between the types of variables in a hedonic regression for real estate valuation and ski area ticket pricing. The three main factors affecting real estate price in a hedonic model, characteristics of the property, location, and environment. For ski areas, these are the same, but the property characteristics can be further broken down into two classifications: ones which ski areas have control over, and ones which they do not. Thus, there are four main categories of variables to describe a ski area: the characteristics of the mountain, operation, geography, and environment. Each is explained in section 3.2 along with the variables in the hedonic model.

3.2: Variables in Hedonic Model

The variables used in the study are defined below, subdivided into their respective categories.

Dependent Variable	The variable in question whose value should depend on the other variables in the hedonic model.
DayTicket:	The price of a one-day adult weekend non-holiday ski lift ticket during the 2018-2019 season.
Mountain Characteristics	Physical traits of the ski area property, attributes that can generally not be altered by the ski area, such as the size and location of the mountain.

Vertical:	Elevation difference between the summit and base of the mountain, measured in feet.
Acres:	Area on the mountain that the ski resort has designated for skiing, including trails, bowls, and glades; measured in acres.
Trails:	Total number of designated slopes for skiing, often ranked in increasing difficulty from green circle to blue square, black diamond, and double black diamond.
Variety:	Diversity and appropriate mixture of trail difficulty, a value that is derived in section 3.3: Methodology of Derived Variables.
Operation Characteristics	Internal aspects of the ski area that the management has full control over, such as the quantity and quality of lifts, trails, and factors relating to customer experience.
SnowMaking:	Acres of skiable terrain to which the ski area has the capability of distributing artificial snow in addition to natural snow, increasing the reliability of their snow cover.
LiftAge:	Average age of all of the standing and operational lifts on the mountain, including any surface lifts (j-bar, t-bar, magic carpet, rope tow, platter), fixed chairlifts, detachable chairlifts, gondolas, and aerial trams.
Parks:	Number of areas on the mountain designated as a terrain park, which typically consists of jumps, rails, and boxes along a trail.
NightSkiing:	Acres of skiable terrain that the ski area operates past sundown, requiring the ski area to illuminate the trails for customers.
Geography Characteristics	Nearby amenities and conveniences to the ski area, as well as its broader location in New England with respect to other ski areas and potential customers.
Hotels:	Number of lodging locations designated by Trip Advisor to be "nearby" the ski area's location.
Restaurants:	Number of locations to dine in or pick up food designated by Trip Advisor to be "nearby" the ski area's location.
Competition:	A measure of the influence of other ski areas in New England to draw customers away from a ski area by offering competitive services, a value that is derived in section 3.3.
People:	Distance-weighted measure of population in New England and the surrounding areas that could go to a ski area, a value that is derived in section 3.3.
Environment Characteristics	Climate and weather of the ski area, affecting the snow cover and seasonal operation days.
Snowfall:	Average annual snowfall at a ski area, typically affected by ski area elevation, climate, and nearby lakes; measured in inches.

3.3: Methodology of Derived Variables

Several variables were calculated from statistics of a ski area. It is important to note that the resulting values have no real physical meaning. Rather, the variables of Variety, Competition, and People are useful only when the ski areas are compared with one another so that the values are relative.

3.3.1: Methodology of Variety

The variable Variety in this study is used to compare how well ski areas diversify the difficulty of their terrain. Sugarloaf Mountain Resort (ME) is 22% easy trails, 32% intermediate trails, and 46% advanced trails, while Jiminy Peak Mountain Resort (MA) is 50% easy trails, 30% intermediate trails, and 20% advanced trails. Both resorts have very different breakdowns of trail difficulty, as each resort is meant for skiers of different ability

levels. It is not necessarily expected that more variety will correlate with a higher ticket price; this measure is in the study to see if there is any relationship.

To create a relative measure of the variety of trail difficulty, each ski area was compared to the average trail variety. Of all 60 ski areas in this study, mountains average 27% easy trails, 41% intermediate trails, and 32% advanced trails. Divergence from the average was measured using the following equation for ski area X:

$$\text{Variety}_X = 1 - (|E_X - E_{AVG}| + |I_X - I_{AVG}| + |A_X - A_{AVG}|)$$

where E, I, and A are the proportions of trails that are easy, intermediate, and advanced respectively.

A larger Variety value means that a mountain's trail difficulties are more similar to that of the average New England mountain in the study. Crotched Mountain (NH) trail diversity is most similar to the average, with a Variety value of 0.979 from 28% easy trails, 40% intermediate trails, and 32% advanced trails. Big Rock Ski Area (ME) trail diversity is most dissimilar to the average, with a Variety value of 0.418 from 10% easy trails, 70% intermediate trails, and 20% advanced trails.

Note: difficult (black diamond) and expert (double black diamond) ski runs were combined into one advanced category because some ski areas, such as Mad River Glen (VT) and Jay Peak (VT), do not differentiate between the two difficulties.

3.3.2: Methodology of Competition

Ski area ticket pricing is expected to be influenced by how many other ski areas are nearby, saturating the market in a certain area. In order to calculate such a relative value, ski area coordinates were used to find the relative distance between ski areas, which was then inversely weighted based on the acreage of the competing ski area, factoring in a general influence of the size of the other ski area. This process can be described by the following equation for ski area X:

$$\text{Competition}_X = \sum_{i=1}^{i=59} \frac{AREA_i}{\sqrt{(LAT_X - LAT_i)^2 + (LONG_X - LONG_i)^2}}$$

where i represents all other ski areas in this study.
for ease, each value was divided by 1,000.

It is important to note that subtracting longitudes and latitudes (which are described by spherical coordinates) do not produce a measurable distance but gives a value that is used to compare the relative "Competition" that each ski area experiences.

Of ski areas with competition values above the mean value, only two are not in Vermont or New Hampshire. This makes sense, as those two states contain the highest density of ski areas used in the study to land size. Mountains with some of the largest Competition values are Stowe Mountain Resort (VT) and Smuggler's Notch (VT), which are both very close to each other. Mount Jefferson Ski Area (ME) has one of the lowest competition values, as it is over 50 miles from any other ski area in this study.

3.3.3: Methodology of People

The variable People is used to measure how close a ski area is to its current and potential customers, whether they are locals or visitors. It is expected that the closer a ski area is to population centers, the higher it can charge for an adult one day ticket. The method to determine a relative value for People is similar to that of Competition: the coordinates of each ski area were used to find the relative distance between it and population centers, inversely squared and weighted by the population of the city or town. A database of 1527 of the largest cities in New England (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont), New

York, Pennsylvania, New Jersey, Quebec, Ontario, and New Brunswick was used in the study. Each ski area was compared to all population centers in the database. The value for People can be modeled by the following equation for ski area X:

$$\text{People}_X = \sum_{i=1}^{i=1527} \frac{POPULATION_i}{(LAT_X - LAT_i)^2 + (LONG_X - LONG_i)^2}$$

where i represents all population centers in the database.
for ease, each value was divided by 1,000,000.

As with the derivation of Competition, subtracting longitudes and latitudes (which are described by spherical coordinates) do not produce a measurable distance but gives a value that is used to compare the relative availability of customers of each ski area.

Using Killington Mountain Resort (VT) as an example, we can see how this measure works. To the right is a table of some of the largest places that people come from to go to Killington, based on the above model. As seen, both larger cities that are far away from the mountain and smaller local towns have population influence on the potential customers of the ski area.

Location	**Influence**
Boston, MA	0.968
Montreal, QC	0.818
New York, NY	0.804
Rutland, VT	0.464
Woodstock, VT	0.295
Philadelphia, PA	0.243
Total People Value	8.72

With the exception of Lost Valley Ski Area outside of Lewiston and Auburn, Maine, all ski areas in the study that are in Connecticut, Massachusetts, and Rhode Island have larger People values than that of all ski areas in Maine, New Hampshire, and Vermont. This makes sense due to the low populations of the three northern states. Places such as Blue Hills Ski Area and Nashoba Valley Ski Area have exceptionally high People values due to their close proximity to Boston, the largest city in New England. Additionally, the largest cities in each northern state (Portland ME, Manchester NH, and Burlington VT) rank only 37th, 44th, and 60th in population in the cities described in the database respectively.

Note that the People and Competition variables are not proportional with the data used in this study.

3.4: Excluded Variables

It would be ideal to test whether more characteristics of a ski area affect its ticket price. However, the number of variables used in this study was limited by two factors: (1) the number of variables that can be used in a Hedonic model with only 60 ski areas to produce statistically significant results and (2) available information on ski areas (*Pavlov 2000*). Some unused variables brainstormed for this study include:

Type of Lifts	Number of Lifts	Grooming Capabilities
Lift Capacity	Property Taxes	Total Length of Ski Trails
Annual Events	Number of Lodges	Population Within 2 Hours
Base Elevation	Free Shuttle Services	Rainfall in Winter Months
Years Open	Ski Rental Availability	Participation in Multipasses
Longest Run	Distance to Airport	(such as the Ikon Pass)
Attractions	Season Length	Other Winter Activities
Congestion	Summer Activity	(such as a snow coaster)

§4: Data

4.1: Ski Areas in New England

There are a total of 135 ski areas in New England, including large resorts and smaller mountains with surface lifts only. Due to limited accurate information on certain key variables, not all New England ski areas could be included in the study. Below is a table breaking down the 60 ski areas by state, compared to the total number of ski areas. Figure 1 shows a map of ski areas used in this study (New England Ski Resort Map, 2018).

State	Total Ski Areas	Ski Areas Used in Study
Connecticut	6	5
Maine	31	11
Massachusetts	20	11
New Hampshire	39	16
Rhode Island	1	1
Vermont	38	16
Total	**135**	**60**

4.2: Data Sources

Ski area data for this study was compiled from multiple sources. The dependent variable, adult one-day ticket prices, was obtained from each ski area's website. On The Snow provided information on vertical drop, acres, trails, variety, snowmaking, parks, night skiing, and average snowfall. Wikipedia was used to confirm statistics on vertical drop, acres, and trails. Any conflicting data points were checked with other sources, such as Verticalfeet.com. New England Ski History also was used to check conflicting or missing data points, as well as find information on lift age using their ski lift database. Nearby hotel and restaurant figures were obtained from TripAdvisor. For ski area competition and people, GPS coordinates were found using gps-coordinates.net and city data was obtained from Simple Maps.

4.3: Descriptive Statistics

Variable	Mean	Median	Minimum	Maximum	Standard Deviation
DayTicket	73.75	73.5	20	147	26.812
Vertical	1263.0	1145	220	3050	765.181
Acres	265.0	168	12	1509	298.350
Trails	48.7	40	9	162	37.524
Variety	0.748	0.757	0.418	0.979	0.146
SnowMaking	174.4	118	0	654	162.564
LiftAge	29.6	29	3.5	56	11.106
Parks	2.73	2	0	10	2.024
NightSkiing	28.9	0	0	140	36.495
Snowfall	137.1	118	24	349	75.506
Hotels	4.55	2	1	25	5.936
Restaurants	34.00	18	1	187	40.786
Competition	15.49	14	3.41	47.63	7.955
People	24.92	9	1.45	196.30	36.654

Number of Observations: 60

4.4: List of Ski Areas Used

Attitash Mountain Resort	King Pine	Saddleback Mountain
Berkshire East Mountain Resort	Loon Mountain Resort	Shawnee Peak
Big Rock Ski Area	Lost Valley Ski Area	Ski Bradford
Black Mountain Resort	Mad River Glen	Ski Butternut
Blue Hills Ski Area	Magic Mountain Ski Area	Ski Sundown
Bolton Valley	Middlebury College Snow Bowl	Ski Ward
Bousquet Mountain Ski Area	Mohawk Mountain	Smugglers Notch
Bretton Woods	Mount Abram	Stowe Mountain Resort
Bromley Mountain Resort	Mount Jefferson	Stratton Mountain Resort
Burke Mountain Resort	Mount Snow	Sugarbush Resort
Camden Snow Bowl	Mount Southington	Sugarloaf Mountain Resort
Cannon Mountain	Mount Sunapee Resort	Suicide Six
Catamount	Nashoba Valley Ski Area	Sunday River
Cranmore Mountain Resort	New Hermon Mountain	Titcomb Mountain Ski Area
Crotched Mountain	Okemo Mountain Resort	Wachusett Mountain Ski Area
Dartmouth Skiway	Otis Ridge	Waterville Valley Resort
Gunstock Mountain Resort	Pats Peak	Whaleback Mountain
Jay Peak Resort	Pico Mountain	Wildcat Mountain
Jiminy Peak Mountain Resort	Powder Ridge	Woodbury
Killington Mountain Resort	Ragged Mountain Resort	Yawgoo Valley

§5: Results

5.1: OLS Regression Output

	Variable	Coefficient	T-Value	VIF
	Intercept	1.09100**	2.2770	
ln	Vertical	0.19940**	2.1520	10.30
ln	Acres	0.27300***	-3.0480	16.91
ln	Trails	0.27730***	2.6910	13.15
ln	Variety	0.04204	0.3660	1.31
ln	Snow Making	0.20780***	3.1830	8.90
ln	Lift Age	-0.04944	-0.9270	1.42
	Night Skiing	-0.00003	-0.0380	1.54
	Parks	0.01675	1.1210	1.86
ln	Snowfall	0.09750	1.2250	4.73
ln	Hotels	-0.07727*	-1.7810	3.93
ln	Restaurants	0.07003**	2.1190	4.19
ln	Competition	0.17440**	2.4150	2.95
ln	People	0.09589***	2.8350	2.74

Note: ***, **, and * indicate significance at 1%, 5% and 10%, respectively.

Residuals:	Min	Q1	Median	Q3	Max
	-0.34805	-0.11224	0.01752	0.10743	0.32273

Residual standard error: 0.1663 on 46 degrees of freedom

Multiple R-squared: 0.8579 | Adjusted R-squared: 0.8178

5.2: Multicollinearity of Mountain Size

Collinearity occurs in regression models when two predictor variables are too closely correlated. Similarly, multicollinearity is between three or more variables, causing unstable estimates of regression coefficients because of their redundancy, which increases the model's variance (Kassambara, 2018).

A typical rule of thumb for testing multicollinearity is whether a variable has a VIF greater than 10. All variables adhere to this condition except for Acres, Trails, and Vertical. It makes sense that these variables are closely related in this model as a ski area with more trails most likely has more acreage and vertical, and vice versa. For this reason, we can interpret the three characteristics of a ski area together (O'Brien, 2007). The three variables all describe a similar concept, yet not a quantitative characteristic: the general size of a ski area. Because all three coefficients show a positive correlation between general size (Acres, Trails, and Vertical) and day ticket price, and are statistically significant, we will ignore their high VIFs.

In order to prove that each variable is not also colinear with any other variables, which would mean that they need to be removed, below are the VIFs of all variables when only each individual size variable is used. As seen, all VIF scores except for Acres are below 10 with these tests, an acceptable measure for these purposes. It is better to accept larger VIF values than to alter the method with the goal of reducing multicollinearity (O'Brien, 2007). The farthest right column displays the difference between the maximum and minimum VIF for each variable, indicating the relative effect that changing between the three size variables has on collinearity. Note that Snowmaking is the only variable which is significantly affected by changing between using Vertical, Acres, and Trails, yet is still under the VIF threshold of 10 (Allison, 2012).

	Variable	Only Vertical	Only Acres	Only Trails	Max VIF - Min VIF
ln	Vertical	6.14	UNUSED	UNUSED	N/A
ln	Acres	UNUSED	10.99	UNUSED	N/A
ln	Trails	UNUSED	UNUSED	8.27	N/A
ln	Variety	1.24	1.23	1.27	0.04
ln	Snow Making	3.09	7.85	5.13	4.76
ln	Lift Age	1.38	1.38	1.37	0.01
	Night Skiing	1.50	1.53	1.50	0.03
	Parks	1.83	1.72	1.80	0.09
ln	Snowfall	4.50	4.42	4.03	0.47
ln	Hotels	3.37	3.58	3.34	0.24
ln	Restaurants	3.11	3.63	3.08	0.55
ln	Competition	2.91	2.81	2.81	0.10
ln	People	2.39	2.39	2.72	0.33

5.3: Ranking of Ski Areas by Estimated Ticket Prices

Rank	Ski Area Name	State	Estimate ($)	Actual ($)	Under/Over ($)
1	Okemo Mountain Resort	VT	133.72	127	-6.72
2	Stowe Mountain Resort	VT	133.65	139	5.35
3	Sugarbush Resort	VT	119.06	119	-0.06
4	Killington Mountain Resort	VT	112.04	119	6.96
5	Stratton Mountain Resort	VT	111.11	125	13.89
6	Mount Snow	VT	108.99	110	1.01
7	Sunday River	ME	108.91	105	-3.91
8	Cannon Mountain	NH	97.62	79	-18.62
9	Bretton Woods	NH	95.20	99	3.80

10	Bolton Valley	VT	92.45	79	-13.45
11	Loon Mountain Resort	NH	89.78	98	8.22
12	Smugglers Notch	VT	89.12	79	-10.12
13	Jay Peak Resort	VT	89.00	89	0.00
14	Sugarloaf Mountain Resort	ME	87.47	99	11.53
15	Pico Mountain	VT	87.42	85	-2.42
16	Berkshire East Mountain	MA	86.73	69	-17.73
17	Bromley Mountain Resort	VT	86.36	87	0.64
18	Wildcat Mountain	NH	86.22	89	2.78
19	Catamount	MA	85.29	69	-16.29
20	Waterville Valley Resort	NH	84.88	93	8.12
21	Mount Sunapee Resort	NH	84.16	98	13.84
22	Cranmore Mountain Resort	NH	83.38	83	-0.38
23	Attitash Mountain Resort	NH	82.69	89	6.31
24	Burke Mountain Resort	VT	81.61	73	-8.61
25	Gunstock Mountain Resort	NH	78.78	92	13.22
26	Ragged Mountain Resort	NH	74.81	84	9.19
27	Shawnee Peak	ME	74.70	65	-9.70
28	Saddleback Mountain	ME	73.57	80	6.43
29	Ski Butternut	MA	72.76	60	-12.76
30	Magic Mountain Ski Area	VT	70.92	74	3.08
31	Jiminy Peak Mountain	MA	70.06	81	10.94
32	Pats Peak	NH	70.04	72	1.96
33	Black Mountain Resort	NH	68.96	59	-9.96
34	Wachusett Mountain	MA	67.85	71	3.15
35	Bousquet Mountain Ski Area	MA	66.53	47	-19.53
36	Mad River Glen	VT	65.22	89	23.78
37	Dartmouth Skiway	NH	62.14	50	-12.14
38	Crotched Mountain	NH	60.79	69	8.21
39	Whaleback Mountain	NH	59.53	45	-14.53
40	Mount Southington	CT	58.45	60	1.55
41	Powder Ridge	CT	57.39	55	-2.39
42	Ski Sundown	CT	55.14	62	6.86
43	Mount Abram	ME	54.92	49	-5.92
44	Mohawk Mountain	CT	54.50	65	10.50
45	Lost Valley Ski Area	ME	52.33	55	2.67
46	Ski Bradford	MA	52.22	55	2.78
47	King Pine	NH	52.18	58	5.82
48	Suicide Six	VT	52.13	72	19.87
49	Nashoba Valley Ski Area	MA	51.79	58	6.21
50	Middlebury Snow Bowl	VT	51.54	60	8.46
51	Blue Hills Ski Area	MA	50.95	45	-5.95
52	Ski Ward	MA	44.87	55	10.13
53	Camden Snow Bowl	ME	43.63	43	-0.63
54	Big Rock Ski Area	ME	42.13	40	-2.13
55	Woodbury	CT	41.92	42	0.08
56	Otis Ridge	MA	40.94	40	-0.94
57	Yawgoo Valley	RI	38.67	48	9.33
58	New Hermon Mountain	ME	36.87	32	-4.87
59	Titcomb Mountain Ski Area	ME	33.99	24	-9.99
60	Mount Jefferson	ME	17.03	20	2.97

5.4: Ranking of Ski Resorts by Value Estimate

Where a negative over/under shows more value to the ski area because the actual price is less than the estimated one, and a positive over/under shows the ski area is not a good value because the actual price is greater than the estimated one.

Rank	Ski Area Name	State	Estimate ($)	Actual ($)	Over/Under ($)
1	Bousquet Mountain Ski Area	MA	66.53	47	-19.53
2	Cannon Mountain	NH	97.62	79	-18.62
3	Berkshire East Mountain	MA	86.73	69	-17.73
4	Catamount	MA	85.29	69	-16.29
5	Whaleback Mountain	NH	59.53	45	-14.53
6	Bolton Valley	VT	92.45	79	-13.45
7	Ski Butternut	MA	72.76	60	-12.76
8	Dartmouth Skiway	NH	62.14	50	-12.14
9	Smugglers Notch	VT	89.12	79	-10.12
10	Titcomb Mountain Ski Area	ME	33.99	24	-9.99
11	Black Mountain Resort	NH	68.96	59	-9.96
12	Shawnee Peak	ME	74.70	65	-9.70
13	Burke Mountain Resort	VT	81.61	73	-8.61
14	Okemo Mountain Resort	VT	133.72	127	-6.72
15	Blue Hills Ski Area	MA	50.95	45	-5.95
16	Mount Abram	ME	54.92	49	-5.92
17	New Hermon Mountain	ME	36.87	32	-4.87
18	Sunday River	ME	108.91	105	-3.91
19	Pico Mountain	VT	87.42	85	-2.42
20	Powder Ridge	CT	57.39	55	-2.39
21	Big Rock Ski Area	ME	42.13	40	-2.13
22	Otis Ridge	MA	40.94	40	-0.94
23	Camden Snow Bowl	ME	43.63	43	-0.63
24	Cranmore Mountain Resort	NH	83.38	83	-0.38
25	Sugarbush Resort	VT	119.06	119	-0.06
26	Jay Peak Resort	VT	89.00	89	0.00
27	Woodbury	CT	41.92	42	0.08
28	Bromley Mountain Resort	VT	86.36	87	0.64
29	Mount Snow	VT	108.99	110	1.01
30	Mount Southington	CT	58.45	60	1.55
31	Pats Peak	NH	70.04	72	1.96
32	Lost Valley Ski Area	ME	52.33	55	2.67
33	Ski Bradford	MA	52.22	55	2.78
34	Wildcat Mountain	NH	86.22	89	2.78
35	Mount Jefferson	ME	17.03	20	2.97
36	Magic Mountain Ski Area	VT	70.92	74	3.08
37	Wachusett Mountain	MA	67.85	71	3.15
38	Bretton Woods	NH	95.20	99	3.80
39	Stowe Mountain Resort	VT	133.65	139	5.35
40	King Pine	NH	52.18	58	5.82
41	Nashoba Valley Ski Area	MA	51.79	58	6.21
42	Attitash Mountain Resort	NH	82.69	89	6.31
43	Saddleback Mountain	ME	73.57	80	6.43
44	Ski Sundown	CT	55.14	62	6.86
45	Killington Mountain Resort	VT	112.04	119	6.96

46	Waterville Valley Resort	NH	84.88	93	8.12
47	Crotched Mountain	NH	60.79	69	8.21
48	Loon Mountain Resort	NH	89.78	98	8.22
49	Middlebury Snow Bowl	VT	51.54	60	8.46
50	Ragged Mountain Resort	NH	74.81	84	9.19
51	Yawgoo Valley	RI	38.67	48	9.33
52	Ski Ward	MA	44.87	55	10.13
53	Mohawk Mountain	CT	54.50	65	10.50
54	Jiminy Peak Mountain	MA	70.06	81	10.94
55	Sugarloaf Mountain Resort	ME	87.47	99	11.53
56	Gunstock Mountain Resort	NH	78.78	92	13.22
57	Mount Sunapee Resort	NH	84.16	98	13.84
58	Stratton Mountain Resort	VT	111.11	125	13.89
59	Suicide Six	VT	52.13	72	19.87
60	Mad River Glen	VT	65.22	89	23.78

5.5: Statistics by State

State	Average Price Rank	Average Estimate ($)	Average Actual ($)	Average Under/Over ($)
CT	44.40	53.48	56.80	3.32
MA	38.00	62.73	59.09	3.64
ME	40.72	56.87	55.63	-1.23
NH	25.56	76.95	78.56	1.62
RI*	57.00	38.67	48.00	9.33
VT	17.25	92.77	95.38	2.61

* data from one ski area (Yawgoo Valley)

Note: the average of all under/over estimates is $0.66, indicating that all ski areas are an average of 66 cents overpriced. This value was not expected to be $0.00 due to the nature of a hedonic model.

5.6: Fit of Model to Data

Overall, the hedonic equation and variables provide a good model of the data, equating for approximately 81.8% of the variance between adult day ski lift ticket prices. Additionally, 4 coefficients are statistically significant at the 1% level, 4 coefficients at 5%, and 1 at 10%, while 5 are statistically insignificant.

§6: Conclusion

6.1: Importance of Certain Ski Area Characteristics

The first determination of this study using the hedonic regression model on ski lift tickets is to break down the individual effects that each characteristic has on ski area ticket prices. To review, the variables used were: Vertical, Acres, Trails, Variety, SnowMaking, LiftAge, NightSkiing, Parks, Snowfall, Hotels, Restaurants, Competition, and People. At a p-value of 0.05, Variety, LiftAge, NightSkiing, Parks, Snowfall, and Hotels were statistically insignificant. This leaves the following finding: Vertical, Acres, Trails, SnowMaking, Restaurants, and People are statistically significant and positively correlated to ski ticket prices; Competition is statistically significant and negatively correlated to ski ticket prices.

Results show that ski area ticket pricing is significantly affected by the size of the ski area. Doubling vertical feet with no other changes increases the ticket price in the model by 12.9%. Similarly, Acres and Trails produce a 17.2% increase and a 21.2% increase in ticket price respectively when doubled. However, note that due to multicollinearity issues discussed before in section 5.2, the mountain size does not cause a total 51.3% increase in price each time it doubles. Although, it still has the single largest effect of all variables. The next largest influence on ski ticket pricing is the SnowMaking variable, which is indicative of the quality of the skiing slope, and accounts for a 15.5% increase in ticket price if snow making capabilities are doubled with no other changes. Lastly, the number of nearby restaurants and the accessibility of a ski area matter in the value of a ski area to its customers. With no other changes, doubling the People measure (of arbitrary value) is expected to lead to a 6.9% increase of an adult day ticket price. Doing the same to Restaurants will lead to a 5.0% estimated increase in adult day ticket price. Note that the characteristics described that significantly having a positive effect on adult day ticket price in New England are not the only ones determined from this study.

The competition of a ski area, specifically its distance to other ski areas weighted by size as discussed in section 3.3.2, is negatively correlated with ticket price. Doubling a mountain's competition (of arbitrary value), ticket price is estimated to be able to increase by 12.8%. This is contrary to a common assumption, that more competition drives down the price of each ski area. Perhaps this is due to the nature of how ski area locations are chosen. As the Appalachian Mountains in New England are smaller compared to other ski destinations (such as the Rocky's, Alps, or Andes), many ski areas are concentrated in the areas with the largest mountains. For instance, there are concentrations of ski areas along the Green Mountains of Vermont and in the White Mountains of New Hampshire, where both locations offer large peaks for large ski areas. Competition is created in these areas because of the geographical benefits of such a location, a separate variable which may be influencing this measure. Another thought is that nearby ski areas allow people to come one location and ski multiple mountains in the same trip, a characteristic that would be expected to increase ticket price. Due to the close proximity of ski areas in New England and limited places to create larger ones, the measure of competition may be influenced more by the placement and scale of ski areas rather than by the characteristic itself.

In conclusion, New England customers are willing to pay more for ski areas that are larger, have better trail coverage, have more off-mountain amenities, and are in closer proximity to where they live.

One variable that is surprisingly not statistically significant is average annual snowfall. This can perhaps be explained by the relatively low snowfall that New England ski resorts receive. Other areas in the United States can get up to and over 500 or 600 inches of snow per year. Compare this to New England, where only 10 ski resorts have an average annual snowfall over 200 inches per year. Additionally, New England is not known as a top powder skiing location in the country, and so ski areas may not always be expected to have such fresh snow, hence why the actual snowfall of the mountain is rendered unimportant in the hedonic pricing model. Additionally, the New England region is smaller than other skiing regions such as the Rockies, so one storm will often pass over many of the ski areas, dumping similar amounts of snow. These effects are also evidenced by the significant influence that snow making has on ticket price (Falk, 2011).

6.2: Results of Estimated Ticket Prices

According to the hedonic model used for predictions in this study, in the respect to the variables with a significant influence on ticket price, the ski areas in New England can be ranked by their characteristics. Okemo Mountain Resort (VT) and Stowe Mountain Resort (VT) are by far the best, each with an estimated $133 per day adult ticket price. Sugarbush Resort (VT), Killington Mountain Resort (VT), and Stratton Mountain Resort (VT) are estimated to be worth $119, $112, and $111 per day respectively. Mount Snow (VT) and Sunday River (ME) take 6th and 7th place with a $108 per day estimated value. All other ski areas are estimated to be valued at less than $100 per day. The least valued ski area in the study, by at least $16 per day from the next ski area, is Mount Jefferson (ME) at an estimated price of $17 per day.

The results also reveal information about quality of skiing in each state. Note that the top six ski areas ranked by value are all in Vermont. Furthermore, Vermont has the highest average estimated ticket price, at an average of $92.77 per day. Next comes New Hampshire, Massachusetts, Maine, Connecticut, and Rhode Island. It is the same ranking when the average actual ticket prices are compared between states.

6.3: Results of Ski Area Value

Section 5.4 ranks the ski areas in the hedonic model based on their observed value, done by comparing the estimated ticket price to the actual ticket price. Of the 60 ski areas in the study, 25 are said to be underpriced, with 9 being underpriced by more than $10. The best valued mountains according to the model are, in order, Bousquet Mountain Ski Area (MA), Cannon Mountain (NH), Berkshire East Mountain (MA), Catamount (MA), and Whaleback Mountain (NH), which are all estimated to be underpriced by $14 or greater.

A total of 7 ski area ticket prices are correctly estimated by within a dollar of the actual ticket price, and 22 are correctly estimated within five dollars of the actual ticket price. Notably, the hedonic price model estimates that Jay Peak Resort's (VT) ticket price should be $89.00, which is their exact actual ticket price.

34 ski areas are said to be overpriced, with 9 that have adult day tickets overpriced by more than $10. The most overpriced mountains are, in order, Mad River Glen (VT), Suicide Six (VT), Stratton Mountain Resort (VT), Mount Sunapee Resort (NH), and Gunstock Mountain Resort (NH). Unlike with the most underpriced ski resorts, Suicide Six and especially Mad River Glen stand out as severely overpriced compared to the other mountains. However, each resort has a unique reason that may explain their expensive tickets. Mad River Glen instituted a flat rate ticket price at the window, which they say on their website's 2018-2019 season ticket pricing page, is to "reward skiers who make a commitment to Mad River Glen." Essentially, they overcharge to reduce crowding at the low capacity and local-preferred ski area. Suicide Six's highly overpriced tickets may be explained by the fact that the ski area is owned by the Woodstock Inn and Resort, an all-inclusive 4 star hotel.

The most underpriced state (and in fact the only state where average actual price minus average estimated price is negative) is Maine by $1.23. The most overpriced state is Massachusetts with an average of $3.64 estimated price over the actual price (this metric excludes Rhode Island, which has an average overpriced amount of $9.33 because there is only one ski area in the state).

6.4: Small/Urban and Large/Rural Ski Area Trend

Although such a relationship is not studied in this analysis of New England ski areas, it is interesting to qualitatively note the trend between the size of ski areas and their distance to population centers, both of which are characteristics positively correlated with ticket price. Among the 60 ski areas studied, some divide into several groups. The first is small ski areas that are near the largest cities in New England, such as Nashoba Valley Ski Area (MA) and Blue Hills Ski Area (MA) outside of Boston, Yawgoo Valley (RI) outside Providence, and Mount Southington (CT) outside of Hartford. These types of ski areas are smaller, but their reasonable ticket prices are mainly due to the close proximity to their customers. On the other hand, many of the largest ski resorts in New England are far away from major cities, such as Sunday River (ME), Killington Mountain Resort (VT), Stowe Mountain Resort (VT), and Sugarloaf Mountain Resort (ME). These mountains are unable the charge for close proximity but are able to charge more in their ticket price because of their large size. We can see such a trend from the results of the study: similarly priced ski areas in New England appear to be on a scale between small mountains in urban locations and large mountains in rural locations.

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