



conrad

School of Entrepreneurship and Business

Agenda

01

Mid-Term
Walkthrough

02

Logistic
Regression
Contd.

03

Multicollinearity

Questions

Q1 Since merchant perceptions of relationship success is important for Brand X, they are interested in knowing whether there is proportional difference between merchants who say that the business relationship has been a success compared to ones who say that it has not been a success? **2 Marks**

Q2 Brand X is interested in knowing whether there is any relationship between the time that the merchants have been in existence and the number of locations that they have? This will help Brand X figure out whether they need an overall company focused pitch or a more localized approach pitch when Brand X's salespeople approach new Merchants to come to the platform. Can you help? **3 Marks**

Q3 Brand X is focused on making sure that its merchants continue their business relationship. To that end, they are interested in knowing whether the number of locations and number of customers merchants received from their deals compared to what they were expecting had any bearing on their likelihood of continuing business relationship with Brand X? **5 Marks**

Q4 Since word of mouth is a powerful tool for promoting a business, Brand X is really interested in knowing how well does relational satisfaction impact recommendation by merchants to other businesses. Can you decipher the strength and nature of this relationship and quantify it so it can be used for predictive purposes? **5 Marks**

Q5 Brand X is committed to enhancing overall satisfaction of business relationship with its merchants. To accomplish that goal, Brand X would like to understand the nature relationship between overall satisfaction and various factors related to performance of their most recent Brand X deal, the value of their most recent Brand X promotion, and interactions with Brand X staff. They would like to prioritize their efforts, so they need your help in identifying nature and strength of significant factors. **10 Marks**

BONUS QUESTION: To serve its Merchants better, Brand X is interested in knowing whether the size of the company has any relation to deal performance in terms of the number of customers expected by Merchants. The answer to this question is critical for Brand X as that can help them focus their efforts to enhance deal performance. Can you help? **5 Marks**

Question 2

Q2 Brand X is interested in knowing whether there is any relationship between the time that the merchants have been in existence and the number of locations that they have? This will help Brand X figure out whether they need an overall company focused pitch or a more localized approach pitch when Brand X's salespeople approach new Merchants to come to the platform. Can you help? **3 Marks**

Relevant Survey Question (s): D2. How long have you been in business?

- 01 – 0-3 years
- 02 – 4-6 years
- 03 – 7-15 years
- 04 – 16 or more years
- 99 – Prefer not to answer

Eliminate this category

D3. How many locations does your business have?

- 01 – 1
- 02 – 2-3
- 03 – 4-5
- 04 – 6 or more
- 99 – Prefer not to answer

Eliminate this category

Analysis: Ordinal data, hence we'll use **Spearman's Correlation**

Correlations

Significant Correlation

	D2 (How long have you been in business?)	Correlation Coefficient	1.000	.176**
Spearman's rho		Sig. (2-tailed)		.005
	N		259	254
D3 (How many locations does your business have?)	Correlation Coefficient	.176**	1.000	
	Sig. (2-tailed)	.005		
	N		254	256

**. Correlation is significant at the 0.01 level (2-tailed).

Question 3

Q3 Brand X is focused on making sure that its merchants continue their business relationship. To that end, they are interested in knowing whether the number of locations and number of customers merchants received from their deals compared to what they were expecting had any bearing on their likelihood of continuing business relationship with Brand X? **5 Marks**

Relevant Survey Question(s):

10. How has the number of customers you received from your deal compared to what you were expecting? (Please select one) D3. How many locations does your business have?

- 01 – The number of customers met your expectations
- 02 – You received fewer customers than you expected
- 03 – You received more customers than you expected

- 01 – 1
- 02 – 2-3
- 03 – 4-5
- 04 – 6 or more
- 99 – Prefer not to answer

Eliminate this category 

5. How likely are you to continue your business relationship with Brand X?

Very Unlikely 1	2	3	4	5	6	7	8	9	Very Likely 10
-----------------------	---	---	---	---	---	---	---	---	----------------------

Analysis: We have two Ordinal (Categorical) independent variables (Q10 and D3) and 1 Dependent Variable (Q5), hence a **2 Way ANOVA**

Question 3

Q3 Brand X is focused on making sure that its merchants continue their business relationship. To that end, they are interested in knowing whether the number of locations and number of customers merchants received from their deals compared to what they were expecting had any bearing on their likelihood of continuing business relationship with Brand X? **5 Marks**

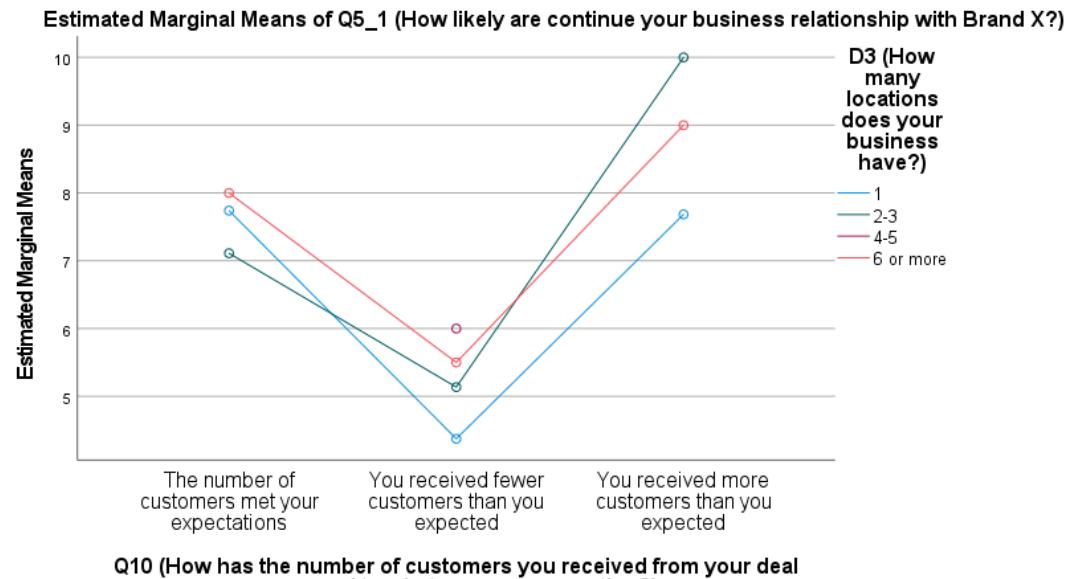
Tests of Between-Subjects Effects

Dependent Variable: Q5_1 (How likely are continue your business relationship with Brand

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	619.213 ^a	9	68.801	7.721	.000
Intercept	1267.771	1	1267.771	42.269	.000
d3	13.783	3	4.594	.516	.672
q10	86.724	2	43.362	4.866	.008
d3 * q10	17.534	4	4.383	.492	.742
Error	2192.127	246	8.911		
Total	10699.000	256			
Corrected Total	2811.340	255			

a. R Squared = .220 (Adjusted R Squared = .192)

Significant Effect



Question 4

Q4 Since word of mouth is a powerful tool for promoting a business, Brand X is really interested in knowing how well does relational satisfaction impact recommendation by merchants to other businesses. Can you decipher the strength and nature of this relationship and quantify it so it can be used for predictive purposes? **5 Marks**

Relevant Survey Question(s):

1. What is your overall satisfaction with the business relationship between you and Brand X?

Very Dissatisfied 1	2	3	4	5	6	7	8	9	Very Satisfied 10
------------------------	---	---	---	---	---	---	---	---	----------------------

4. How likely are you to recommend Brand X to another business?

Very Unlikely 1	2	3	4	5	6	7	8	9	Very Likely 10
--------------------	---	---	---	---	---	---	---	---	-------------------

Analysis: Since we are asked to decipher strength and nature and quantify the relationship between an independent variable (Q1) and a dependent variable (Q4), we will use a **Simple Linear Regression**.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.889 ^a	.791	.790	1.512

a. Predictors: (Constant), Q1_1 (What is your overall satisfaction with the business relationship between you and Brand X?)

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2244.020	1	2244.020	981.508	.000 ^b
	Residual	594.438	260	2.286		
	Total	2838.458	261			

a. Dependent Variable: Q4_1 (How likely are you to recommend Brand X to another business?)

b. Predictors: (Constant), Q1_1 (What is your overall satisfaction with the business relationship between you and Brand X?)

Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients Beta	t	Sig.	
	B	Std. Error				
1	(Constant)	.417	.179	2.334	.020	
	Q1_1 (What is your overall satisfaction with the business relationship between you and Brand X?)	.892	.028	.889	31.329	.000

a. Dependent Variable: Q4_1 (How likely are you to recommend Brand X to another business?)

$$\text{Recommendation} = 0.417 + 0.892 * \text{Satisfaction}$$

Question 5

Q5 Brand X is committed to enhancing overall satisfaction of business relationship with its merchants. To accomplish that goal, Brand X would like to understand the nature relationship between overall satisfaction and various factors related to performance of their most recent Brand X deal, the value of their most recent Brand X promotion, and interactions with Brand X staff. They would like to prioritize their efforts, so they need your help in identifying nature and strength of significant factors. **10 Marks**

Relevant Survey Question(s):

1. What is your overall satisfaction with the business relationship between you and Brand X?

Very Dissatisfied 1	2	3	4	5	6	7	8	9	Very Satisfied 10
------------------------	---	---	---	---	---	---	---	---	----------------------

6. Please rate the performance of your most recent Brand X deal in the following areas:

- a. How well the Brand X deal increased awareness of your business within the community.
- b. How well the deal helped your business reach new customers.
- c. How well the Brand X deal allowed you to effectively use your capacity.
- d. How well the Brand X deal brought in customers to your business.

Poor 1	2	3	4	5	6	Excellent 7	Don't know 99
-----------	---	---	---	---	---	----------------	------------------

Eliminate this category

7. Please rate the value of your most recent Brand X promotion on the following:

- a. The benefits received compared to the costs incurred.
- b. Brand X's cost effectiveness compared to other marketing channels you have used.
- c. How well Brand X structured the terms of the overall deal.
- d. How well the deal brought in customers who spent more than the value of the Brand X.
- e. The effort required to run a Brand X promotion.

Poor 1	2	3	4	5	6	Excellent 7	Don't know 99
-----------	---	---	---	---	---	----------------	------------------

Eliminate this category

8. Thinking about your interactions with Brand X staff (i.e. calls, emails, etc.) how satisfied were you at the following stages of your deal:

- a. Before you signed your contract (setting up your deal).
- b. After you signed your contract but before your deal went live. This was when you were being prepared for your deal to launch.
- c. After your deal launched.

Very Dissatisfied 1	2	3	4	5	6	Very Satisfied 7	Don't know 99
------------------------	---	---	---	---	---	---------------------	------------------

Eliminate this category

Question 5

Q5 Brand X is committed to enhancing overall satisfaction of business relationship with its merchants. To accomplish that goal, Brand X would like to understand the nature relationship between overall satisfaction and various factors related to performance of their most recent Brand X deal, the value of their most recent Brand X promotion, and interactions with Brand X staff. They would like to prioritize their efforts, so they need your help in identifying nature and strength of significant factors. **10 Marks**

Analysis: Since we are dealing with multiple independent variables (Q6, Q7 and Q8 series) and one dependent variable (Q1), we will be using **Multiple Linear Regression**

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.912 ^a	.831	.819	1.408

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1668.228	12	139.019	70.077	.000 ^b
	Residual	339.229	171	1.984		
	Total	2007.457	183			

Question 5

Q5 Brand X is committed to enhancing overall satisfaction of business relationship with its merchants. To accomplish that goal, Brand X would like to understand the nature relationship between overall satisfaction and various factors related to performance of their most recent Brand X deal, the value of their most recent Brand X promotion, and interactions with Brand X staff. They would like to prioritize their efforts, so they need your help in identifying nature and strength of significant factors. **10 Marks**

Model	Coefficients ^a				
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1	(Constant)	-.681	.300		.024
	Q6_1 How well the Brand X deal increased awareness of your business within the community.	-.190	.124	-.134	-1.527 .128
	Q6_2 How well the deal helped your business reach new customers.	.057	.158	.042	.357 .722
4	Q6_3 How well the Brand X deal allowed you to effectively use your capacity.	.227	.115	.165	1.976 .050
	Q6_4 How well the Brand X deal brought in customers to your business.	.279	.157	.201	1.777 .077
	Q7_1 The benefits received compared to the costs incurred.	-.058	.105	-.037	-.550 .583
3	Q7_2 Brand X's cost effectiveness compared to other marketing channels you have used.	.294	.087	.197	3.376 .001
	Q7_3 How well Brand X structured the terms of the overall deal.	.119	.089	.078	1.338 .183
5	Q7_4 How well the deal brought in customers who spent more than the value of the Brand X.	-.160	.081	-.106	-1.988 .048
2	Q7_5 The effort required to run a Brand X promotion.	.289	.080	.200	3.604 .000
	Q8_1 Before you signed your contract (setting up your deal).	.085	.082	.053	1.038 .301
	Q8_2 After you signed your contract but before your deal went live. This was when you were being prepared for your deal to launch.	.010	.090	.007	.112 .911
1	Q8_3 After your deal launched - (How satisfied were you at the following stages of your deal?)	.542	.074	.392	7.367 .000

Ranking

Significant Effects, p<0.05

Data Analysis



UNIVERSITY OF
WATERLOO

a. Dependent Variable: Q1_1 (What is your overall satisfaction with the business relationship between you and Brand X?)

Bonus Question

BONUS QUESTION: To serve its Merchants better, Brand X is interested in knowing whether the size of the company has any relation to deal performance in terms of the number of customers expected by Merchants. The answer to this question is critical for Brand X as that can help them focus their efforts to enhance deal performance. Can you help? **5 Marks**

Relevant Survey Question(s):

D1. How many employees do you have at your business?

- 01 – None, I run the business myself
- 02 – 1 other employee
- 03 – 2-5 employees
- 04 – 6-10 employees
- 05 – 11-20 employees
- 06 – 21-50 employees
- 07 – 51-100 employees
- 08 – More than 100 employees
- 99 – Prefer not to answer

10. How has the number of customers you received from your deal compared to what you were expecting? (Please select one)

- 01 – The number of customers met your expectations
- 02 – You received fewer customers than you expected
- 03 – You received more customers than you expected

Recode to preserve ordinality

Eliminate this category

Analysis: Since we have two ordinal variables, let's use **Spearman's Correlation**

Correlations

			NewQ10	
	Spearman's rho	NewQ10	Correlation Coefficient	1.000
			.226**	.226**
			.000	.000
			262	257
			D1 (How many employees do you have at your business?)	
			Correlation Coefficient	.226**
			.226**	1.000
			.000	.000
			257	257

**. Correlation is significant at the 0.01 level (2-tailed).

Question 1

Q1 Since merchant perceptions of relationship success is important for Brand X, they are interested in knowing whether there is proportional difference between merchants who say that the business relationship has been a success compared to ones who say that it has not been a success? **2 Marks**

Relevant Survey Question(s)

11. Overall, would you say that your relationship with Brand X has been successful for your business?

01 – Yes

02 – No

03 – Not Sure

Eliminate this category

Analysis: Test of Proportions

Q11 (Overall, would you say that your relationship with Brand X has been successful for your business?)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	103	39.3	51.8	51.8
	No	96	36.6	48.2	100.0
	Total	199	76.0	100.0	
Missing	Not Sure	63	24.0		
	Total	262	100.0		

The value of z is 0.7018. The value of p is .48392. The result is *not* significant at $p < .05$.

Question 1

Q1 Since merchant perceptions of relationship success is important for Brand X, they are interested in knowing whether there is proportional difference between merchants who say that the business relationship has been a success compared to ones who say that it has not been a success? **2 Marks**

Analyses: Test of Proportions

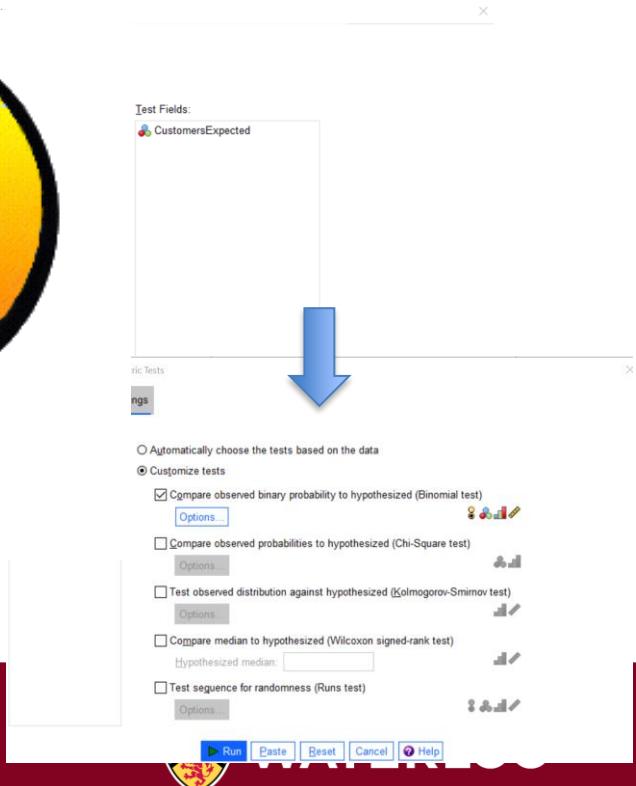
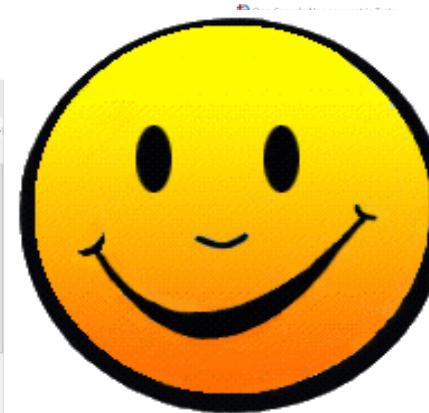
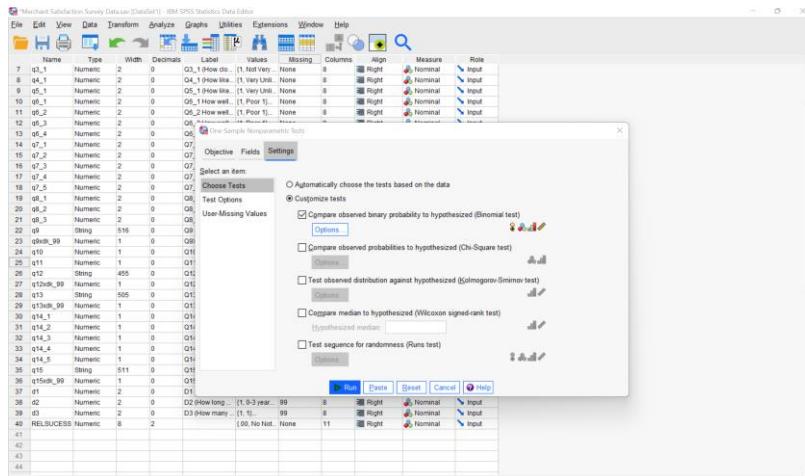
Null: Proportions are equal

Alternative: Proportions are different

Challenge: We must test that the two proportions are different - they only way they would be equal is if they were 50%.
But here they come from the same base.

SO, WHAT TO DO?

Analyses: Binomial Test - a test to observed test results differ from what was expected, which is 50%.



Question 1

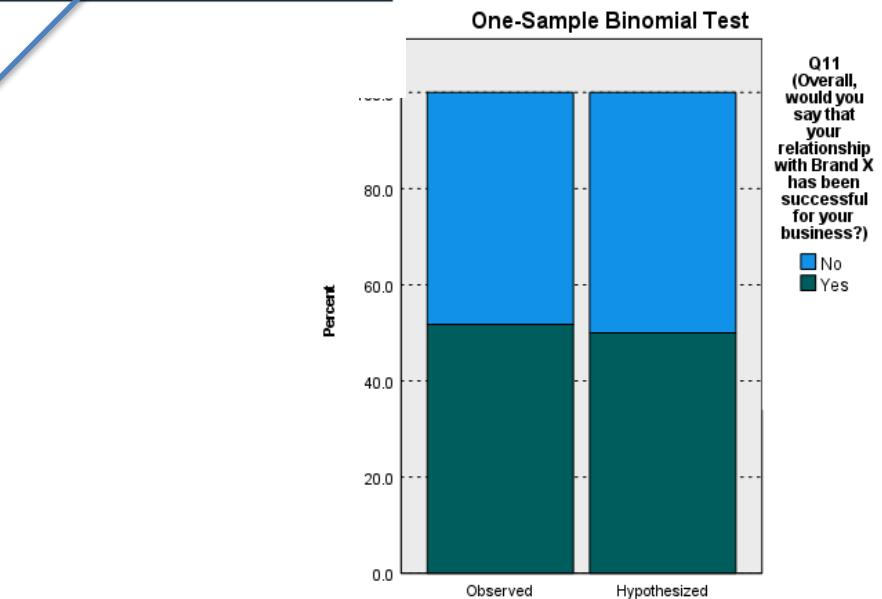
Q1 Since merchant perceptions of relationship success is important for Brand X, they are interested in knowing whether there is proportional difference between merchants who say that the business relationship has been a success compared to ones who say that it has not been a success? **2 Marks**

Hypothesis Test Summary			
	Null Hypothesis	Test	Sig. ^{a,b}
1	The categories defined by Q11 (Overall, would you say that your relationship with Brand X has been successful for your business?) = No and Yes occur with probabilities .500 and .500.	One-Sample Binomial Test	.671

a. The significance level is .050.

b. Asymptotic significance is displayed.

Proportions are same!



Logistic Regression

Logistic Regression

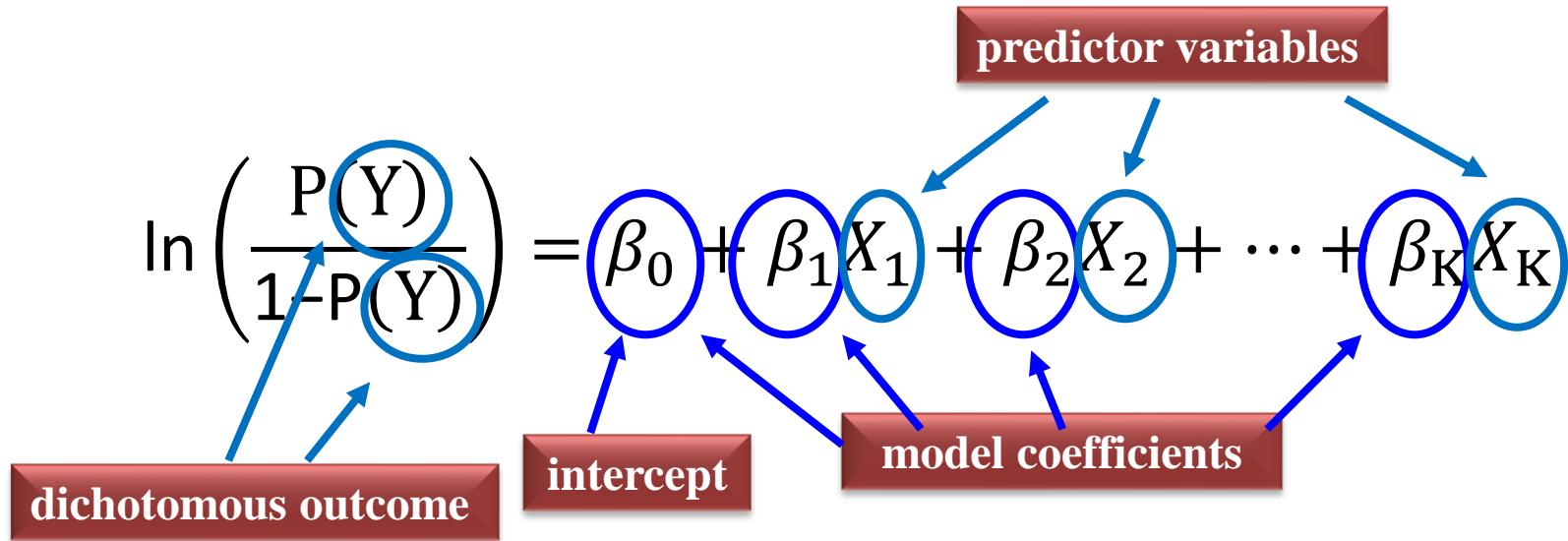
Logistic Regression:

$$\ln \left(\frac{P(Y)}{1-P(Y)} \right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_K X_K$$

Linear Regression:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_K X_K + \varepsilon$$

Logistic Regression



$\ln\left(\frac{P(Y)}{1 - P(Y)}\right)$ is the log(odds) of the outcome.

Form for Predicted Probabilities

$$\ln \left(\frac{P(Y)}{1-P(Y)} \right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_K X_K$$

↔

$$P(Y) = \frac{\exp(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_K X_K)}{1 + \exp(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_K X_K)}$$

In this latter form, the logistic regression model directly relates the probability of Y to the predictor variables.

The Logistic Regression Model

In campaign effectiveness studies, one of the main outcomes is purchase of the advertised product

There is much empirical evidence that the number of advertising exposures play a significant role in product purchase

A recent study examined the effect of the advertisement exposures, on the odds of product purchase

$$\ln\left(\frac{\Pr(\text{product purchase})}{1 - \Pr(\text{product purchase})}\right) = 0.67 + 0.13 * \text{Number of Exposures}$$

⇓

$$\Pr(\text{product purchase}) = \frac{\exp(0.67 + 0.13 * \text{Number of Exposures})}{1 + \exp(0.67 + 0.13 * \text{Number of Exposures})}$$

$$\ln \left(\frac{\Pr(\text{product purchase})}{1 - \Pr(\text{product purchase})} \right) = 0.670 + 0.13 * \text{Number of Exposures}$$

\Updownarrow

$$\Pr(\text{product purchase}) = \frac{\exp(0.67 + 0.13 * \text{Number of Exposures})}{1 + \exp(0.67 + 0.13 * \text{Number of Exposures})}$$

Q1. What is the effect of number of exposures on product purchase?

A.  OR_{product purchase} = $\exp(0.13) = 1.1388$

This implies that for every 1 increase in exposure, the odds of product purchase increases by approximately 1.14 times

Q2. What is the predicted probability of a 5 exposures on the probability of product purchase?

$$\Pr_{\text{product purchase}} = \frac{\exp(0.67 + 0.13 * 5)}{1 + \exp(0.67 + 0.13 * 5)} = 0.79$$

- A. From this model, 5 exposures have around a 79% of product purchase success

$$\ln\left(\frac{\Pr(\text{product purchase})}{1 - \Pr(\text{product purchase})}\right) = 0.670 + .13 * \text{Number of Exposures}$$

⇓

$$\Pr(\text{product purchase}) = \frac{\exp(0.67 + 0.13 * \text{Number of Exposures})}{1 + \exp(0.67 + 0.13 * \text{Number of Exposures})}$$

Q3. Okay, so how does the relationship between the odds ratio and probability work here again?

Recall $\text{OR}_{\text{Product Purchase}} = \exp(0.13) = 1.1388 = 1.14$

This implies that for every 1 increase in exposure, the **odds of product purchase increases by approximately 1.14 times**

Let's try it out

$$\Pr(\text{product purchase}) = \frac{\exp(0.67+0.13*5)}{1+\exp(0.67+0.13*5)} = 0.789, \text{ So } \Pr(\text{non purchase}) = 1-0.789 = 0.211$$

$$\text{So OR (product purchase)} = 0.789/0.211 = 3.739$$

$$\Pr(\text{product purchase}) = \frac{\exp(0.67+0.13*4)}{1+\exp(0.67+0.13*4)} = 0.767, \text{ So } \Pr(\text{non purchase}) = 1-0.767 = 0.233$$

$$\text{So OR (product purchase)} = 0.767/0.233 = 3.292$$

So going from 4 exposures to 5 exposures, the Odds of product purchase increase by ?

$$3.739/3.292 = 1.14$$

Performing the Analysis Using SPSS

Let's revert to the brand questionnaire and data made available for this class for the Mid-Term EXAM

What is the association between those merchants who categorically say that **relationship with Brand X has been successful for their business** and merchants **brand X imagery perceptions** as well as **how long they have been in business** and **the number of locations** they have

Dataset

1) The dependent variable:



2) Independent variables related to brand imagery:

11. Overall, would you say that your relationship with Brand X has been successful for your business?

RANDOMIZE

- a. Brand X is a trusted business partner.
- b. The staff at Brand X are working on your behalf.
- c. The staff at Brand X are knowledgeable.
- d. Brand X has a good reputation among merchants and business owners.
- e. Your success is important to Brand X.

Strongly Disagree 1	2	3	4	5	6	Strongly Agree 7
------------------------	---	---	---	---	---	---------------------

14. To what extent do you agree or disagree with the following statements about Brand X:

3) Independent variables related to business tenure and number of locations

01 – 0-3 years

02 – 4-6 years

03 – 7-15 years

04 – 16 or more years

99 – Prefer not to answer

D2. How long have you been in business?

01 – 1

02 – 2-3

03 – 4-5

04 – 6 or more

99 – Prefer not to answer

D3. How many locations does your business have?

SPSS® Analyze | Regression | Binary Logistic

*Merchant Satisfaction Survey Data.sav [DataSet1] - IBM SPSS Statistics Data Editor

File Edit View Data Transform Analyze Graphs Utilities Extensions Window Help

Power Analysis Reports Descriptive Statistics Bayesian Statistics Tables Compare Means General Linear Model Generalized Linear Models Mixed Models Correlate Regression Automatic Linear Modeling... Loglinear Linear... Neural Networks Curve Estimation... Partial Least Squares... Scale Binary Logistic... Multinomial Logistic... Nonparametric Tests Forecasting Survival Multiple Response Missing Value Analysis... Multiple Imputation Complex Samples Simulation... Quality Control Spatial and Temporal Modeling... Direct Marketing

	Name	Decimals	Label	Values	Missing	C
1	respid	0	(respid)	None	None	8
2	status	0	(status)	None	None	20
3	interview_start	0	(interview_start)	None	None	8
4	interview_end	0	(interview_end)	None	None	8
5	q1_1	0	Q1_1 (What is ...	{1, Very Dissatisfied 1}...	None	8
6	q2_1		(How well...)	{1, Falls Short 1}...	None	8
7	q3_1		(How clos...)	{1, Not Very Close 1}...	None	8
8	q4_1		(How likel...)	{1, Very Unlikely 1}...	None	8
9	q5_1		(How likel...)	{1, Very Unlikely 1}...	None	8
10	q6_1		How well ...	{1, Poor 1}...	99	8
11	q6_2		How well ...	{1, Poor 1}...	99	8
12	q6_3		How well ...	{1, Poor 1}...	99	8
13	q6_4		How well ...	{1, Poor 1}...	99	8
14	q7_1		How well ...	{1, Poor 1}...	99	8
15	q7_2		The bene...	{1, Poor 1}...	99	8
16	q7_3		Brand X's...	{1, Poor 1}...	99	8
17	q7_4	0	Q7_3 How well ...	{1, Poor 1}...	99	8
18	q7_5	0	Q7_4 How well ...	{1, Poor 1}...	99	8
19	q8_1	Numeric 2	Q7_5 The effort...	{1, Poor 1}...	99	8
20	q8_2	Numeric 2	Q8_1 Before yo...	{1, Very Dissatisfied 1}...	99	8
21	q8_3	Numeric 2	Q8_2 After you ...	{1, Very Dissatisfied 1}...	99	8
			Q8_3 After your...	{1, Very Dissatisfied 1}...	99	8

Data View Variable View

Binary Logistic... IBM SPSS Statistics Processor is ready Unicode:ON

Type here to search

Links 2:07 PM 11/4/2020



	Name	Type	Width	Decimals	Label	Values	Missing	C
1	respid	Numeric	8	0	(respid)	None	None	8
2	status	String	8	0	(status)	None	None	20
3	interview_start	Date	10	0	(interview_start)	None	None	8
4	interview_end	Date	10	0	(interview_end)	None	None	8
5	q1_1	N						
6	q2_1	N						
7	q3_1	N						
8	q4_1	N						
9	q5_1	N						
10	q6_1	N					99	8
11	q6_2	N					99	8
12	q6_3	N					99	8
13	q6_4	N					99	8
14	q7_1	N					99	8
15	q7_2	N					99	8
16	q7_3	N					99	8
17	q7_4	Numeric	2	0	Q7_4 How well ... {1, Poor 1}...		99	8
18	q7_5	Numeric	2	0	Q7_5 The effort... {1, Poor 1}...		99	8
19	q8_1	Numeric	2	0	Q8_1 Before yo... {1, Very Dissatisfied 1}...		99	8
20	q8_2	Numeric	2	0	Q8_2 After you ... {1, Very Dissatisfied 1}...		99	8
21	q8_3	Numeric	2	0	Q8_3 After your... {1, Very Dissatisfied 1}...		99	8

Data View Variable View

Type here to search



SPSS output

This part of the output tells you about the cases that were included and excluded from the analysis and the coding of the dependent variable.

Case Processing Summary

Unweighted Cases ^a		N	Percent
Selected Cases	Included in Analysis	254	96.9
	Missing Cases	8	3.1
	Total	262	100.0
Unselected Cases		0	.0
Total		262	100.0

a. If weight is in effect, see classification table for the total number of cases.

Dependent Variable Encoding

Original Value	Internal Value
No	0
Yes	1

SPSS output – Block 0

This part of the output describes a “null model”, which is model with no predictors and just the intercept. This is why you will see all of the variables that you put into the model in the table titled “Variables not in the Equation”

Classification Table^{a,b}

		Predicted		Percentage Correct	
		RELSUCCESS			
Observed		RELSUCCESS	No Yes		
Step 0	RELSUCCESS	No	153 0	100.0	
		Yes	101 0	.0	
Overall Percentage				60.2	

a. Constant is included in the model.

b. The cut value is .500

Variables in the Equation

	B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-.415	.128	10.494	1 .001	.660

Variables not in the Equation

Step 0	Variables	Score	df	Sig.
	Q14_1 Brand X is a trusted business partner. - (To what extent do you agree or disagree with the following statements about Brand X:)	83.285	1	.000
	Q14_2 The staff at Brand X are working on your behalf. - (To what extent do you agree or disagree with the following statements about Brand X:)	81.071	1	.000
	Q14_3 The staff at Brand X are knowledgeable. - (To what extent do you agree or disagree with the following statements about Brand X:)	65.389	1	.000
	Q14_4 Brand X has a good reputation among merchants and business owners. - (To what extent do you agree or disagree with the following statements about Brand X:)	60.584	1	.000
	Q14_5 Your success is important to Brand X. - (To what extent do you agree or disagree with the following statements about Brand X:)	89.941	1	.000
	D2 (How long have you been in business?)	7.318	1	.007
	D3 (How many locations does your business have?)	1.035	1	.309
Overall Statistics		101.430	7	.000

SPSS output – Block 1

The section contains what is frequently the most interesting part of the output: the overall test of the model (in the “Omnibus Tests of Model Coefficients” table) and the coefficients and odds ratios (in the “Variables in the Equation” table).

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	121.540	7	.000
	Block	121.540	7	.000
	Model	121.540	7	.000

The overall model is statistically significant, $\chi^2(7) = 121.54, p < .01$

SPSS output – Block 1

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	219.858 ^a	.380	.514

a. Estimation terminated at iteration number 5
because parameter estimates changed by less
than .001.

This table contains the Cox & Snell R Square and Nagelkerke R Square values, which are both methods of calculating the explained variation. These values are sometimes referred to as pseudo R^2 values (and will have lower values than in multiple regression). However, they are interpreted in the same manner, but with more caution. Therefore, the explained variation in the dependent variable based on our model ranges from 38.0% to 51.0%, depending on whether you reference the Cox & Snell R^2 or Nagelkerke R^2 methods, respectively.

SPSS output – Block 1

Classification Table^a

Observed		Predicted		Percentage Correct
		RELSUCCESS No	RELSUCCESS Yes	
Step 1	RELSUCCESS	No	126	27
		Yes	24	77
Overall Percentage				79.9

a. The cut value is .500

Logistic regression estimates the probability of an event (in this case, relationship success) occurring. If the estimated probability of the event occurring is greater than or equal to 0.5 (better than even chance), SPSS Statistics classifies the event as occurring (e.g., relationship being successful). If the probability is less than 0.5, SPSS Statistics classifies the event as not occurring (e.g., relationship not successful). It is very common to use binomial logistic regression to predict whether cases can be correctly classified (i.e., predicted) from the independent variables. Therefore, it becomes necessary to have a method to assess the effectiveness of the predicted classification against the actual classification.

SPSS output – Block 1

Variables in the Equation

	B	S.E.	Wald	df	Sig.	Exp(B)
Step 1	Q14_1 Brand X is a trusted business partner. - (To what extent do you agree or disagree with the following statements about Brand X:)	.350	.193	3.270	1 .071	1.419
	Q14_2 The staff at Brand X are working on your behalf. - (To what extent do you agree or disagree with the following statements about Brand X:)	.228	.145	2.473	1 .116	1.256
	Q14_3 The staff at Brand X are knowledgeable. - (To what extent do you agree or disagree with the following statements about Brand X:)	.019	.173	.012	1 .914	1.019
	Q14_4 Brand X has a good reputation among merchants and business owners. - (To what extent do you agree or disagree with the following statements about Brand X:)	-.069	.172	.161	1 .688	.933
	Q14_5 Your success is important to Brand X. - (To what extent do you agree or disagree with the following statements about Brand X:)	.382	.146	6.799	1 .009	1.465
	D2 (How long have you been in business?)	.252	.142	3.122	1 .077	1.286
	D3 (How many locations does your business have?)	.253	.325	.607	1 .436	1.288
	Constant	-5.535	.828	44.646	1 .000	.004

The Wald test ("Wald" column) is used to determine statistical significance for each of the independent variables. The statistical significance of the test is found in the "Sig." column. From these results you can see that **Q14_1** ($p = .071$), **Q14_5** ($p = .009$) and **D2** ($p = .077$) added significantly to the model/prediction, but Q14_2 ($p = .116$), Q14_3 ($p = .914$), Q14_4 ($p = .688$), and D3 ($p = .436$) did not add significantly to the model.

SPSS output – Block 1

Variables in the Equation

	B	S.E.	Wald	df	Sig.	Exp(B)
Step 1	Q14_1 Brand X is a trusted business partner. - (To what extent do you agree or disagree with the following statements about Brand X:)	.350	.193	3.270	1	.071
	Q14_2 The staff at Brand X are working on your behalf. - (To what extent do you agree or disagree with the following statements about Brand X:)	.228	.145	2.473	1	.116
	Q14_3 The staff at Brand X are knowledgeable. - (To what extent do you agree or disagree with the following statements about Brand X:)	.019	.173	.012	1	.914
	Q14_4 Brand X has a good reputation among merchants and business owners. - (To what extent do you agree or disagree with the following statements about Brand X:)	-.069	.172	.161	1	.688
	Q14_5 Your success is important to Brand X. - (To what extent do you agree or disagree with the following statements about Brand X:)	.382	.146	6.799	1	.009
	D2 (How long have you been in business?)	.252	.142	3.122	1	.077
	D3 (How many locations does your business have?)	.253	.325	.607	1	.436
	Constant	-5.535	.828	44.646	1	.000
						.004

You can use the information in the "Variables in the Equation" table to predict the odds of an event occurring based on a one-unit change in an independent variable when all other independent variables are kept constant.

The table shows that the odds of relationship being successful ("yes" category) is 1.465 times greater for every unit change in the perception of "Your success in important to Brand X".

Multicollinearity in Multiple Regression

Multicollinearity

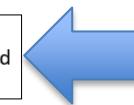
- The term multicollinearity refers to the correlation among the independent variables. Causation is not implied by multicollinearity.
- When the independent variables are highly correlated (say, $|r| > .8$), it is not possible to determine the separate effect of any independent variable on the dependent variable.
- Since multicollinearity is almost always present, it is a problem of degree, not merely existence.
- In extreme case of multicollinearity, signs of coefficients may be contrary to those expected.

Research Question

Q5 *Brand X is committed to enhancing overall satisfaction of business relationship with its merchants. To accomplish that goal, Brand X would like to understand the nature relationship between **overall satisfaction** and various factors related to **performance of their most recent Brand X deal**, the value of their most recent Brand X promotion, and interactions with Brand X staff. They would like to prioritize their efforts, so they need your help in identifying nature and strength of significant factors*

1. What is your overall satisfaction with the business relationship between you and Brand X?

Very Dissatisfied 1	2	3	4	5	6	7	8	9	Very Satisfied 10
------------------------	---	---	---	---	---	---	---	---	----------------------



6. Please rate the **performance of your most recent Brand X deal** in the following areas:

- a. How well the Brand X deal increased awareness of your business within the community.
- b. How well the deal helped your business reach new customers
- c. How well the Brand X deal allowed you to effectively use your capacity.
- d. How well the Brand X deal brought in customers to your business.

Poor 1	2	3	4	5	6	Excellent 7	Don't know 99
-----------	---	---	---	---	---	----------------	------------------

7. Please rate the **value of your most recent Brand X promotion** on the following:

- a. The benefits received compared to the costs incurred.
- b. Brand X's cost effectiveness compared to other marketing channels you have used.
- c. How well Brand X structured the terms of the overall deal.
- d. How well the deal brought in customers who spent more than the value of the Brand X.
- e. The effort required to run a Brand X promotion.

Poor 1	2	3	4	5	6	Excellent 7	Don't know 99
-----------	---	---	---	---	---	----------------	------------------

8. Thinking about your **interactions with Brand X staff** (i.e. calls, emails, etc.) how satisfied were you at the following stages of your deal:

- a. Before you signed your contract (setting up your deal).
- b. After you signed your contract but before your deal went live. This was when you were being prepared for your deal to launch.
- c. After your deal launched.

Very Dissatisfied 1	2	3	4	5	6	Very Satisfied 7	Don't know 99
------------------------	---	---	---	---	---	---------------------	------------------

Research Question

Q5 *Brand X is committed to enhancing overall satisfaction of business relationship with its merchants. To accomplish that goal, Brand X would like to understand the nature relationship between **overall satisfaction** and various factors related to **performance of their most recent Brand X deal, the value of their most recent Brand X promotion, and interactions with Brand X staff**. They would like to prioritize their efforts, so they need your help in identifying nature and strength of significant factors*

The image shows two overlapping SPSS dialog boxes. The left dialog is titled 'Bivariate Correlations' and includes sections for 'Variables' (listing questions Q14_2 through Q7_4), 'Correlation Coefficients' (checkboxes for Pearson, Kendall's tau-b, and Spearman), 'Test of Significance' (radio buttons for Two-tailed and One-tailed), and 'Flag significant correlations' (checkboxes for lower triangle and diagonal). The right dialog is titled 'Linear Regression: Statistics' and includes sections for 'Regression Coefficie...' (checkboxes for Estimates, Confidence intervals, Covariance matrix), 'Residuals' (checkboxes for Durbin-Watson, Casewise diagnostics, Outliers outside 3 standard deviations, and All cases), and 'Model fit' (checkboxes for R squared change, Descriptives, Part and partial correlations, and Collinearity diagnostics). Both dialogs have 'OK', 'Paste', 'Reset', 'Cancel', and 'Help' buttons at the bottom.

Evidence of Multicollinearity

Correlations													
		Q6_1 How well the Brand X deal increased awareness of your business within the community.	Q6_2 How well the deal helped your business reach new customers.	Q6_3 How well the Brand X deal allowed you to effectively use your capacity.	Q6_4 How well the Brand X deal brought in customers to your business.	Q7_1 The benefits received compared to the costs incurred.	Q7_2 Brand X's cost effectiveness compared to other marketing channels you have used.	Q7_3 How well Brand X structured the terms of the overall deal.	Q7_4 How well the deal brought in customers who spent more than the value of the Brand X.	Q7_5 The effort required to run a Brand X promotion.	Q8_1 Before you signed your contract (setting up your deal).	Q8_2 After you signed your contract but before your deal went live. This was when you were being prepared for your deal to launch.	Q8_3 After your deal launched.
Q6_1 How well the Brand X deal increased awareness of your business within the community.	Pearson Correlation	1	.925**	.871**	.913**	.744**	.686**	.596**	.694**	.641**	.381**	.470**	.578**
	Sig. (2-tailed)		.000	.000	.000		.000	.000	.000	.000	.000	.000	.000
	N	240	238	229	238	220	219	232	227	235	235	235	232
Q6_2 How well the deal helped your business reach new customers.	Pearson Correlation	.925**	1	.912**	.957**	.734**	.662**	.632**	.738**	.630**	.417**	.496**	.585**
	Sig. (2-tailed)		.000	.000	.000		.000	.000	.000	.000	.000	.000	.000
	N	238	257	244	244	237	232	248	243	250	251	252	248
Q6_3 How well the Brand X deal allowed you to effectively use your capacity.	Pearson Correlation	.871**	.912**	1	.915**	.751**	.662**	.672**	.715**	.649**	.437**	.511**	.610**
	Sig. (2-tailed)		.000	.000	.000		.000	.000	.000	.000	.000	.000	.000
	N	229	244	246	244	226	224	238	232	241	240	241	238
Q6_4 How well the Brand X deal brought in customers to your business.	Pearson Correlation	.913**	.957**	.915**	1	.742**	.668**	.621**	.747**	.628**	.414**	.489**	.574**
	Sig. (2-tailed)		.000	.000	.000		.000	.000	.000	.000	.000	.000	.000
	N	238	253	244	256	236	232	247	243	250	250	251	248
Q7_1 The benefits received compared to the costs incurred.	Pearson Correlation	.744**	.734**	.751**	.742**	1	.813**	.715**	.700**	.649**	.359**	.458**	.563**
	Sig. (2-tailed)		.000	.000	.000		.000	.000	.000	.000	.000	.000	.000
	N	220	237	226	236	239	225	234	231	235	235	237	233
Q7_2 Brand X's cost effectiveness compared to other marketing channels you have used.	Pearson Correlation	.686**	.662**	.662**	.668**	.813**	1	.709**	.637**	.641**	.384**	.437**	.531**
	Sig. (2-tailed)		.000	.000	.000		.000		.000	.000	.000	.000	.000
	N	219	232	224	232	225	235	228	226	231	231	233	230
Q7_3 How well Brand X structured the terms of the overall deal.	Pearson Correlation	.596**	.632**	.672**	.621**	.715**	.709**	1	.628**	.689**	.472**	.571**	.648**
	Sig. (2-tailed)		.000	.000	.000		.000		.000	.000	.000	.000	.000
	N	232	248	238	247	234	228	250	238	247	246	247	243
Q7_4 How well the deal brought in customers who spent more than the value of the Brand X.	Pearson Correlation	.694**	.738**	.715**	.747**	.700**	.637**	.628**	1	.561**	.358**	.453**	.547**
	Sig. (2-tailed)		.000	.000	.000		.000		.000	.000	.000	.000	.000
	N	227	243	232	243	231	226	238	246	241	241	242	240
Q7_5 The effort required to run a Brand X promotion.	Pearson Correlation	.641**	.630**	.649**	.628**	.649**	.641**	.689**	.561**	1	.509**	.558**	.632**
	Sig. (2-tailed)		.000	.000	.000		.000		.000		.000	.000	.000
	N	235	250	241	250	235	231	247	241	254	249	250	246
Q8_1 Before you signed your contract (setting up your deal).	Pearson Correlation	.381**	.417**	.437**	.414**	.359**	.384**	.472**	.358**	.509**	1	.752**	.551**
	Sig. (2-tailed)		.000	.000	.000		.000		.000		.000	.000	.000
	N	235	251	240	250	235	231	246	241	249	256	255	249
Q8_2 After you signed your contract but before your deal went live. This was when you were being prepared for your deal to launch.	Pearson Correlation	.470**	.496**	.511**	.489**	.458**	.437**	.571**	.453**	.558**	.752**	1	.705**
	Sig. (2-tailed)		.000	.000	.000		.000		.000		.000	.000	.000
	N	235	252	241	251	237	233	247	242	250	255	257	251
Q8_3 After your deal launched.	Pearson Correlation	.578**	.585**	.610**	.574**	.563**	.531**	.648**	.547**	.632**	.551**	.705**	1
	Sig. (2-tailed)		.000	.000	.000		.000		.000		.000	.000	.000
	N	232	248	238	248	233	230	243	240	246	249	251	253

**. Correlation is significant at the 0.01 level (2-tailed).

Checking for Multicollinearity

Model		Coefficients ^a				
		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-.681	.300		-2.272	.024
	Q6_1 How well the Brand X deal increased awareness of your business within the community.	-.190	.124	-.134	-1.527	.128
	Q6_2 How well the deal helped your business reach new customers.	.057	.158	.042	.357	.722
	Q6_3 How well the Brand X deal allowed you to effectively use your capacity.	.227	.115	.165	1.976	.050
	Q6_4 How well the Brand X deal brought in customers to your business.	.279	.157	.201	1.777	.077
	Q7_1 The benefits received compared to the costs incurred.	-.058	.105	-.037	-.550	.583
	Q7_2 Brand X's cost effectiveness compared to other marketing channels you have used.	.294	.087	.197	3.376	.001
	Q7_3 How well Brand X structured the terms of the overall deal.	.119	.089	.078	1.338	.103
	Q7_4 How well the deal brought in customers who spent more than the value of the Brand X.	-.160	.084	-.106	-1.988	.048
	Q7_5 The effort required to run a Brand X promotion.	.289	.080	.200	3.604	.000
	Q8_1 Before you signed your contract (setting up your deal).	.085	.082	.053	1.038	.301
	Q8_2 After you signed your contract but before your deal went live. This was when you were being prepared for your deal to launch.	.010	.090	.007	.112	.911
	Q8_3 After your deal launched. - (How satisfied were you at the following stages of your deal?)	.542	.074	.392	7.367	.000

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.912	.831	.819	1.408

Observations:

- A very high R^2 but not a lot of independent variables that are highly significant
- Some counter-intuitive results

Analysis



UNIVERSITY OF
WATERLOO

a. Dependent Variable: Q1_1 (What is your overall satisfaction with the business relationship between you and your deal?)

Collinearity Diagnostics in SPSS

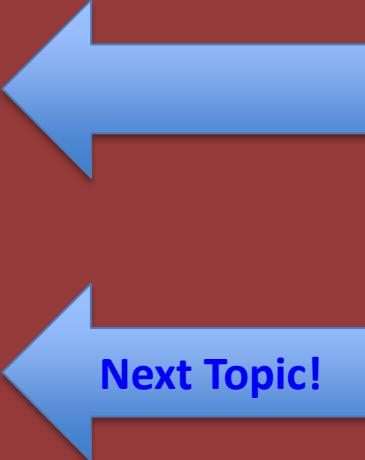
Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients Beta	t	Sig.	Collinearity Statistics	
		B	Std. Error				Tolerance	VIF
1	(Constant)	-.681	.300		-2.272	.024		
	Q6_1 How well the Brand X deal increased awareness of your business within the community.	-.190	.124	-.134	-1.527	.128	.128	7.818
	Q6_2 How well the deal helped your business reach new customers.	.057	.158	.042	.357	.722	.071	14.047
	Q6_3 How well the Brand X deal allowed you to effectively use your capacity.	.227	.115	.165	1.976	.050	.142	7.049
	Q6_4 How well the Brand X deal brought in customers to your business.	.279	.157	.201	1.777	.077	.077	12.969
	Q7_1 The benefits received compared to the costs incurred.	-.058	.105	-.037	-.550	.583	.216	4.640
	Q7_2 Brand X's cost effectiveness compared to other marketing channels you have used.	.294	.087	.197	3.376	.001	.290	3.445
	Q7_3 How well Brand X structured the terms of the overall deal.	.119	.089	.078	1.338	.183	.290	3.446
	Q7_4 How well the deal brought in customers who spent more than the value of the Brand X.	-.160	.081	-.106	-1.988	.048	.345	2.900
	Q7_5 The effort required to run a Brand X promotion.	.289	.080	.200	3.604	.000	.319	3.130
	Q8_1 Before you signed your contract (setting up your deal).	.085	.082	.053	1.038	.301	.375	2.668
	Q8_2 After you signed your contract but before your deal went live. This was when you were being prepared for your deal to launch.	.010	.090	.007	.112	.911	.281	3.564
	Q8_3 After your deal launched. - (How satisfied were you at the following stages of your deal:)	.542	.074	.392	7.367	.000	.348	2.870

Check for VIF values of 10 and above

a. Dependent Variable: Q1_1 (What is your overall satisfaction with the business relationship between you and Brand X?)

Multicollinearity: Remedies

- Do nothing – live with what you have!
 - Increase sample size
 - Omit Variables
 - Factor Analysis
- 
- Next Topic!

Old Model**Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.912	.831	.819	1.408

New Model**Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.908	.824	.814	1.427

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients Beta	t	Sig.	Collinearity Statistics	
		B	Std. Error				Tolerance	VIF
1	(Constant)	-.779	.302		-2.582	.011		
	Q6_1 How well the Brand X deal increased awareness of your business within the community.	-.045	.097	-.032	-.466	.642	.216	4.638
	Q6_3 How well the Brand X deal allowed you to effectively use your capacity.	.376	.098	.273	3.836	.000	.200	5.005
	Q7_1 The benefits received compared to the costs incurred.	-.055	.106	-.035	-.514	.608	.216	4.624
	Q7_2 Brand X's cost effectiveness compared to other marketing channels you have used.	.265	.087	.177	3.039	.003	.296	3.375
	Q7_3 How well Brand X structured the terms of the overall deal.	.128	.090	.083	1.421	.157	.294	3.406
	Q7_4 How well the deal brought in customers who spent more than the value of the Brand X. -	-.110	.078	-.073	-1.404	.162	.375	2.667
	Q7_5 The effort required to run a Brand X promotion.	.304	.081	.210	3.763	.000	.324	3.090
	Q8_1 Before you signed your contract (setting up your deal).	.117	.082	.073	1.429	.155	.382	2.617
	Q8_2 After you signed your contract but before your deal went live. This was when you were being prepared for your deal to launch.	.003	.091	.002	.038	.970	.280	3.573
	Q8_3 After your deal launched.	.534	.074	.385	7.162	.000	.349	2.866

No Funny Results!

a. Dependent Variable: Q1_1 (What is your overall satisfaction with the business relationship between you and Brand X?)



TILL
NEXT
TIME

