Pricing Golf: A Consultancy Report

Executive Summary

This project provides consulting advice to Municipal Golf of Seattle (MGS) about maximizing revenue through increasing the number of rounds played by addressing these questions: Should the MGS alter its green free structure, particularly in winter months? Should it fund paving of cart paths or build a driving range to increase the number of rounds of golf played?

In order to justify the recommendations, a panel data set from 1998 was used that includes information on the number of rounds of golf played and its associated possible explanatory variables. With this information, a Wald test (corrected for heteroskedasticity) was used to arrive a final estimated model of:

$$\mathrm{ROUNDSi} = -4258.767 - 1586.647\,(\mathrm{WINTER}) + 252.2443\,(\mathrm{FEE}) - 5.112867\,(\mathrm{FEE^{\wedge}2}) - 337.5988\,(\mathrm{MGS} * \mathrm{FEE}) + 337.2793\,(\mathrm{MGS} * \mathrm{FEESUB}) + 626.1423\,(\mathrm{FEESUB}) + 154.5381\,(\mathrm{RATING}) - 51.66263\,(\mathrm{SLOPE}) - 789.0537\,(\mathrm{RAIN}) + 44.61818\,(\mathrm{RAIN^{\wedge}2}) - 293.1054\,(\mathrm{TEMP}) + 2.430749\,(\mathrm{TEMP^{\wedge}2}) + 965.7971\,(\mathrm{CART} * \mathrm{WINTER}) - 19.52331(\mathrm{DISTANCE}).$$

The price elasticity for MGS courses was found to be to be **-.5468** and the winter elasticity to be **-2.2205**. Thus, during the non-winter months, MGS could raise their revenue by raising their green fee. Conversely, in the winter months, as the elasticity changes from inelastic to elastic, a decrease in the fee would increase revenue. In terms of capital improvement, the variables cart and range had an insignificant impact on the number of rounds played during the non-winter months. However, during the winter months, having golf carts did have a significant impact on the number of rounds played.

The current fee structure for the MGS courses is inefficient at maximizing revenue. The fee could be raised in the non-winter months and then lowered in the winter months in order to increase the revenue stream. For future capital improvement projects, paving cart paths and purchasing golf carts are recommended before building a driving range. However, the recommendations come with a caveat capital expenditure costs are not factored into into account, but only the goal of revenue maximization in mind.

<u>Introduction</u>

This project is designed to provide advice to the Municipal Golf of Seattle (MGS) with regards to the green fee structure during winter months and capital improvements of its three golf courses in Jackson, Jefferson andst Seattle. MGS currently does not charge at a seasonal rate, and instead employs a fixed rate so as to claim more market power over the number of rounds of golf played in non-winter months. The study seeks to answer these two questions in order to maximize the number of rounds of golf played and hence an increase in the revenue stream at MGS:

1) If MGS should alter its green fee structure, particularly in winter months
2) If MGS should invest in paving a cart path or building a driving range

<u>Methodology</u>

The recommendations provided are based on a regression analysis done on a panel data set of 22 public courses in the Seattle area for the 12 months in the year of 1998. The data set includes information on the number of rounds of golf played and several possible explanatory variables. With this data, the study started out with an unrestricted model including the following variables:

$$
\begin{aligned}
ROUNDSi = {} & \beta 1\, WINTER + \beta 2\, FEE + \beta 3\, FEE\text{^}2 + \beta 4\,(MSG * FEE) + \beta 5\,(MGS * FEESUB) \\
& + \beta 6\, FEESUB + \beta 7\, FEESUB\text{^}2 + \beta 8\, RATING + \beta 9\, SLOPE + \beta 10\, RAIN \\
& + \beta 11\, RAIN\text{^}2 + \beta 12\, TEMP + \beta 13\, TEMP2 + \beta 14\,(CART * WINTER) \\
& + \beta 15\, DISTANCE + \beta 16\, RANGE + \beta 17\,(WINTER * FEE)
\end{aligned}
$$

After evaluating the residuals of the regression, the data was tested for heteroskedasticity with a White test - rejecting the null hypothesis of homoskedasticity at the 1% and 5% significance level. After correcting the standard errors for heteroskedasticity, and found the variables FEESUB, $FEESUB^2$, RANGE, and

WINTER*FEE to be insignificant. A Wald test was then used to determine if these 4 variables were insignificant to the overall model.

Wald Test 1:

H_o: β6 = β7 = β16 = β17 = 0

H_A: H_o is not true // At least one variable (FEESUB, $FEESUB^2$, RANGE, or WINTER*FEE) is statistically significant

Test Results 1:

F-test statistic:

$$[(3.01E + 08 - 2.71E + 08) / 4] / [(2.71E + 08) / (264 - 18)] = 6.80811808118$$

F critical value: ~2.45 at 5% level of significance and ~3.48 at 1% level of significance

F-test statistic > F critical value at both 5% and 1% level of significance

Based on the results of the first Wald test, the null hypothesis was rejected because it shows that the fit of the unrestricted model is significantly better than the restricted model's fit. This leads to the assumption that at least one of the variables that were thrown out (FEESUB, $FEESUB^2$, RANGE, or WINTER*FEE) is in fact statistically significant. Hence, the study proceeded by throwing out $FEESUB^2$, RANGE, and WINTER*FEE to run another Wald test.

Wald Test 2:

H_o: β7 = β16 = β17 = 0

H_A: H_o is not true // At least one variable ($FEESUB^2$, RANGE, or WINTER*FEE) is statistically significant

Test Results 2:

F-test statistic:

$$[(2.72E + 08 - 2.71E + 08) / 3] / [(2.71E + 08) / (264 - 18)] = 0.30258302583$$

F critical value: ~2.68 at 5% level of significance and ~3.95 at 1% level of significance

F-test statistic < F critical value at both 5% and 1% level of significance

The second Wald test failed to reject the null hypothesis. This suggests that the imposed constraints appeared to be correct and the study have arrived at the model that includes variables which best explain the number of rounds of golf played.

The model:

$$ROUNDSi = \beta 0 + \beta 1\, WINTER + \beta 2\, FEE + \beta 3\, FEE\hat{}2 + \beta 4\, (MGS * FEE) + \beta 5\, (MGS * FEESUB) + \beta 6\, FEESUB + \beta 7\, RATING + \beta 8\, SLOPE + \beta 9\, RAIN + \beta 10\, RAIN\hat{}2 + \beta 11\, TEMP + \beta 12\, TEMP\hat{}2 + \beta 13\, (CART * WINTER) + \beta 14\, DISTANCE$$

Residual Demand Function:

$$ROUNDSi = -4258.767 - 1586.647 * WINTER + 252.2443 * FEE - 5.112867 * FEE\hat{}2 + 337.5988 * (MGS * FEE) + 337.2793 * (MGS * FEESUB) + 626.1423 * FEESUB + 154.5381 * RATING - 51.66263 * SLOPE - 789.0537 * RAIN + 44.61818 * RAIN\hat{}2 - 293.1054 * TEMP + 2.430749 * TEMP\hat{}2 + 965.7971 * (CART * WINTER) - 19.52331 * DISTANCE$$

Results

From the analysis of the dataset, several possible explanatory variables were found to be insignificant in attempting to explain the number of rounds played in a month. On the contrary, the significant explanatory variables are WINTER (winter months: November, December, January, February), FEE (average price charged for a round of golf), FEESUB (average price of the competitor), SLOPE (a measure of difficulty for more skilled golfers), RAIN (inches of rain for the month), TEMP (average temperature for the month), CART*WINTER (golf carts in the winter), DISTANCE (minimum distance to downtown Seattle or Bellevue).

The independent variables FEE, RAIN, and TEMP have non-linear relationships with the dependent variable, ROUNDSi. To account for this non-linearity, squared terms are included to increase the accuracy of the model.

In order to tailor the recommendations to the MGS courses and provide seasonally segmented advice, several dummy variables are included to allow the model to make separate estimations of the effects of the independent variables on the rounds played due to the characteristics of interest. The variable MGS takes on the value of 1 when the course of interest is in one of the three municipal gold courses, and 0 when it is not. The second dummy variable, WINTER, takes on the value of 1 during the winter months and 0 otherwise. The third dummy variable, CART, takes on the value of 1 if the course in question has golf carts for their players and 0 if they do not. CART by itself is found to have no significant relationship to rounds of golf played. However, when it is combined with the other dummy variable WINTER, the interaction of the terms becomes significant. CART*WINTER takes the value of 1 for golf courses with golf carts during the winter months, and 0 for all other scenarios.

To view the impact of any of the independent variables, it is necessary to take a partial derivative of residual demand function with respect to the variable of interest. When viewing the impact of FEE on the rounds played, the overall relationship for MGS courses is a negative one: a higher fee leads to a decreased number of rounds played. FEESUB has a positive relationship with the rounds demanded with a marginal increase leading to **963** more rounds demanded at MGS course. TEMP has a positive relationship with the rounds demanded at temperatures over **60** degrees. DISTANCE, SLOPE, RAIN, and WINTER all have negative relationships with the rounds demanded with marginal increases in each variable (holding all else constant) leading to **19**, **52**, **699**, and **1587** less rounds demanded respectively. RATING and CART*WINTER have a positive relationship with the rounds demanded with marginal increases leading to **155** and **966** more rounds being demanded.

In order to generate the price elasticity of demand for the MGS courses in the winter and non-winter months, the study used the partial derivative of ROUNDS with respect to FEE assigning a value of 1 to the MGS dummy variables. The equation for price elasticity is : $(-85.3545 - 10.22573 * FEE) * (FEE/ROUNDS)$.

The average values for FEE and ROUNDS at MGS courses from either the entire year or during the winter months was used to calculate the price elasticity of demand of **-0.547** and a seasonal price elasticity of demand of **-2.221**.

As the possible explanatory variable RANGE (whether if a course has a driving range or not) was found to be insignificant on the number of rounds played, and the CART*WINTER variable was found to be significant – meaning that building cart paths and acquiring golf carts is the only capital improvement that has an impact on the number of rounds of golf demanded in a month.

Conclusion

In conclusion, the variables WITNER, FEE, FEESUB, SLOPE, RAIN, TEMP and CART*WINTER significantly impact the number of rounds played. In addition, the non-linear relationships between FEE, RAIN and TEMP with the dependent variable $ROUNDS_i$ required including squared terms to increase model fit. Several dummy variables were added to tailor the recommendations to the MGS courses for seasonally segmented advice. Lastly, the study calculated the price elasticity of demand for the MGS courses in both winter and non-winter months. Thus, study has generated the quantitatively backed recommendations of increasing off-winter pricing, lower the price during winter months, and acquiring golf carts (possibly by renting them) in the winter month to maximize the revenue stream of the Municipal Golf of Seattle.

Appendix

(1) Unrestricted model

EViews - [Equation: UNTITLED Workfile: GOLFDATA::Golfdata\]

File Edit Object View Proc Quick Options Window Help

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: ROUNDS
Method: Least Squares
Date: 03/12/14 Time: 18:59
Sample: 1 264
Included observations: 264

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-43112.28	46108.56	-0.935017	0.3507
WINTER	-1481.155	604.2192	-2.451353	0.0149
FEE	283.4373	84.40191	3.358186	0.0009
FEE^2	-5.752279	1.756596	-3.274674	0.0012
MGS*FEE	-360.8289	153.1987	-2.355301	0.0193
MGS*FEESUB	355.9015	126.5846	2.811570	0.0053
FEESUB	4566.550	4698.354	0.971947	0.3320
FEESUB^2	-96.01619	114.3637	-0.839569	0.4020
RATING	164.6368	52.70698	3.123623	0.0020
SLOPE	-52.80697	12.93631	-4.082075	0.0001
RAIN	-711.1165	185.2090	-3.839536	0.0002
RAIN^2	37.10917	14.28597	2.597596	0.0100
TEMP	-365.0832	159.7802	-2.284909	0.0232
TEMP^2	2.977954	1.164203	2.557935	0.0111
CART*WINTER	980.4989	304.1807	3.223409	0.0014
DISTANCE	-20.44008	5.255268	-3.889445	0.0001
RANGE	-2.525223	182.4770	-0.013839	0.9890
WINTER*FEE	11.74463	37.49592	0.313224	0.7544
YARD	-0.016580	0.098688	-0.168003	0.8667

R-squared	0.873510	Mean dependent var	4466.166
Adjusted R-squared	0.864217	S.D. dependent var	2853.373
S.E. of regression	1051.431	Akaike info criterion	16.82294
Sum squared resid	2.71E+08	Schwarz criterion	17.08030
Log likelihood	-2201.628	Hannan-Quinn criter.	16.92636
F-statistic	93.99546	Durbin-Watson stat	0.629976
Prob(F-statistic)	0.000000		

Path = z:/users/thomas/documents | DB = none | WF = golfdata

(2) White test; found that there is heteroskedasticity at 1% and 5% significance level

EViews - [Equation: UNTITLED Workfile: GOLFDATA::Golfdata\]

File Edit Object View Proc Quick Options Window Help

View Proc Object Print Name Freeze Estimate Forecast Stats Resids

Heteroskedasticity Test: White

F-statistic	1.990145	Prob. F(142,121)	0.0001
Obs*R-squared	184.8524	Prob. Chi-Square(142)	0.0091
Scaled explained SS	261.7718	Prob. Chi-Square(142)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 03/12/14 Time: 19:00
Sample: 1 264
Included observations: 264
Collinear test regressors dropped from specification

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.55E+09	7.91E+10	0.019610	0.9844
WINTER^2	-6.75E+10	1.06E+11	-0.635129	0.5265
WINTER*FEE	1.50E+08	3.49E+08	0.430260	0.6678
WINTER*FEE^2	-538421.2	844446.8	-0.637602	0.5249
WINTER*MGS*FEE	-20122261	1.68E+08	-0.119777	0.9049
WINTER*MGS*FEESUB	22509313	1.51E+08	0.148729	0.8820
WINTER*FEESUB	9.07E+09	1.19E+10	0.759818	0.4488
WINTER*FEESUB^2	-2.94E+08	4.18E+08	-0.703634	0.4830
WINTER*RATING	-34073913	1.00E+08	-0.340313	0.7342
WINTER*SLOPE	4225607.	12710190	0.332458	0.7401
WINTER*RAIN	1.54E+09	4.21E+09	0.365120	0.7157
WINTER*RAIN^2	-2.35E+08	6.86E+08	-0.342554	0.7325
WINTER*CART*WINTER	-4.42E+08	3.54E+09	-0.124841	0.9009
WINTER*DISTANCE	-2561293.	8583142.	-0.298410	0.7659
WINTER*RANGE	-72860.99	19825477	-0.003675	0.9971
WINTER*YARD	140131.5	394188.5	0.355494	0.7228
FEE^2	2551773.	10623314	0.240205	0.8106
FEE*FEE^2	2109.421	12222.05	0.172591	0.8633
FEE*MGS*FEE	24765077	1.60E+08	0.155220	0.8769
FEE*MGS*FEESUB	-5293011.	1.05E+08	-0.050232	0.9600
FEE*FEESUB	28046631	2.02E+08	0.138519	0.8901
FEE*FEESUB^2	-651199.7	4737084.	-0.137468	0.8909
FEE*RATING	-127547.4	639453.1	-0.199463	0.8422
FEE*SLOPE	-42261.52	120764.9	-0.349949	0.7270
FEE*RAIN	4133990.	19885115	0.207894	0.8357
FEE*RAIN^2	-121675.8	1351311.	-0.090043	0.9284
FEE*TEMP	-49144.73	1086803.	-0.045220	0.9640
FEE*TEMP^2	-143.0960	8457.302	-0.016920	0.9865
FEE*CART*WINTER	1722438.	5504991.	0.312887	0.7549
FEE*DISTANCE	-5337.269	33426.79	-0.159670	0.8734
FEE*RANGE	999690.1	6928972.	0.144277	0.8855
FEE*YARD	1761.086	2251.681	0.782120	0.4357
FEE	-2.96E+08	2.16E+09	-0.137489	0.8909
FEE^2^2	-19.25081	111.2624	-0.173022	0.8629
FEE^2*MGS*FEE	-391462.9	3607384.	-0.108517	0.9138
FEE^2*MGS*FEESUB	-381212.6	2296799.	-0.165976	0.8685

(3) White test corrected the standard error of the unrestricted model

EViews - [Equation: UNTITLED Workfile: GOLFDATA::Golfdata\]

File Edit Object View Proc Quick Options Window Help

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: ROUNDS
Method: Least Squares
Date: 03/12/14 Time: 19:01
Sample: 1 264
Included observations: 264
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-43112.28	44608.10	-0.966467	0.3348
WINTER	-1481.155	504.3200	-2.936935	0.0036
FEE	283.4373	83.42472	3.397522	0.0008
FEE^2	-5.752279	1.619093	-3.552778	0.0005
MGS*FEE	-360.8289	139.1654	-2.592806	0.0101
MGS*FEESUB	355.9015	120.5499	2.952316	0.0035
FEESUB	4566.550	4618.005	0.988858	0.3237
FEESUB^2	-96.01619	113.0751	-0.849137	0.3966
RATING	164.6368	45.39093	3.627085	0.0003
SLOPE	-52.80697	10.91506	-4.837991	0.0000
RAIN	-711.1165	178.9209	-3.974475	0.0001
RAIN^2	37.10917	12.96124	2.863089	0.0046
TEMP	-365.0832	130.9321	-2.788340	0.0057
TEMP^2	2.977954	0.944853	3.151766	0.0018
CART*WINTER	980.4989	188.7567	5.194513	0.0000
DISTANCE	-20.44008	4.663755	-4.382751	0.0000
RANGE	-2.525223	224.2765	-0.011259	0.9910
WINTER*FEE	11.74463	31.61032	0.371544	0.7106
YARD	-0.016580	0.064262	-0.258006	0.7966

R-squared	0.873510	Mean dependent var	4466.166
Adjusted R-squared	0.864217	S.D. dependent var	2853.373
S.E. of regression	1051.431	Akaike info criterion	16.82294
Sum squared resid	2.71E+08	Schwarz criterion	17.08030
Log likelihood	-2201.628	Hannan-Quinn criter.	16.92636
F-statistic	93.99546	Durbin-Watson stat	0.629976
Prob(F-statistic)	0.000000	Wald F-statistic	138.4375
Prob(Wald F-statistic)	0.000000		

(4) The first Wald test removal

File Edit Object View Proc Quick Options Window Help

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: ROUNDS
Method: Least Squares
Date: 03/12/14 Time: 19:02
Sample: 1 264
Included observations: 264
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1929.390	4774.677	0.404088	0.6865
WINTER	-1901.058	313.8040	-6.058107	0.0000
FEE	221.8622	63.04651	3.519023	0.0005
FEE^2	-4.916923	1.354348	-3.630473	0.0003
MGS*FEE	-440.4723	140.0853	-3.144316	0.0019
MGS*FEESUB	425.0188	121.6730	3.493124	0.0006
RATING	147.2233	43.73699	3.366105	0.0009
SLOPE	-52.61644	11.52350	-4.566013	0.0000
RAIN	-953.1604	175.3845	-5.434689	0.0000
RAIN^2	58.32181	11.57070	5.040472	0.0000
TEMP	-91.83326	109.0798	-0.841891	0.4007
TEMP^2	1.250127	0.777156	1.608593	0.1090
CART*WINTER	886.6776	188.3026	4.708791	0.0000
DISTANCE	-18.46121	4.536634	-4.069362	0.0001

R-squared	0.859651	Mean dependent var	4466.166
Adjusted R-squared	0.852353	S.D. dependent var	2853.373
S.E. of regression	1096.404	Akaike info criterion	16.88903
Sum squared resid	3.01E+08	Schwarz criterion	17.07866
Log likelihood	-2215.352	Hannan-Quinn criter.	16.96523
F-statistic	117.7907	Durbin-Watson stat	0.653552
Prob(F-statistic)	0.000000	Wald F-statistic	179.7456
Prob(Wald F-statistic)	0.000000		

(5) The second Wald test removal and the final model

EViews - [Equation: UNTITLED Workfile: GOLFDATA::Golfdata\]

File Edit Object View Proc Quick Options Window Help

View Proc Object Print Name Freeze Estimate Forecast Stats Resids

Dependent Variable: ROUNDS
Method: Least Squares
Date: 03/12/14 Time: 19:03
Sample: 1 264
Included observations: 264
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4258.767	5186.763	-0.821084	0.4124
WINTER	-1586.647	318.7976	-4.976973	0.0000
FEE	252.2443	58.40388	4.318964	0.0000
FEE^2	-5.112867	1.200513	-4.258903	0.0000
MGS*FEE	-337.5988	137.0800	-2.462787	0.0145
MGS*FEESUB	337.2793	119.0120	2.833994	0.0050
FEESUB	626.1423	136.9569	4.571822	0.0000
RATING	154.5381	42.84852	3.606614	0.0004
SLOPE	-51.66263	11.14236	-4.636598	0.0000
RAIN	-789.0537	176.2255	-4.477522	0.0000
RAIN^2	44.61818	11.85764	3.762821	0.0002
TEMP	-293.1054	93.06746	-3.149387	0.0018
TEMP^2	2.430749	0.664877	3.655939	0.0003
CART*WINTER	965.7971	178.4968	5.410724	0.0000
DISTANCE	-19.52331	4.292563	-4.548171	0.0000

R-squared	0.873062	Mean dependent var	4466.166
Adjusted R-squared	0.865925	S.D. dependent var	2853.373
S.E. of regression	1044.798	Akaike info criterion	16.79617
Sum squared resid	2.72E+08	Schwarz criterion	16.99935
Log likelihood	-2202.095	Hannan-Quinn criter.	16.87782
F-statistic	122.3280	Durbin-Watson stat	0.635058
Prob(F-statistic)	0.000000	Wald F-statistic	173.6140
Prob(Wald F-statistic)	0.000000		