The SAS System

The GLM Procedure

Dependent Variable: Satis200

BK2

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	164.3111118	82.1555559	113.79	<.0001
Error	197	142.2280882	0.7219700		
Corrected Total	199	306.5392000			

R-Square	Coeff Var	Root MSE	Satis200 Mean
0.536020	12.22221	0.849688	6.952000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Customer_type200	2	164.3111118	82.1555559	113.79	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Customer_type200	2	164.3111118	82.1555559	113.79	<.0001

One-way Anova

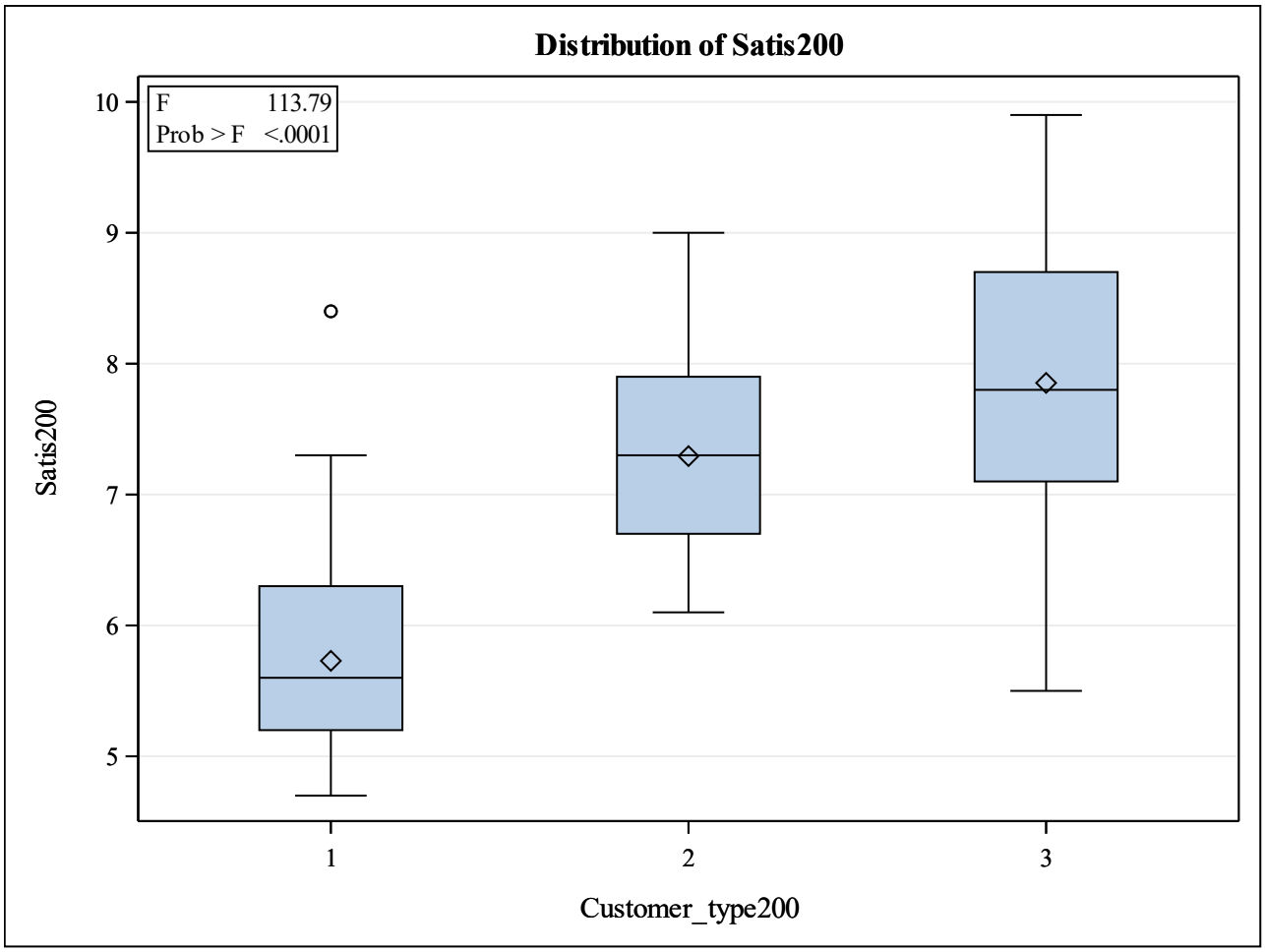
$\boldsymbol{H_0}: \mu_1 = \mu_2 = \mu_3$
$\boldsymbol{H_a}: not\ all\ means\ are\ equal$

$F_{2,197} = 113.79$;. P-value < 0.0001 Reject $\boldsymbol{H_0}$. Mean satisfaction is not the same for all levels of customer_type200. At least one mean is different.

The SAS System

The GLM Procedure

Dependent Variable: Satis200



Boxplots of Satisfaction by *customer_type200*

Customer_type200, Group 1 has an outlier above the upper whisker.

Customer_type200, group 1 has the lowest, followed by Customer_type200, group 2, and then Customer_type200, group 3 with the highest satisfaction scores.

The SAS System

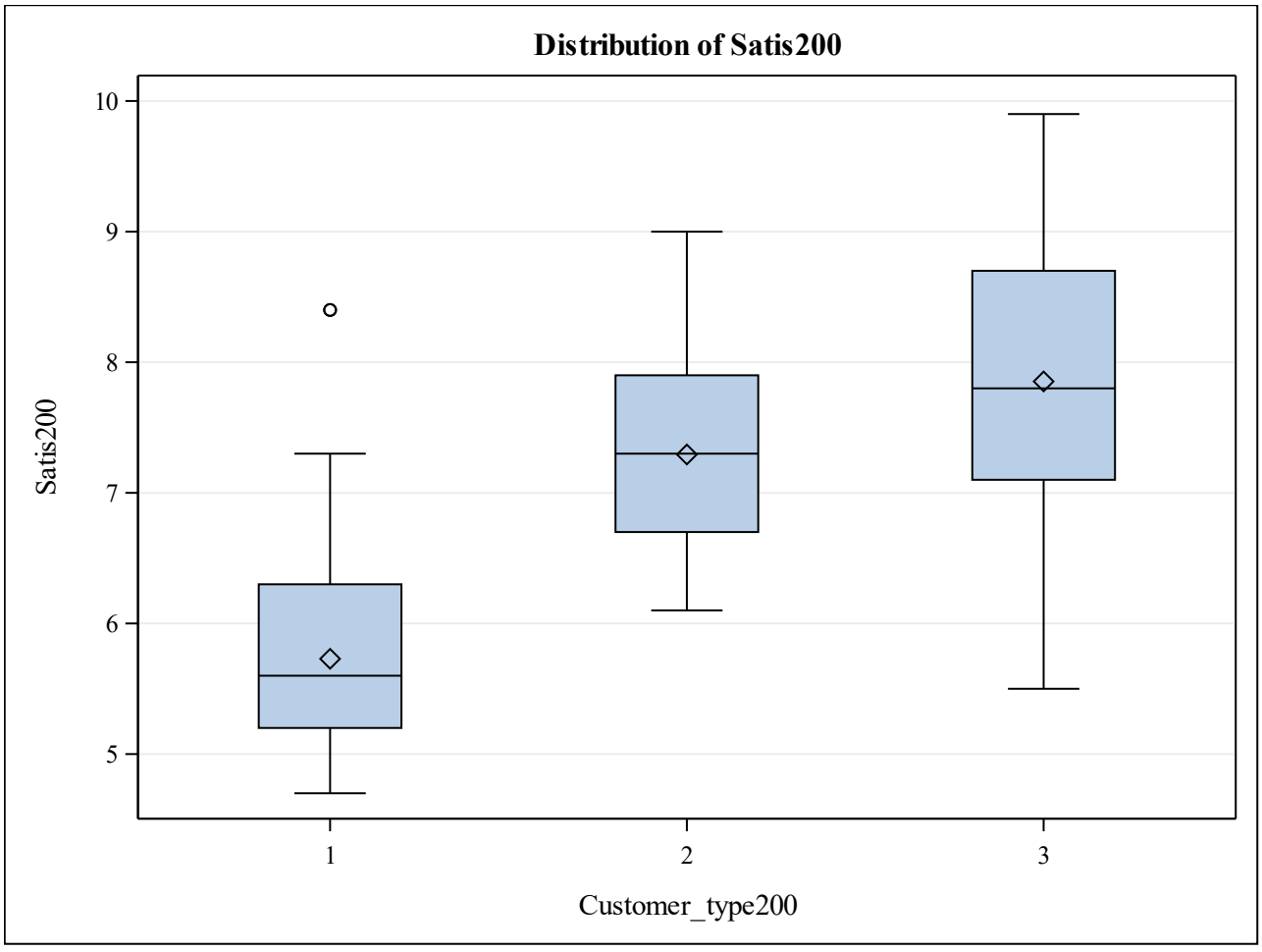
The GLM Procedure

Levene's Test for Homogeneity of Satis200 Variance ANOVA of Squared Deviations from Group Means					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Customer_type200	2	12.1883	6.0942	4.70	0.0101
Error	197	255.3	1.2962		

Levene's Test

$\boldsymbol{H_0}: \sigma_1^2 = \sigma_2^2 = \sigma_3^2$
$\boldsymbol{H_a}: not\ all\ variances\ are\ equal$

$F_{2,197} = 4.7$;. P-value = 0.0101; Reject $\boldsymbol{H_0}$. Not all variances are equal, but the sample sizes of the groups are equal so the assumption of equal variance remains robust.



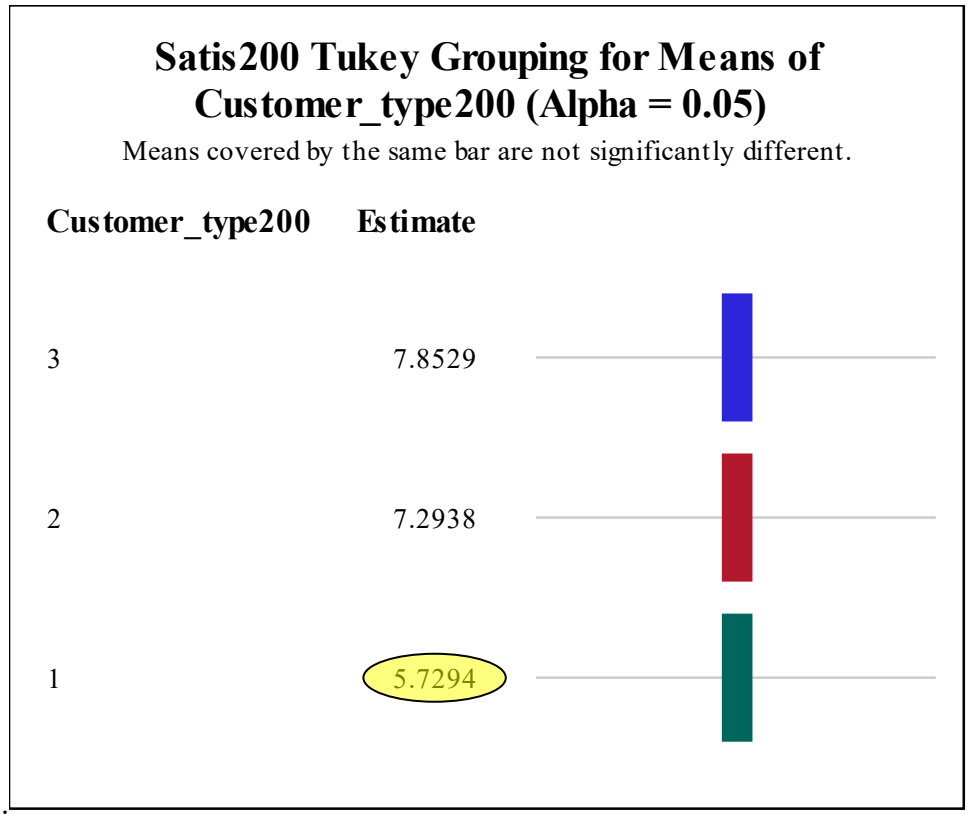
The SAS System

The GLM Procedure

Note: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than REGWQ.

Alpha	0.05
Error Degrees of Freedom	197
Error Mean Square	0.72197
Critical Value of Studentized Range	3.33976
Minimum Significant Difference	0.3477
Harmonic Mean of Cell Sizes	66.61224

Note: Cell sizes are not equal.



Tukey's Pairwise comparisons

The means for customer_type200 groups 2 and 3 are not statistically different.
Customer_type200 group 1 estimated mean is 5.7294, different (and lower) than both group 3 and group 2 means, its confidence interval does not overlap with those of the other groups.

The SAS System

The GLM Procedure

Dependent Variable: Satis200

BK3

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	210.0080241	42.0016048	84.41	<.0001
Error	194	96.5311759	0.4975834		
Corrected Total	199	306.5392000			

R-Square	Coeff Var	Root MSE	Satis200 Mean
0.685094	10.14666	0.705396	6.952000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Customer_type200	2	164.3111118	82.1555559	165.11	<.0001
Partner200	1	39.1830264	39.1830264	78.75	<.0001
Customer_*Partner200	2	6.5138859	3.2569430	6.55	0.0018

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Customer_type200	2	17.71911911	8.85955955	17.81	<.0001
Partner200	1	39.24560250	39.24560250	78.87	<.0001
Customer_*Partner200	2	6.51388592	3.25694296	6.55	0.0018

Two-way ANOVA

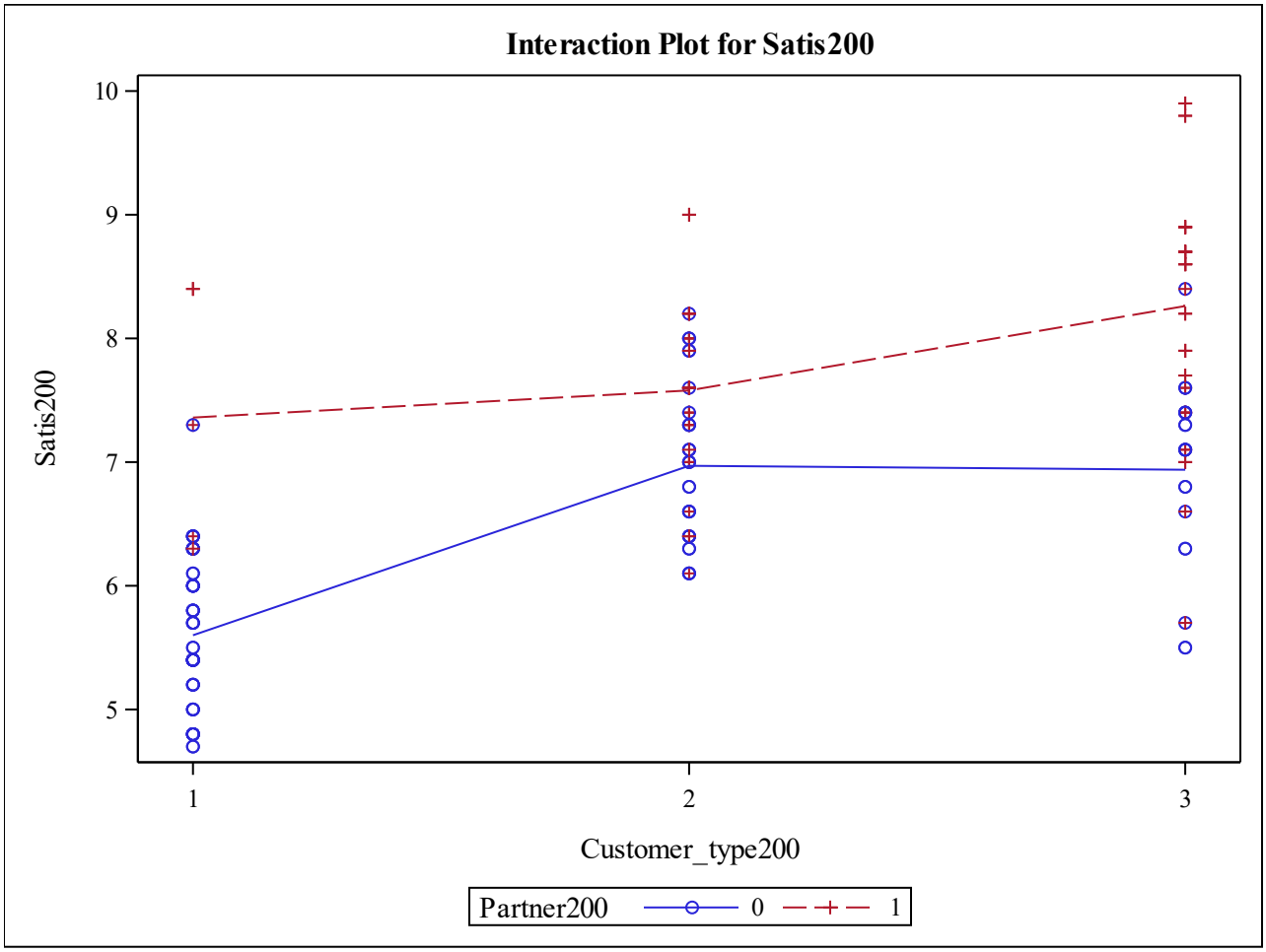
H_0: There is no interaction between customer_type200 and partner200 on average satisfaction.
H_1: There is interaction.

$F_{2,194} = 6.55$;. P-value = 0.0018; Reject **H_0**. There is interaction, skipping test for the main effects (customer_type200 and partner200). Next up, Tukey-Kramer pairwise comparisons on all pairs of cell means.

The SAS System

The GLM Procedure

Dependent Variable: Satis200



Interaction Plots:

The lines are **not** parallel, visually supporting the presence of an interaction.

The SAS System

The GLM Procedure

Dependent Variable: Satis200

Pairwise Comparisons

$H_0: \mu_i = \mu_j$ $H_a: \mu_i \neq \mu_j$

$H_0: \mu_1 = \mu_2$ $H_a: \mu_1 \neq \mu_2$

t = 3.7414;. P-value = 0.0041;

Differences:

- 1 is different from 2 – 6;
- 2 is different from 6;
- 3 is different from 4 and 6;
- 4 is different from 5 and 6
- 5 is different from 6
- 6 is different from 1 – 5;

All others are not significantly different.

Customer_type200	Partner200	Satis200 LSMEAN	LSMEAN Number
1	0	5.60000000	1
1	1	7.36000000	2
2	0	6.97000000	3
2	1	7.57941176	4
3	0	6.93809524	5
3	1	8.26170213	6

Least Squares Means for Effect Customer_*Partner200
t for H0: LSMean(i)=LSMean(j) / Pr > |t|

Dependent Variable: Satis200

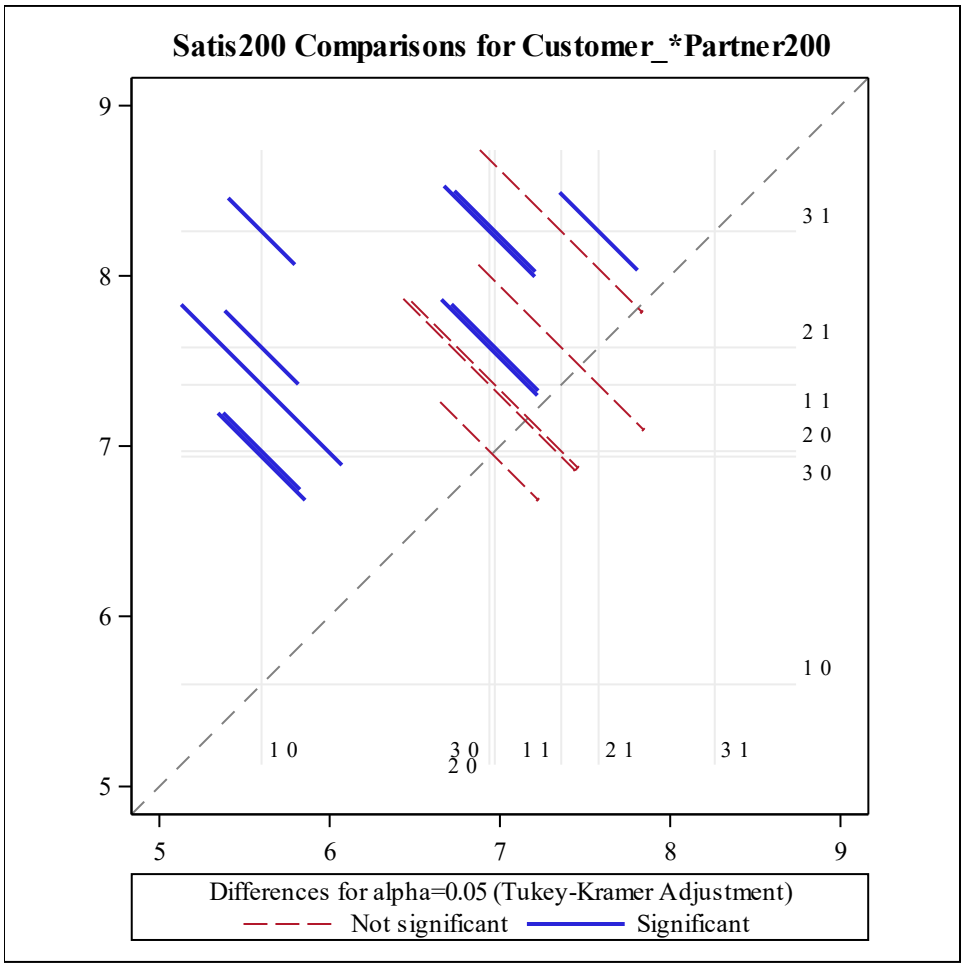
i/j	1	2	3	4	5	6
1		-5.37008 <.0001	-8.75542 <.0001	-13.1864 <.0001	-7.52826 <.0001	-19.5771 <.0001
2	5.370078 <.0001		1.144572 0.8620	-0.64941 0.9870	1.201958 0.8355	-2.71746 0.0764
3	8.755422 <.0001	-1.14457 0.8620		-3.44896 0.0089	0.158967 1.0000	-7.83599 <.0001
4	13.18643 <.0001	0.64941 0.9870	3.448959 0.0089		3.275724 0.0156	-4.29618 0.0004
5	7.528256 <.0001	-1.20196 0.8355	-0.15897 1.0000	-3.27572 0.0156		-7.14875 <.0001
6	19.57715 <.0001	2.717455 0.0764	7.835986 <.0001	4.296177 0.0004	7.148752 <.0001	

Pairwise comparisons of all combinations of the 6 cell means.

The SAS System

The GLM Procedure

Dependent Variable: Satis200



The SAS System

The GLM Procedure

Dependent Variable: Satis200

BK4

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	164.3111118	82.1555559	113.79	<.0001
Error	197	142.2280882	0.7219700		
Corrected Total	199	306.5392000			

R-Square	Coeff Var	Root MSE	Satis200 Mean
0.536020	12.22221	0.849688	6.952000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Customer_type200	2	164.3111118	82.1555559	113.79	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Customer_type200	2	164.3111118	82.1555559	113.79	<.0001

Univariate Analysis for Satis200

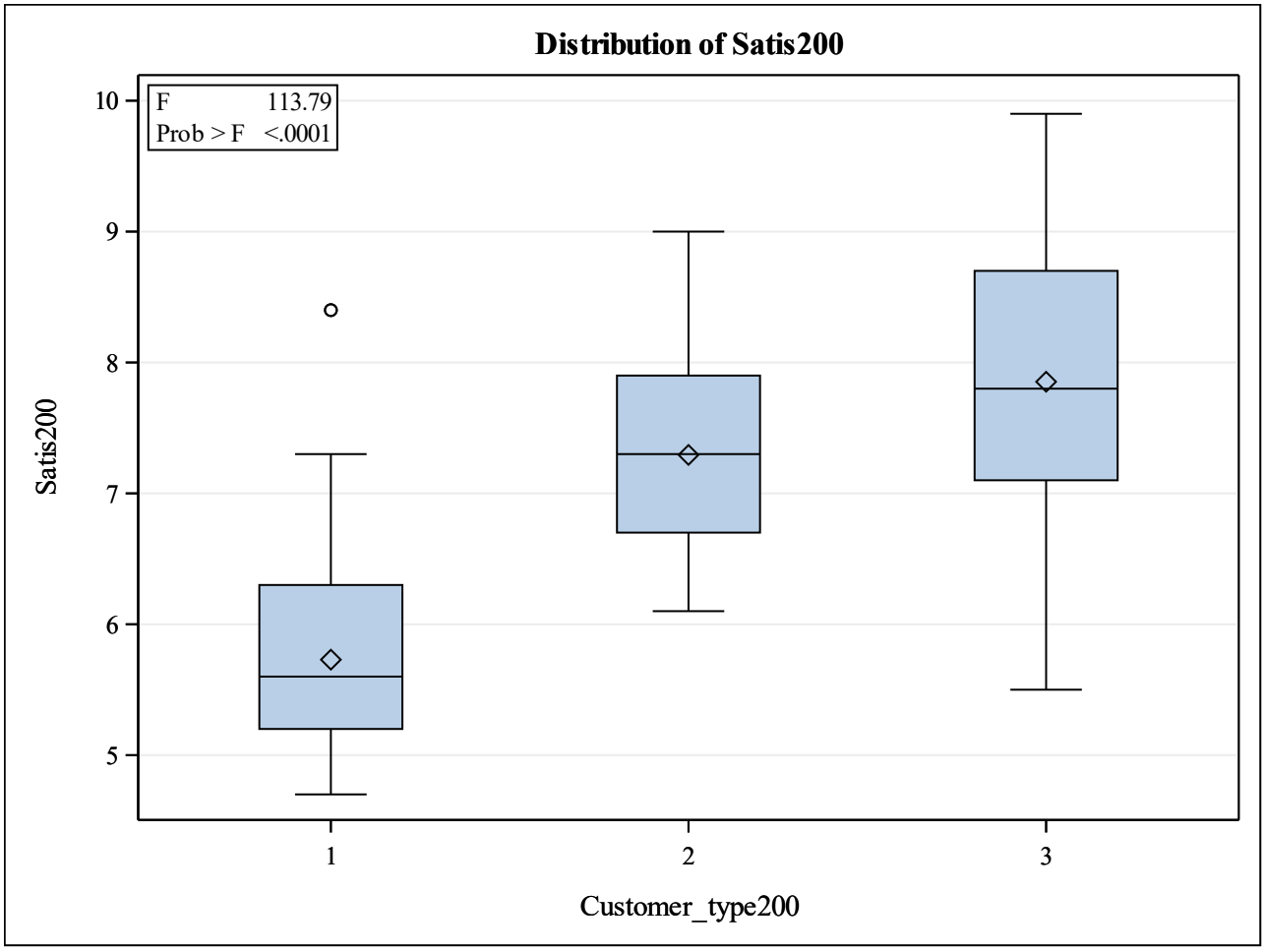
H_0: All group means for Customer_type200 are the same.
H_1: At least one group mean for Customer_type200 is different from the others.

$F_{2,197} = 113.79$;. P-value = <.0001; Reject **H_0**. At least one group mean for Customer_type200 is different from the others. Next up, Tukey-Kramer pairwise comparisons to determine which means are different by groups.

The SAS System

The GLM Procedure

Dependent Variable: Satis200



The SAS System

The GLM Procedure

Dependent Variable: Recommend200

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	71.0427574	35.5213787	43.11	<.0001
Error	197	162.3159926	0.8239390		
Corrected Total	199	233.3587500			

R-Square	Coeff Var	Root MSE	Recommend200 Mean
0.304436	13.05589	0.907711	6.952500

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Customer_type200	2	71.04275735	35.52137868	43.11	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Customer_type200	2	71.04275735	35.52137868	43.11	<.0001

Univariate Analysis for Recommend200

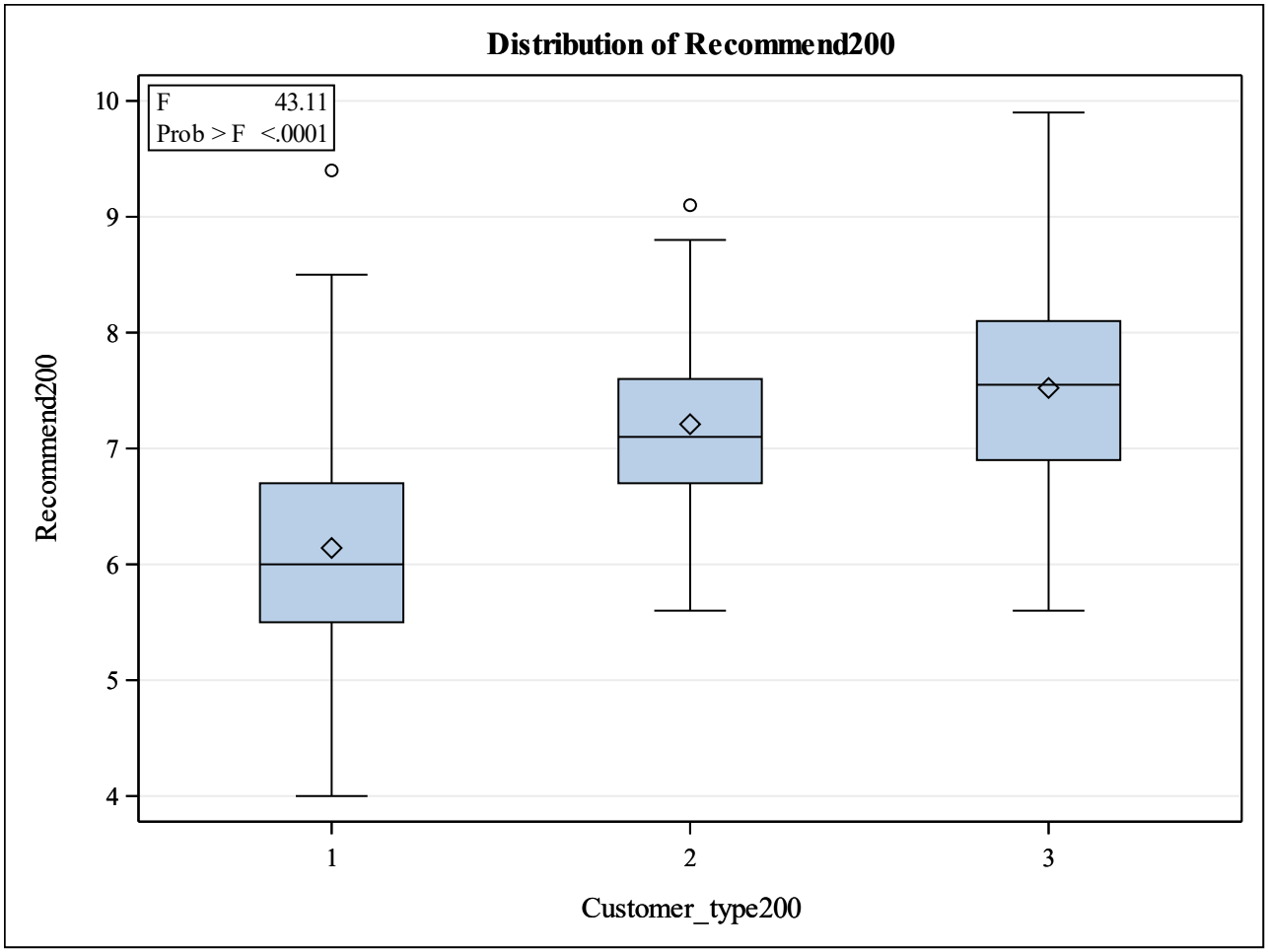
H_0: All group means for Customer_type200 are the same.
H_1: At least one group mean for Customer_type200 is different from the others.

$F_{2,197} = 43.11$;. P-value = <.0001; Reject **H_0**. At least one group mean for Customer_type200 is different from the others. Next up, Tukey-Kramer pairwise comparisons to determine which means are different by groups.

The SAS System

The GLM Procedure

Dependent Variable: Recommend200



The SAS System

The GLM Procedure

Dependent Variable: Future_Purch200

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	53.5452298	26.7726149	50.12	<.0001
Error	197	105.2297702	0.5341613		
Corrected Total	199	158.7750000			

R-Square	Coeff Var	Root MSE	Future_Purch200 Mean
0.337240	9.535073	0.730863	7.665000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Customer_type200	2	53.54522978	26.77261489	50.12	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Customer_type200	2	53.54522978	26.77261489	50.12	<.0001

Univariate Analysis for Future_Purch200

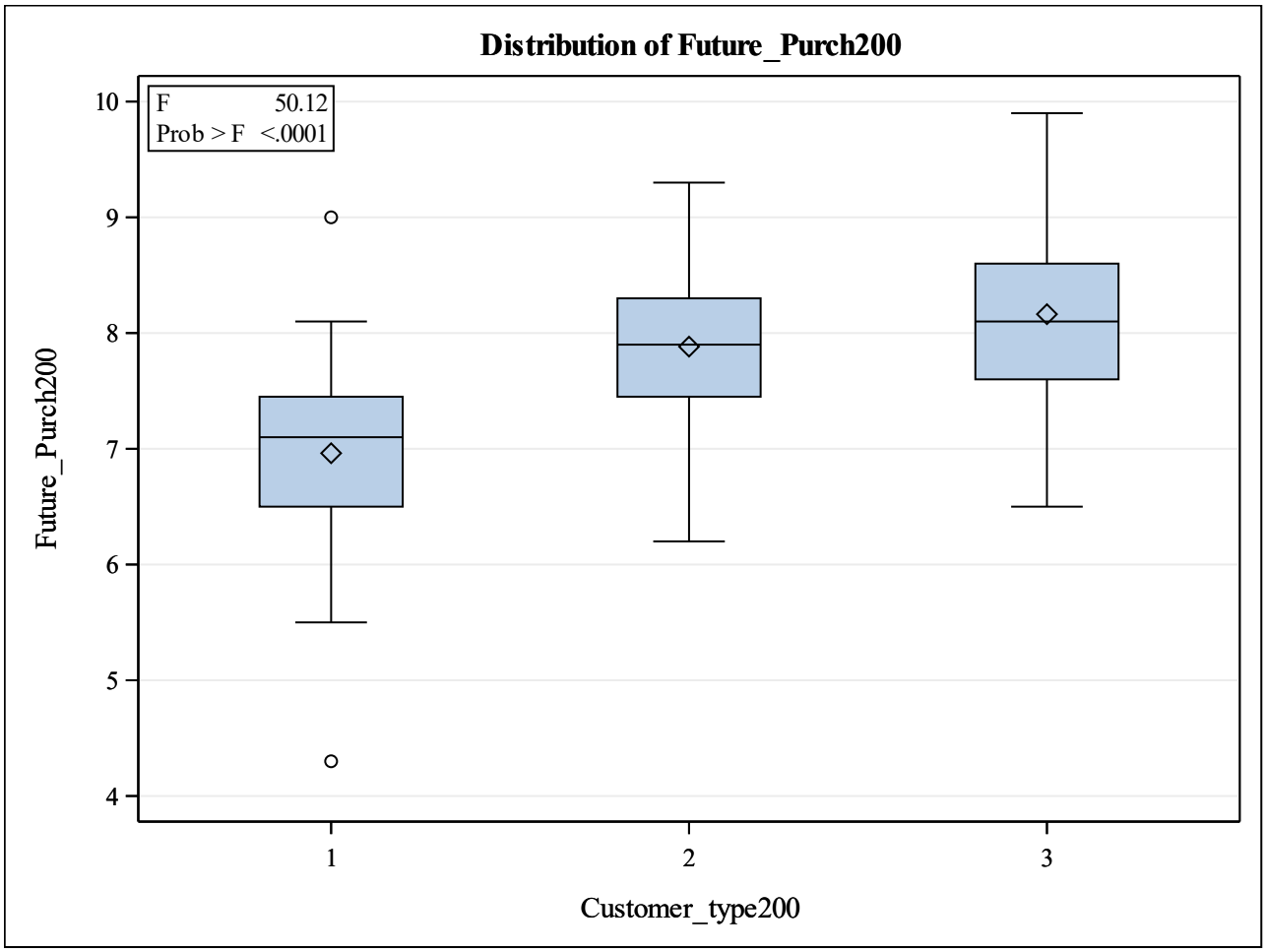
H_0: All group means for Customer_type200 are the same.
H_1: At least one group mean for Customer_type200 is different from the others.

$F_{2,197} = 50.12$;. P-value = <.0001; Reject **H_0**. At least one group mean for Customer_type200 is different from the others. Next up, Tukey-Kramer pairwise comparisons to determine which means are different by groups.

The SAS System

The GLM Procedure

Dependent Variable: Future_Purch200



The SAS System

The GLM Procedure
Multivariate Analysis of Variance

Characteristic Roots and Vectors of: E Inverse * H, where H = Type III SSCP Matrix for Customer_type200 E = Error SSCP Matrix				
Characteristic Root	Percent	Characteristic Vector V'EV=1		
		Satis200	Recommend200	Future_Purch200
1.18285003	99.88	0.07830229	-0.00578970	0.01813551
0.00143810	0.12	-0.08309143	0.07493203	0.05932686
0.00000000	0.00	-0.01092698	-0.07224349	0.10234418

MANOVA Test Criteria and F Approximations for the Hypothesis of No Overall Customer_type200 Effect
H = Type III SSCP Matrix for Customer_type200
E = Error SSCP Matrix

S=2 M=0 N=96.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.45745880	31.10	6	390	<.0001
Pillai's Trace	0.54331936	24.37	6	392	<.0001
Hotelling-Lawley Trace	1.18428813	38.39	6	258.23	<.0001
Roy's Greatest Root	1.18285003	77.28	3	196	<.0001

NOTE: F Statistic for Roy's Greatest Root is an upper bound.

NOTE: F Statistic for Wilks' Lambda is exact.

$\boldsymbol{H_0}: \begin{bmatrix}\mu_{11}\\ \mu_{12}\\ \mu_{13}\end{bmatrix} = \begin{bmatrix}\mu_{21}\\ \mu_{22}\\ \mu_{23}\end{bmatrix} = \begin{bmatrix}\mu_{31}\\ \mu_{32}\\ \mu_{33}\end{bmatrix}$; Multivariate Test;

Wilks' Lambda = 0.457, $F_{6,390}$=31.1, p-value < 0.0001. Reject $\boldsymbol{H_0}$. Not all mean vectors are the same. Next step is a univariate test to determine which dependent variables, *satis200*, *recommend200*, *future_purch200*, differ by *customer_type200*.

The SAS System

The GLM Procedure

Levene's Test for Homogeneity of Satis200 Variance ANOVA of Squared Deviations from Group Means					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Customer_type200	2	12.1883	6.0942	4.70	0.0101
Error	197	255.3	1.2962		

Levene's Test for Homogeneity of Recommend200 Variance ANOVA of Squared Deviations from Group Means					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Customer_type200	2	9.0417	4.5209	2.75	0.0667
Error	197	324.4	1.6469		

Levene's Test for Homogeneity of Future_Purch200 Variance ANOVA of Squared Deviations from Group Means					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Customer_type200	2	1.3593	0.6797	1.01	0.3657
Error	197	132.4	0.6723		

Levene's Test

H_0: $\sigma_1^2 = \sigma_2^2 = \sigma_3^2$
H_1: Variances are not equal.

Satis200
$F_{2,197} = 4.7$; P-Value = 0.0101. Reject H_0. The result suggests that different customer types have different mean Satis200 scores.

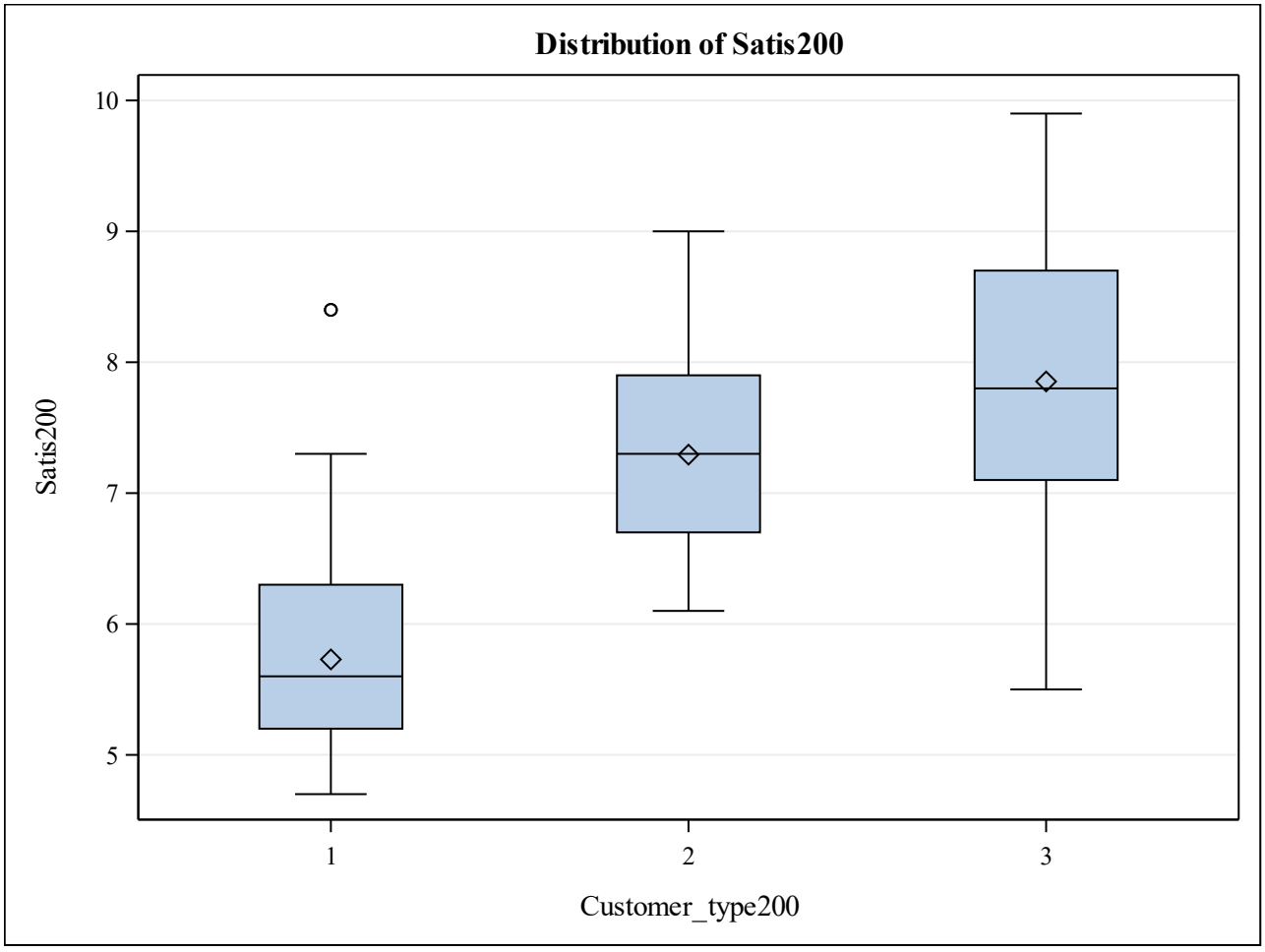
Recommend200
$F_{2,197} = 2.75$; P-Value = 0.0667. Fail to reject. Variances are equal.

Future_Purch200
$F_{2,197} = 1.01$; P-Value = 0.3657. Fail to reject. Variances are equal.

Assumption of homogeneity of variances is equal for both Recommend200 and Future_Purch200, and the sample sizes of the groups are equal, so the assumption of equal variance remains robust.

The SAS System

The GLM Procedure



The SAS System

The GLM Procedure

Note: This test controls the Type I experimentwise error rate.

Satis200

Alpha	0.05
Error Degrees of Freedom	197
Error Mean Square	0.72197
Critical Value of Studentized Range	3.33976

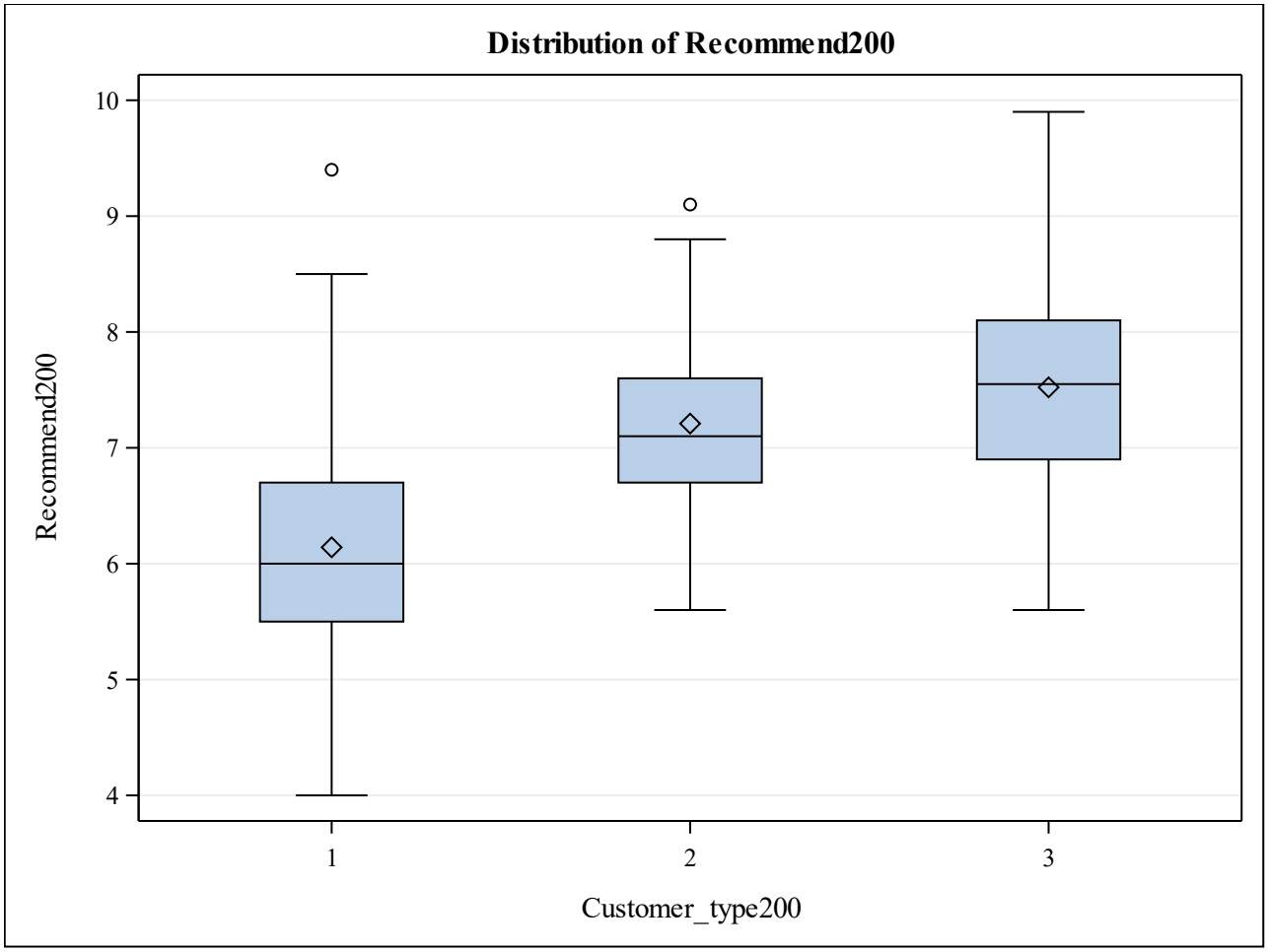
Comparisons significant at the 0.05 level are indicated by *.**				
Customer_type200 Comparison	**Difference Between Means**	**Simultaneous 95% Confidence Limits**		
3 - 2	0.5592	0.2097	0.9087	***
3 - 1	2.1235	1.7794	2.4677	***
2 - 3	-0.5592	-0.9087	-0.2097	***
2 - 1	1.5643	1.2149	1.9138	***
1 - 3	-2.1235	-2.4677	-1.7794	***
1 - 2	-1.5643	-1.9138	-1.2149	***

Satis200

All means are different.

The SAS System

The GLM Procedure



The SAS System

The GLM Procedure

Note: This test controls the Type I experimentwise error rate.

Recommend200

Alpha	0.05
Error Degrees of Freedom	197
Error Mean Square	0.823939
Critical Value of Studentized Range	3.33976

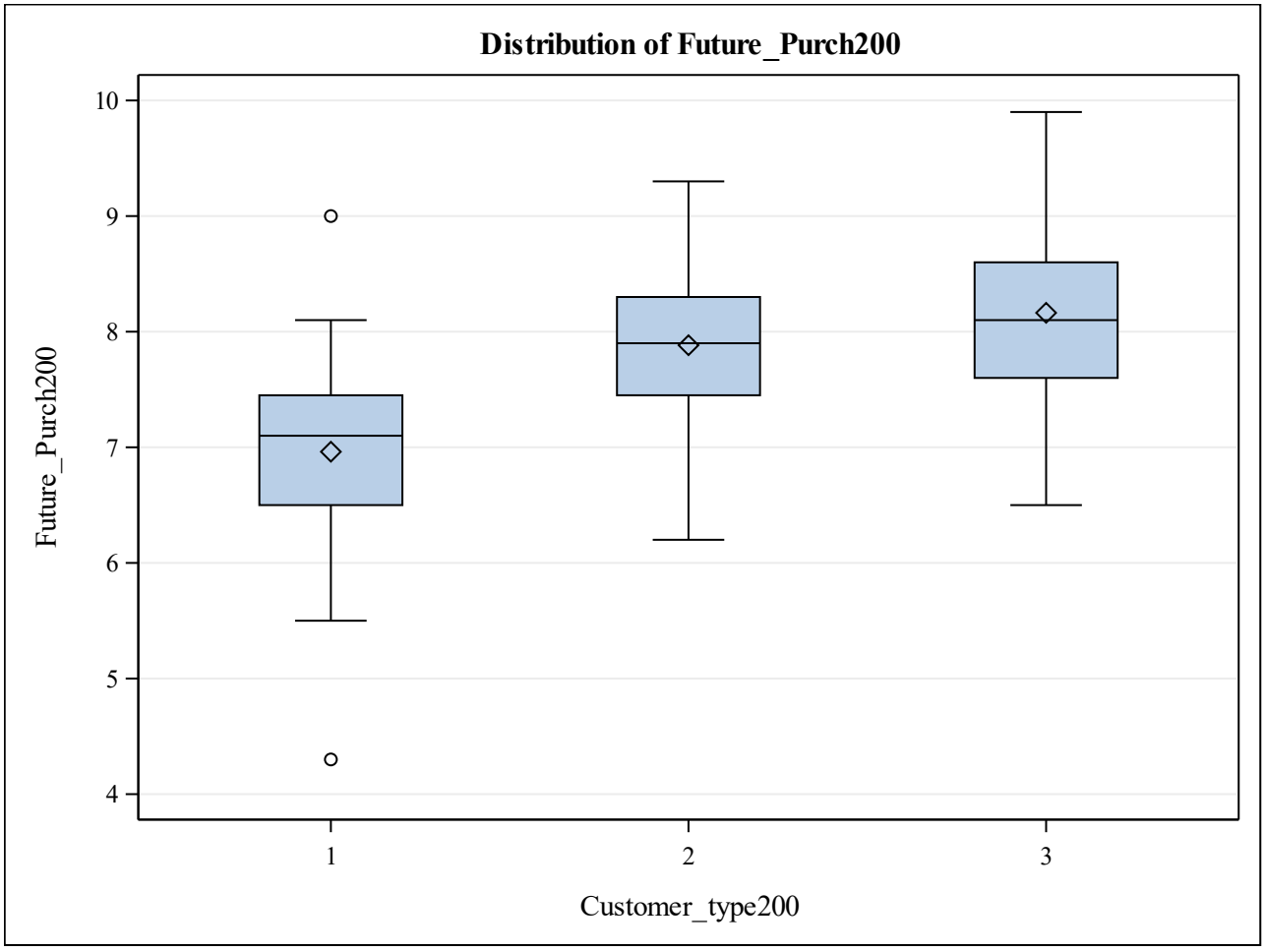
Comparisons significant at the 0.05 level are indicated by *.**				
Customer_type200 Comparison	**Difference Between Means**	**Simultaneous 95% Confidence Limits**		
3 - 2	0.3127	-0.0606	0.6860	
3 - 1	1.3809	1.0133	1.7485	***
2 - 3	-0.3127	-0.6860	0.0606	
2 - 1	1.0682	0.6949	1.4415	***
1 - 3	-1.3809	-1.7485	-1.0133	***
1 - 2	-1.0682	-1.4415	-0.6949	***

Recommend200

All means are different except: 3 and 2.

The SAS System

The GLM Procedure



The SAS System

The GLM Procedure

Note: This test controls the Type I experimentwise error rate.

Future_Purch200

Alpha	0.05
Error Degrees of Freedom	197
Error Mean Square	0.534161
Critical Value of Studentized Range	3.33976

Comparisons significant at the 0.05 level are indicated by *.**				
Customer_type200 Comparison	**Difference Between Means**	**Simultaneous 95% Confidence Limits**		
3 - 2	0.2804	-0.0202	0.5810	
3 - 1	1.2015	0.9055	1.4975	***
2 - 3	-0.2804	-0.5810	0.0202	
2 - 1	0.9210	0.6205	1.2216	***
1 - 3	-1.2015	-1.4975	-0.9055	***
1 - 2	-0.9210	-1.2216	-0.6205	***

Future_purch200

All means are different except: 3 and 2.

The SAS System

The GLM Procedure

Dependent Variable: Satis200

BK5

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	210.0080241	42.0016048	84.41	<.0001
Error	194	96.5311759	0.4975834		
Corrected Total	199	306.5392000			

R-Square	Coeff Var	Root MSE	Satis200 Mean
0.685094	10.14666	0.705396	6.952000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Customer_type200	2	164.3111118	82.1555559	165.11	<.0001
Partner200	1	39.1830264	39.1830264	78.75	<.0001
Customer_*Partner200	2	6.5138859	3.2569430	6.55	0.0018

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Customer_type200	2	17.71911911	8.85955955	17.81	<.0001
Partner200	1	39.24560250	39.24560250	78.87	<.0001
Customer_*Partner200	2	6.51388592	3.25694296	6.55	0.0018

Univariate Analysis for Satis200

H_0: All group means for Customer_type200 are the same.
H_1: At least one group mean for Customer_type200 is different from the others.

$F_{2,194} = 17.81$;. P-value = <.0001; Reject **H_0**. At least one group mean for Customer_type200 is different from the others. Next up, Tukey-Kramer pairwise comparisons to determine which means are different by groups.

H_0: All group means for Partner200 are the same.
H_1: At least one group mean for Partner200 is different from the others.

$F_{2,194} = 78.87$;. P-value = <.0001; Reject **H_0**. At least one group mean for Partner200 is different from the others. Next up, Tukey-Kramer pairwise comparisons to determine which means are different by groups.

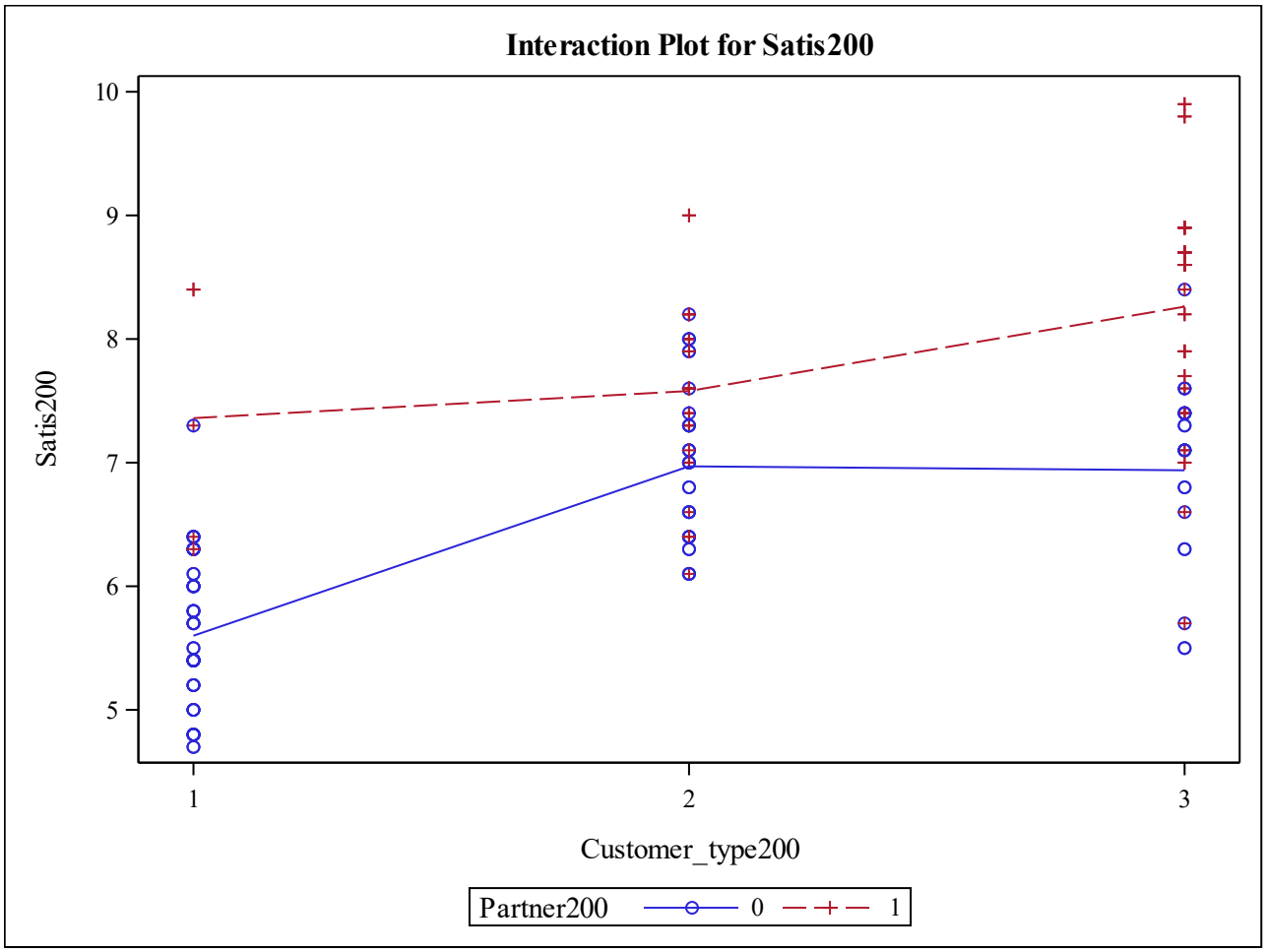
Test For Interaction
H_0: There is no interaction between customer_type200 and partner200 on average satisfaction.
H_1: There is interaction.

$F_{2,194} = 6.55$;. P-value = 0.0018; Reject **H_0**. There is interaction.

The SAS System

The GLM Procedure

Dependent Variable: Satis200



Interaction Plot Satis200

The lines are **not** parallel, visually supporting the presence of an interaction.

The SAS System

The GLM Procedure

Dependent Variable: Recommend200

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	132.0212367	26.4042473	50.55	<.0001
Error	194	101.3375133	0.5223583		
Corrected Total	199	233.3587500			

R-Square	Coeff Var	Root MSE	Recommend200 Mean
0.565744	10.39545	0.722744	6.952500

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Customer_type200	2	71.04275735	35.52137868	68.00	<.0001
Partner200	1	48.94340620	48.94340620	93.70	<.0001
Customer_*Partner200	2	12.03507313	6.01753657	11.52	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Customer_type200	2	0.23833108	0.11916554	0.23	0.7962
Partner200	1	58.03451239	58.03451239	111.10	<.0001
Customer_*Partner200	2	12.03507313	6.01753657	11.52	<.0001

Univariate Analysis for Recommend200

H_0: All group means for Customer_type200 are the same.
H_1: At least one group mean for Customer_type200 is different from the others.

$F_{2,194} = 0.23$;. P-value = 0.7962; Fail to reject. All group means for Customer_type200 are the same.

H_0: All group means for Partner200 are the same.
H_1: At least one group mean for Partner200 is different from the others.

$F_{2,194} = 111.1$;. P-value = <.0001; Reject **H_0**. At least one group mean for Partner200 is different from the others. Next up, Tukey-Kramer pairwise comparisons to determine which means are different by groups.

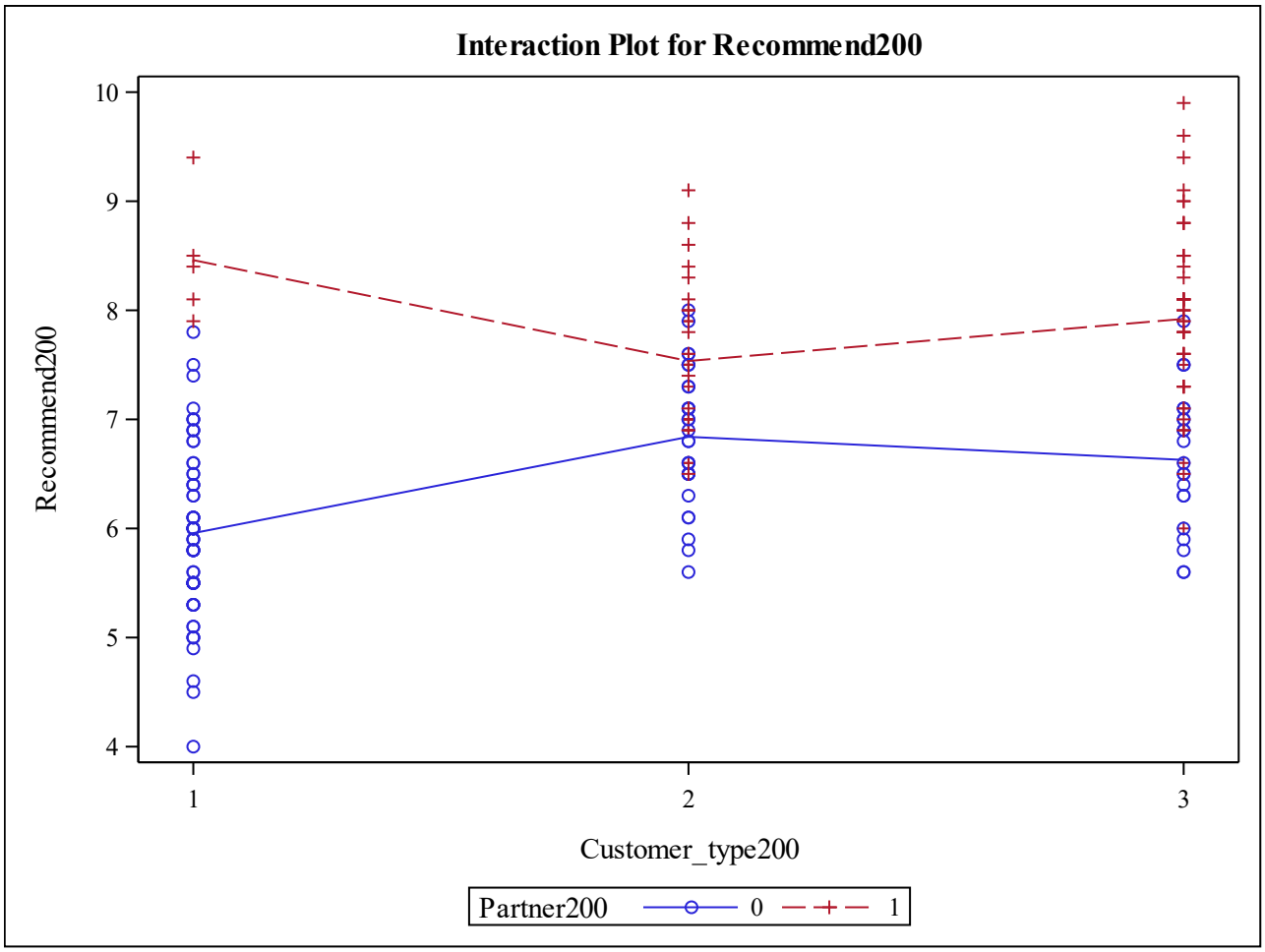
Test For Interaction
H_0: There is no interaction between customer_type200 and partner200 on average satisfaction.
H_1: There is interaction.

$F_{2,194} = 11.52$;. P-value = <.0001; Reject **H_0**. There is interaction.

The SAS System

The GLM Procedure

Dependent Variable: Recommend200



Interaction Plot Recommend200

The lines are **not** parallel, visually supporting the presence of an interaction.

The SAS System

The GLM Procedure

Dependent Variable: Future_Purch200

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	71.5194462	14.3038892	31.80	<.0001
Error	194	87.2555538	0.4497709		
Corrected Total	199	158.7750000			

R-Square	Coeff Var	Root MSE	Future_Purch200 Mean
0.450445	8.749506	0.670650	7.665000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Customer_type200	2	53.54522978	26.77261489	59.53	<.0001
Partner200	1	16.97414684	16.97414684	37.74	<.0001
Customer_*Partner200	2	1.00006955	0.50003478	1.11	0.3311

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Customer_type200	2	5.20396871	2.60198436	5.79	0.0036
Partner200	1	15.84784247	15.84784247	35.24	<.0001
Customer_*Partner200	2	1.00006955	0.50003478	1.11	0.3311

Univariate Analysis for Future_Purch200

H_0: All group means for Customer_type200 are the same.
H_1: At least one group mean for Customer_type200 is different from the others.

$F_{2,194} = 5.79$;. P-value = 0.0036; Reject **H_0**. At least one group mean for Customer_type200 is different from the others. Next up, Tukey-Kramer pairwise comparisons to determine which means are different by groups.

H_0: All group means for Partner200 are the same.
H_1: At least one group mean for Partner200 is different from the others.

$F_{2,194} = 35.24$ P-value = <.0001; Reject **H_0**. At least one group mean for Partner200 is different from the others. Next up, Tukey-Kramer pairwise comparisons to determine which means are different by groups.

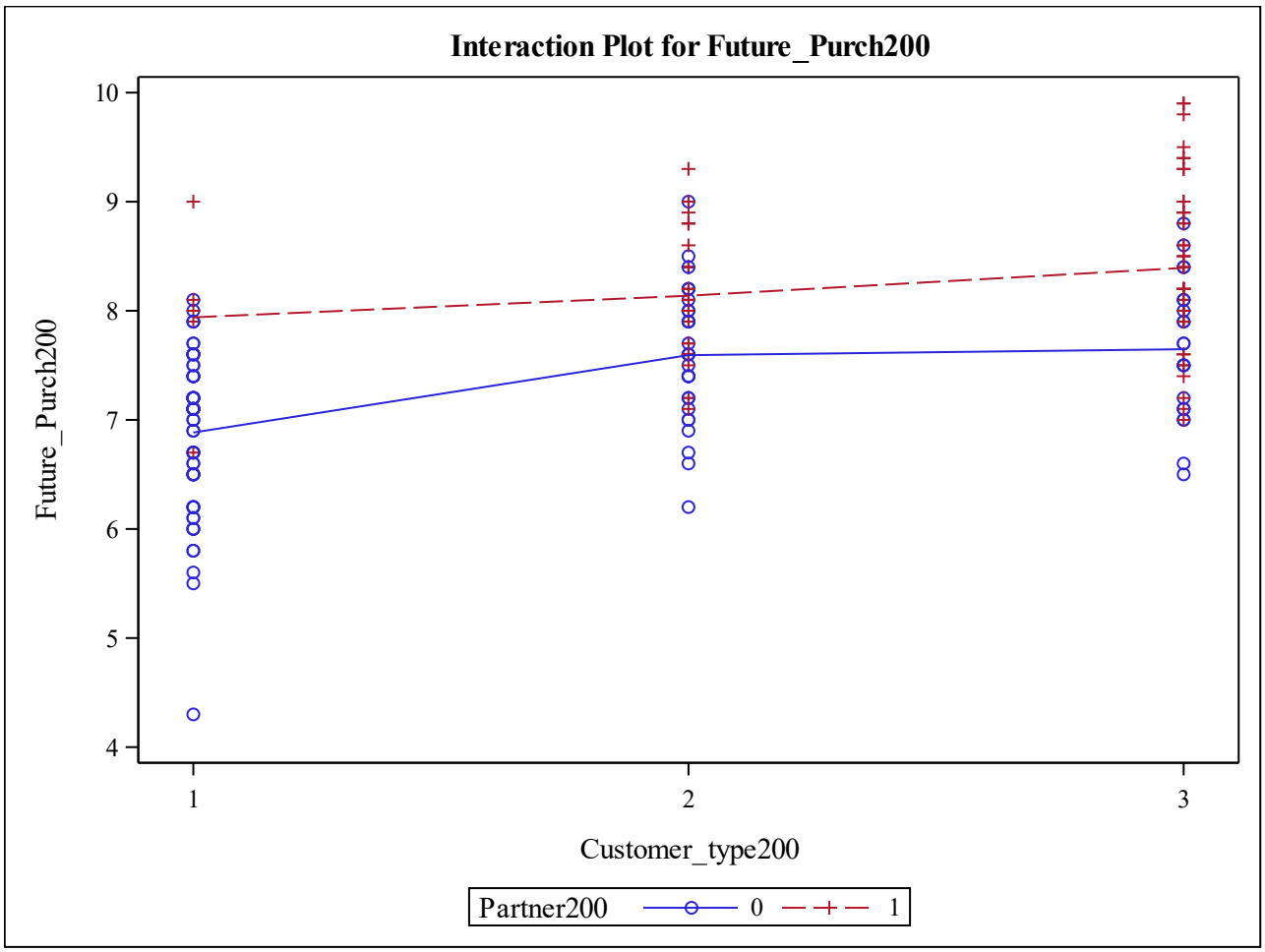
Test For Interaction
H_0: There is no interaction between customer_type200 and partner200 on average satisfaction.
H_1: There is interaction.

$F_{2,194} = 1.11$;. P-value = 0.3311; Fail to reject. There is no interaction.

The SAS System

The GLM Procedure

Dependent Variable: Future_Purch200



Interaction Plot Future_Purch200

The lines are **not** parallel, visually supporting the presence of an interaction.

The SAS System

The GLM Procedure
Multivariate Analysis of Variance

MANOVA Test Criteria and F Approximations for the Hypothesis of No Overall Customer_type200 Effect
H = Type III SSCP Matrix for Customer_type200
E = Error SSCP Matrix

S=2 M=0 N=95

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.81186488	7.03	6	384	<.0001
Pillai's Trace	0.18852031	6.70	6	386	<.0001
Hotelling-Lawley Trace	0.23125762	7.38	6	254.23	<.0001
Roy's Greatest Root	0.22918751	14.74	3	193	<.0001

NOTE: F Statistic for Roy's Greatest Root is an upper bound.

NOTE: F Statistic for Wilks' Lambda is exact.

MANOVA Test Criteria and Exact F Statistics for the Hypothesis of No Overall Partner200 Effect
H = Type III SSCP Matrix for Partner200
E = Error SSCP Matrix

S=1 M=0.5 N=95

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.59119706	44.25	3	192	<.0001
Pillai's Trace	0.40880294	44.25	3	192	<.0001
Hotelling-Lawley Trace	0.69148339	44.25	3	192	<.0001
Roy's Greatest Root	0.69148339	44.25	3	192	<.0001

MANOVA – Test for difference in mean vectors

$\boldsymbol{H_0}: \begin{bmatrix}\mu_{11}\\ \mu_{12}\\ \mu_{13}\end{bmatrix} = \begin{bmatrix}\mu_{21}\\ \mu_{22}\\ \mu_{23}\end{bmatrix} = \begin{bmatrix}\mu_{31}\\ \mu_{32}\\ \mu_{33}\end{bmatrix}$; for Customer_type200; $\boldsymbol{H_0}: \begin{bmatrix}\mu_{11}\\ \mu_{12}\\ \mu_{13}\end{bmatrix} = \begin{bmatrix}\mu_{21}\\ \mu_{22}\\ \mu_{23}\end{bmatrix}$; for Partner200

$\boldsymbol{H_1}$: Not all mean vectors are the same.

For Customer_type200: Wilks' Lambda = 0.8119, $F_{6,184}$=14.72, p-value = < .0001. Reject $\boldsymbol{H_0}$. Not all mean vectors are the same.

For Partner200: Wilks' Lambda = 0.5912, $F_{3,92}$=16.52, p-value <0.0001. Reject $\boldsymbol{H_0}$. Not all mean vectors are the same.

The SAS System

The GLM Procedure
Multivariate Analysis of Variance

MANOVA Test Criteria and F Approximations for the Hypothesis of No Overall Customer_*Partner200 Effect
H = Type III SSCP Matrix for Customer_*Partner200
E = Error SSCP Matrix

S=2 M=0 N=95

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.87348550	4.48	6	384	0.0002
Pillai's Trace	0.12781840	4.39	6	386	0.0003
Hotelling-Lawley Trace	0.14334595	4.58	6	254.23	0.0002
Roy's Greatest Root	0.13204071	8.49	3	193	<.0001

NOTE: F Statistic for Roy's Greatest Root is an upper bound.

NOTE: F Statistic for Wilks' Lambda is exact.

MANOVA – Test for Interaction

$\boldsymbol{H_0}$: There is no interaction.
$\boldsymbol{H_1}$: There is interaction.

Wilks' Lambda = 0.8735, $F_{6,33_{84}}$=4.48, p-value = 0.0002. Reject $\boldsymbol{H_0}$. There is interaction. Next up, univariate analysis for each dependent variable to understand the specific nature of the interaction, and to identify which dependent variable(s) contribute most.

The SAS System

The GLM Procedure

Tukey's Studentized Range (HSD) Test for Satis200

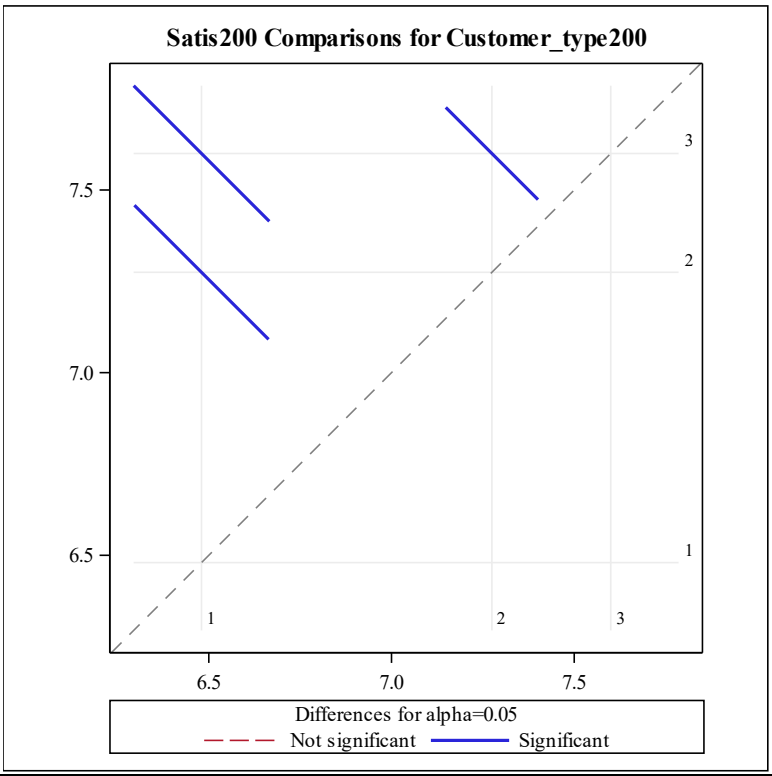
Customer_type200	Satis200 LSMEAN	LSMEAN Number
1	6.48000000	1
2	7.27470588	2
3	7.59989868	3

Least Squares Means for Effect Customer_type200
t for H0: LSMean(i)=LSMean(j) / Pr > |t|

Dependent Variable: Satis200

i/j	1	2	3
1		-4.26873 <.0001	-5.95017 <.0001
2	4.268731 <.0001		-2.54122 0.0118
3	5.950174 <.0001	2.541223 0.0118	

Pairwise comparisons for dependent variable, *satis200*, and *customer_type200*. All three means are significantly different. Group 3 mean is the highest, then group 2, finally group 1 mean.



Plot of significant differences for dependent variable, *satis200*, and *customer_type200*.

The SAS System

The GLM Procedure

Tukey's Studentized Range (HSD) Test for Satis200

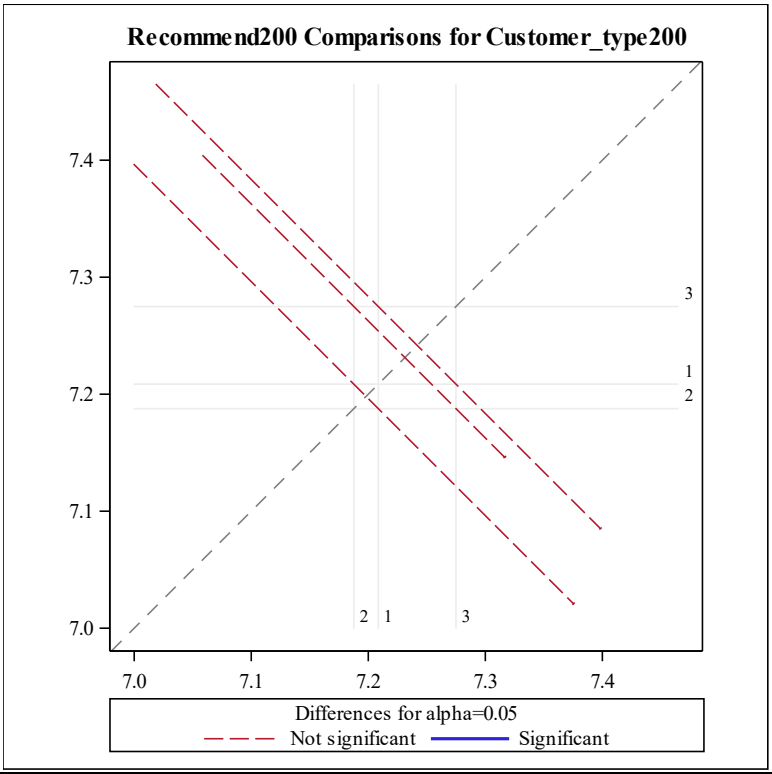
Customer_type200	Recommend200 LSMEAN	LSMEAN Number
1	7.20857143	1
2	7.18764706	2
3	7.27492401	3

Least Squares Means for Effect Customer_type200
t for H0: LSMean(i)=LSMean(j) / Pr > |t|

Dependent Variable: Recommend200

i/j	1	2	3
1		0.109697 0.9128	-0.34408 0.7312
2	-0.1097 0.9128		-0.66566 0.5064
3	0.344078 0.7312	0.665656 0.5064	

Pairwise comparisons for dependent variable, *recommend200*, and *customer_type200*. All three means are significantly different. Group 3 mean is the highest, then group 2, finally group 1 mean.



Plot of significant differences for dependent variable, *Recommend200*, and *customer_type200*.

The SAS System

The GLM Procedure

Tukey's Studentized Range (HSD) Test for Satis200

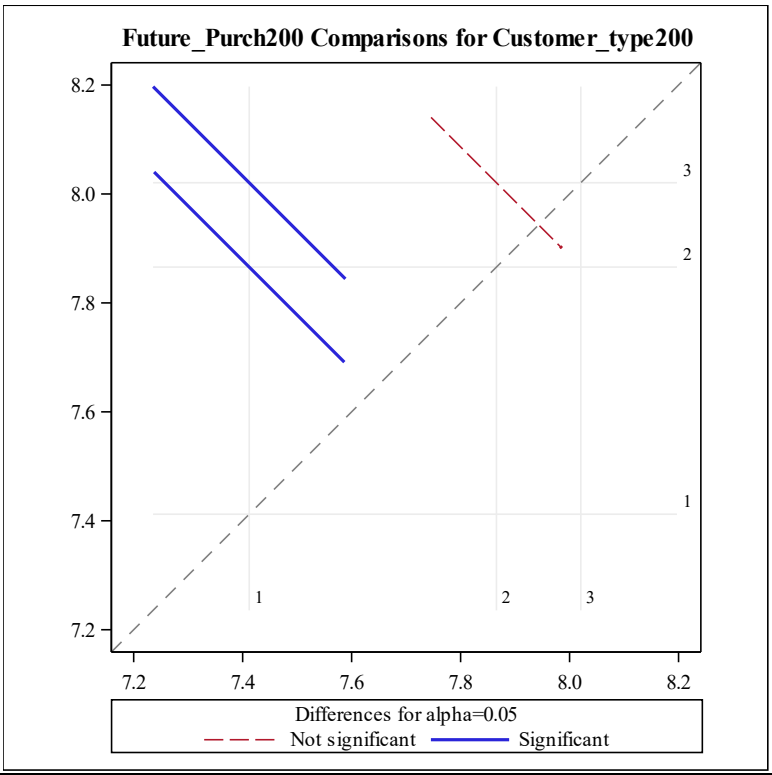
Customer_type200	Future_Purch200 LSMEAN	LSMEAN Number
1	7.41206349	1
2	7.86578431	2
3	8.02061803	3

Least Squares Means for Effect Customer_type200
t for H0: LSMean(i)=LSMean(j) / Pr > |t|

Dependent Variable: Future_Purch200

i/j	1	2	3
1		-2.56341 0.0111	-3.40085 0.0008
2	2.563412 0.0111		-1.27264 0.2047
3	3.400852 0.0008	1.272637 0.2047	

Pairwise comparisons for dependent variable, *recommend200*, and *customer_type200*. Group 1 mean is significantly different from group 2 mean and from group 3 mean. Group 3 is highest mean and not different from group 2 mean.



Plot of significant differences for dependent variable, *Future_Purch200*, and *customer_type200*.

The SAS System

The GLM Procedure

Tukey's Studentized Range (HSD) Test for Satis200

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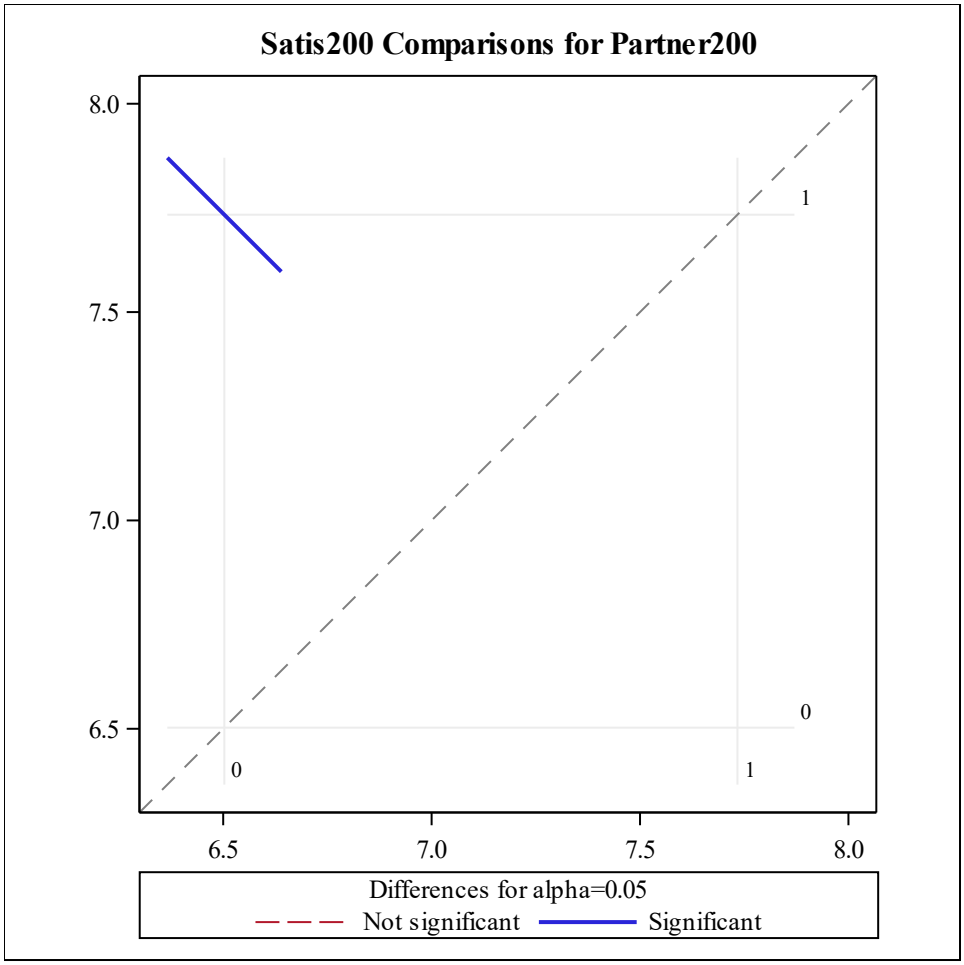
Note: To ensure overall protection level, only probabilities associated with pre-planned comparisons should be used.

Partner200	Satis200 LSMEAN	H0:LSMean1=LSMean2 t Value	Pr > |t|
0	6.50269841	-8.88	<.0001
1	7.73370463		

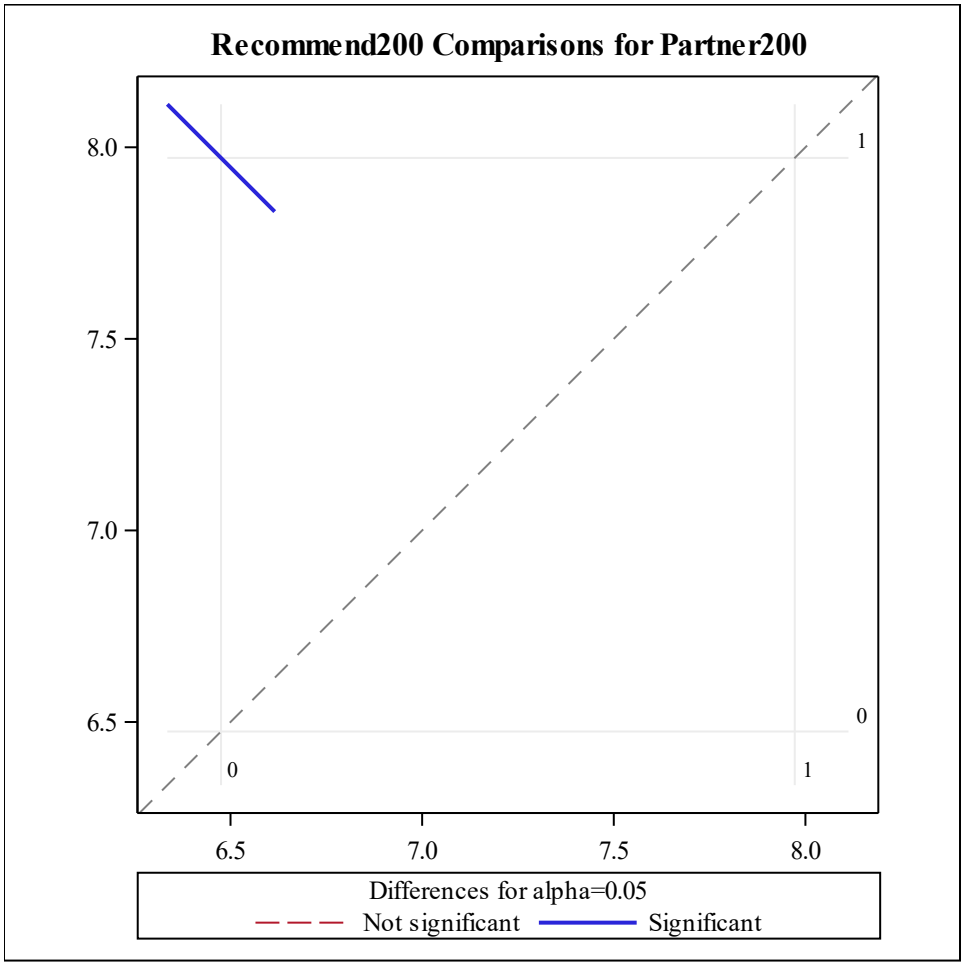


The SAS System

The GLM Procedure

Tukey's Studentized Range (HSD) Test for Satis200

Partner200	Recommend200 LSMEAN	H0:LSMean1=LSMean2 t Value	Pr > |t|
0	6.47523810	-10.54	<.0001
1	7.97219024		

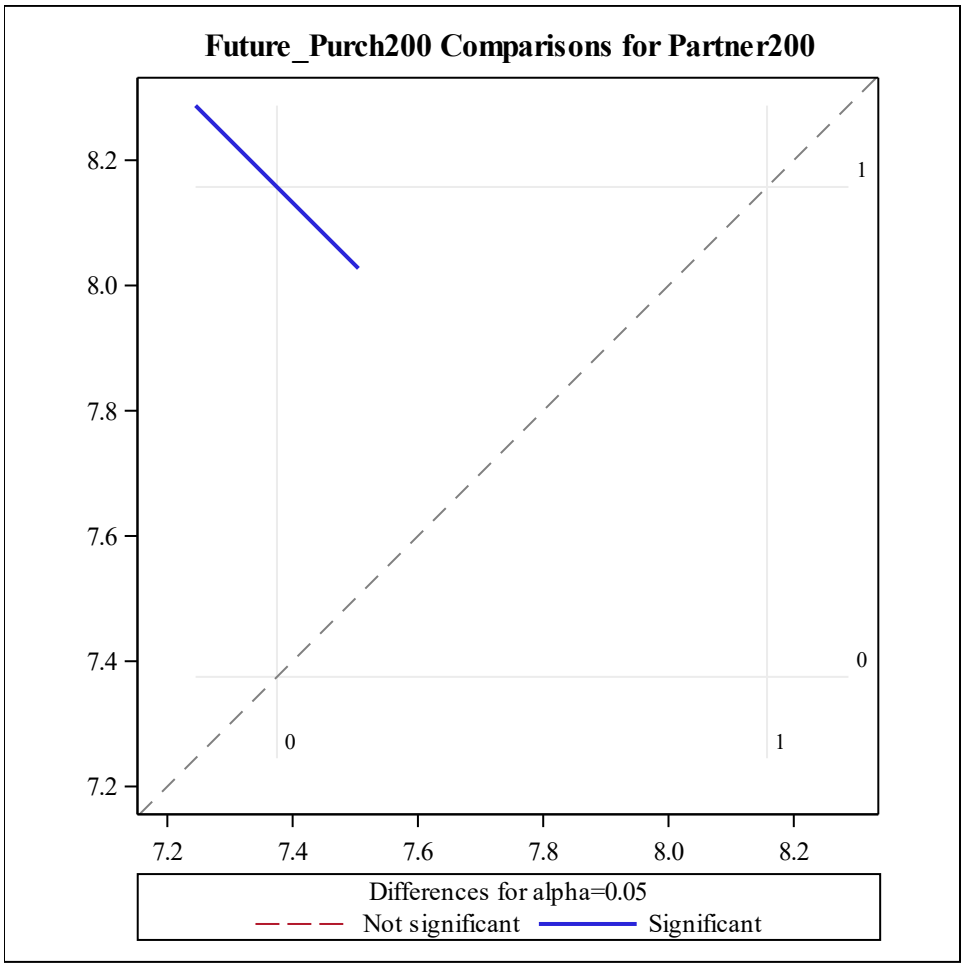


The SAS System

The GLM Procedure

Tukey's Studentized Range (HSD) Test for Satis200

Partner200	Future_Purch200 LSMEAN	H0:LSMean1=LSMean2 t Value	Pr > |t|
0	7.37502646	-5.94	<.0001
1	8.15728411		



The SAS System

The GLM Procedure

Tukey's Studentized Range (HSD) Test for Satis200

Final MANOVA Summary

Research Objective and Analysis Plan: Using a sample size of 200, and a goal of determining if there are significant differences in customer satisfaction, the likelihood of recommending HBAT to other firms as a supplier of paper products, and likelihood of future purchases based on the extent to which the customer perceives his or her firm would engage in strategic partnership with HBAT. A MANOVA will be used to assess if the length of the customer relationship ranging from less than a year, between one and two years, or longer than five years affects satisfaction, recommendation, or future purchases. There will be an examination to check for interaction effects between the variables Partner200 and Customer_type200 on the dependent variables. Assumptions of normality and homogeneity will also be checked.

Dependent Variables:
Satis200: Customer satisfaction with past purchases from HBAT. (10-point scale)
Recommend200: Likelihood of recommending HBAT to other firms as a supplier of paper products. (10-point scale)
Future_Purch200: Likelihood of purchasing paper products from HBAT in the future. (10-point scale)

Non-Metric Independent Variables:
Customer_type200: Length of time a particular customer has been buying from HBAT.
(1= less than 1 year; 2=between 1 and 2 years; 3=longer than 5 years)
Partner200: Extent to which the customer/respondent perceives his or her firm would engage in strategic partnership with HBAT.
(0=Would not consider; 1= Yes, would consider strategic partnership)

Comparisons for Partner200

Satis200

Partner200	Satis200 LSMEAN	H0 t Value	H0 Pr > |t|
0	6.50269841	-8.88	<.0001
1	7.73370463		

Recommend200

Partner200	Recommend200 LSMEAN	H0 t Value	H0 Pr > |t|
0	6.47523810	-10.54	<.0001
1	7.97219024		

Future_Purch200

Partner200	Future_Purch200 LSMEAN	H0 t Value	H0 Pr > |t|
0	7.37502646	-5.94	<.0001
1	8.15728411		

Interaction: Testing showed that interaction was found to be significant for variables Satis200 and Recommend200, but no interaction for Future_Purch200. According to the interaction plots, there is evidence of interactions, including non-parallel lines, and differences in slopes suggest that the effect of one factor depends on the level of another factor.

Normality: The box plots for all dependent variables showed that the residuals are approximately symmetric with few outliers, suggesting that the data might be normally distributed.

Homogeneity: The result suggests of Levene's Test show that means for Satis200 differ, but assumption of homogeneity of variances is reasonable for both Recommend200 and Future_Purch200, and the sample sizes of the groups are equal, so the assumption of equal variance remains robust.

Analysis of the Variate: Customers willing to engage in a strategic partnership have higher satisfaction, likelihood of recommending HBAT, and purchasing future paper products from HBAT than customers not willing to form an alliance. Customers buying from HBAT for more than five years have the highest average means for all three dependent variables. Considering the importance of strategic partnerships and longevity of customer relationships, investments should be made to seek new partnerships that could improve customer retention. Enhanced membership benefits for existing partners along with a trial period that would allow new customers to try out a membership before making a commitment would be of interest. Sales and marketing should consider using testimonials from satisfied customers as well.

The SAS System

The GLM Procedure

Tukey's Studentized Range (HSD) Test for Satis200