MULTIPLE REGRESSION ANALYSIS

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Concepts of Statistics II
Week# 4 Project – Multiple Regression
08/02/20

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OVERVIEW

Multiple regression analysis was performed on six different variables on the HBAT.xls file with x_{19} (customer satisfaction) as the criterion, or dependent variable, and all other variables listed below as the predictors, or explanatory/independent variables. The tables and figures provide visual understanding of the multivariate relationships in efforts to explain the degree to which the independent variables predict the dependent variable (customer satisfaction).

Interpretations for variables under investigation will consist of the following:

a. ***R^2 vs Adjusted-R^2*** – percent of variation in the dependent variable explained by the independent variables.
    1. R^2 : to be used for simple regression, 1 dependent and 1 independent variable
    2. Adjusted-R^2: used for multiple regression, 1 dependent and 2 or more independent variables
b. ***Significance Level***: examines p-value
    1. High >0.05 – statistically insignificant, does not greatly affect the dependent variable
        i. Highest p-value should be removed and multiple regression to be performed again
    2. Low <0.05 – statistically significant, affects the dependent variable
c. ***Regression Coefficients (Parameter Estimates)***: dependent rate of change (positive or negative) per 1 unit change of the independent variable

ID	Variable	Measurement	Description	Type
x_6	Product Quality	metric	Performance	Independent
x_7	E-Commerce Activity	metric	Performance	Independent
x_9	Complaint Resolution	metric	Performance	Independent
x_{11}	Product Line	metric	Performance	Independent
x_{12}	Salesforce Image	metric	Performance	Independent
x_{19}	Satisfaction	metric	Relationship	Dependent

INTERPRETATION

Table 4.8 – *Regression Analysis with 1 predictor*
Regression analysis of one predictor variable and one criterion variable. R^2 was used instead of Adjusted-R^2 because only one independent variable under investigation and therefore a simple regression.

- Variables used:
  - Dependent variable: $\boldsymbol{x_{19}}$ Customer Satisfaction
  - Independent variable: $\boldsymbol{x_9}$ Complaint Resolution

a. $\boldsymbol{R^2}$ = 36.39% variation in Customer Satisfaction is explained by Complaint Resolution
b. ***Significance Level:*** low p-value (<0.001) = statistically significant
c. ***Regression Coefficients / Parameter Estimates***:
   - $\boldsymbol{x_9}$ **=** 0.594 : as Complaint Resolution increases by 1.000, Customer Satisfaction mean responds with an increase of 0.595 unit.

Table 4.9 – *Multiple Regression Analysis with 2 predictors*
Multiple Regression analysis of two predictor variables and one criterion variable. Adjusted-R^2 was used since there are two independent variables under investigation.

- Variables used:
  - Dependent variable: $\boldsymbol{x_{19}}$ Customer Satisfaction
  - Independent variable: $\boldsymbol{x_9}$ Complaint Resolution; $\boldsymbol{x_6}$ Product Quality

a. **Adjusted-$\boldsymbol{R^2}$** = 53.48% variation in Customer Satisfaction is explained by Complaint Resolution and Product Quality
b. ***Significance Level:*** low p-value (<0.001) = statistically significant
c. ***Regression Coefficients / Parameter Estimates***:
   - $\boldsymbol{x_9}$ **=** 0.550 : as Complaint Resolution increases by 1.000, Customer Satisfaction mean responds with an increase of 0.550 unit.
   - $\boldsymbol{x_6}$ **=** 0.364 : as Product Quality increases by 1.000, Customer Satisfaction mean responds with an increase of 0.364 unit.

Table 4.10 – *Multiple Regression Analysis with 3 predictors*
Multiple Regression analysis of three predictor variables and one criterion variable. Adjusted-R^2 was used since there are more than two independent variables under investigation.

- Variables used:
  - Dependent variable: $\boldsymbol{x_{19}}$ Customer Satisfaction
  - Independent variable: $\boldsymbol{x_9}$ Complaint Resolution; $\boldsymbol{x_6}$ Product Quality; $\boldsymbol{x_{12}}$ Salesforce Image

a. **Adjusted-$\boldsymbol{R^2}$** = 74.48% variation in Customer Satisfaction is explained by Complaint Resolution, Product Quality, and Salesforce Image.
b. ***Significance Level:*** low p-value (<0.001) = statistically significant
c. ***Regression Coefficients / Parameter Estimates***:

- x_9 = 0.433 : as Complaint Resolution increases by 1.000, Customer Satisfaction mean responds with an increase of 0.443 unit.
- x_6 = 0.437 : as Product Quality increases by 1.000, Customer Satisfaction mean responds with an increase of 0.437 unit.
- x_{12} = 0.530 : as Salesforce Image increases by 1.000, Customer Satisfaction mean responds with an increase of 0.530 unit.

Table 4.11 – *Multiple Regression Analysis with 5 predictors*

Multiple Regression analysis of five predictor variables and one criterion variable. Adjusted-R^2 was used since there are more than two independent variables under investigation.

- Variables used:
  - Dependent variable: x_{19} Customer Satisfaction
  - Independent variable: x_9 Complaint Resolution; x_6 Product Quality; x_{12} Salesforce Image; x_7 E-Commerce Activity; and Product Line x_{11}

d. **Adjusted-R^2** = 77.97% variation in Customer Satisfaction is explained by Complaint Resolution, Product Quality, Salesforce Image, E-Commerce Activity, and Product Line

e. ***Significance Level:*** low p-value (<0.001) = statistically significant

f. ***Regression Coefficients / Parameter Estimates***:

- x_9 = 0. 319 : as Complaint Resolution increases by 1.000, Customer Satisfaction mean responds with an increase of 0.319 unit.
- x_6 = 0.369 : as Product Quality increases by 1.000, Customer Satisfaction mean responds with an increase of 0.369 unit.
- x_{12} = 0.775 : as Salesforce Image increases by 1.000, Customer Satisfaction mean responds with an increase of 0.775 unit.
- x_7 = - 0.417 : as E-Commerce Activity increases by 1.000, Customer Satisfaction mean responds with an increase of -0.417 unit.
- x_{11} = 0.174 : as Product Line increases by 1.000, Customer Satisfaction mean responds with an increase of 0.174 unit.

TBL - 4.8

Analysis of Variance									
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F	Multiple R	R-Square	Adj R-Sq	Standard error
Model	1	51.17801	51.17801	56.07	<.0001	0.6032	0.3639	0.3574	0.9558
Error	98	89.44959	0.91275						
Corrected Total	99	140.62760							

Parameter Estimates										
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate	Tolerance	Variance Inflation	95% Confidence Limits
Intercept	Intercept	1	3.68005	0.44285	8.31	<.0001	0	.	0	2.80123 4.55886
x9	x9	1	0.59499	0.07946	7.49	<.0001	0.60326	1.00000	1.00000	0.43731 0.75268

TBL - 4.9

Analysis of Variance									
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F	Multiple R	R-Square	Adj R-Sq	Standard error
Model	2	76.52686	38.26343	57.90	<.0001	0.7382	0.5442	0.5348	0.8129
Error	97	64.10074	0.66083						
Corrected Total	99	140.62760							

Parameter Estimates										
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate	Tolerance	Variance Inflation	95% Confidence Limits
Intercept	Intercept	1	1.07733	0.56443	1.91	0.0593	0	.	0	-0.04292 2.19757
x6	x6	1	0.36447	0.05885	6.19	<.0001	0.42699	0.98869	1.01144	0.24767 0.48126
x9	x9	1	0.55020	0.06800	8.09	<.0001	0.55784	0.98869	1.01144	0.41524 0.68515

TBL - 4.10

Stepwise Selection Summary					
Step	Effect Entered	Effect Removed	Number Effects In	Adjusted R-Square	SBC
* Optimal Value of Criterion					
0	Intercept		1	0.0000	38.6997
1	x9		2	0.3574	-1.9392
2	x6		3	0.5348	-30.6559
3	x12		4	0.7448*	-87.1506*

Analysis of Variance									
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F	Multiple R	R-Square	Adj R-Sq	Standard error
Model	3	105.83315	35.27772	97.33	<.0001	0.8682	0.7526	0.7448	0.60203
Error	96	34.79445	0.36244						
Corrected Total	99	140.62760							

Parameter Estimates											
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate	Tolerance	Variance Inflation	95% Confidence Limits	
Intercept	Intercept	1	-1.56899	0.51122	-3.07	0.0028	0	.	0	-2.58375	-0.55424
x6	x6	1	0.43706	0.04432	9.86	<.0001	0.51203	0.95589	1.04615	0.34908	0.52504
x9	x9	1	0.43318	0.05201	8.33	<.0001	0.43920	0.92679	1.07899	0.32994	0.53642
x12	x12	1	0.53020	0.05896	8.99	<.0001	0.47703	0.91579	1.09195	0.41316	0.64724

TBL - 4.11

Stepwise Selection Summary					
Step	Effect Entered	Effect Removed	Number Effects In	Adjusted R-Square	SBC
* Optimal Value of Criterion					
0	Intercept		1	0.0000	38.6997
1	x9		2	0.3574	-1.9392
2	x6		3	0.5348	-30.6559
3	x12		4	0.7448	-87.1506
4	x7		5	0.7630	-90.9708
5	x11		6	0.7797*	-94.7114*

Analysis of Variance									
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F	Multiple R	R-Square	Adj R-Sq	Standard error
Model	5	111.20549	22.24110	71.06	<.0001	0.8892	0.7908	0.7797	0.55947
Error	94	29.42211	0.31300						
Corrected Total	99	140.62760							

Parameter Estimates											
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate	Tolerance	Variance Inflation	95% Confidence Limits	
Intercept	Intercept	1	-1.15106	0.49984	-2.30	0.0235	0	.	0	-2.14350	-0.15862
x6	x6	1	0.36900	0.04719	7.82	<.0001	0.43230	0.72831	1.37305	0.27531	0.46269
x9	x9	1	0.31896	0.06068	5.26	<.0001	0.32340	0.58801	1.70065	0.19848	0.43945
x12	x12	1	0.77513	0.08898	8.71	<.0001	0.69740	0.34727	2.87960	0.59846	0.95180
x7	x7	1	-0.41714	0.13192	-3.16	0.0021	-0.24518	0.37019	2.70133	-0.67908	-0.15520
x11	x11	1	0.17435	0.06095	2.86	0.0052	0.19241	0.49188	2.03302	0.05333	0.29538

FIG 4.10

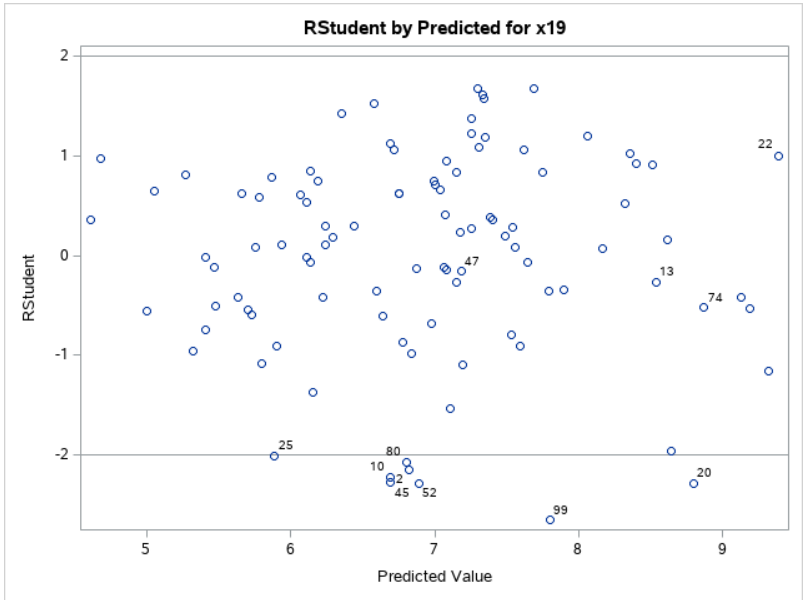

FIG 4.11

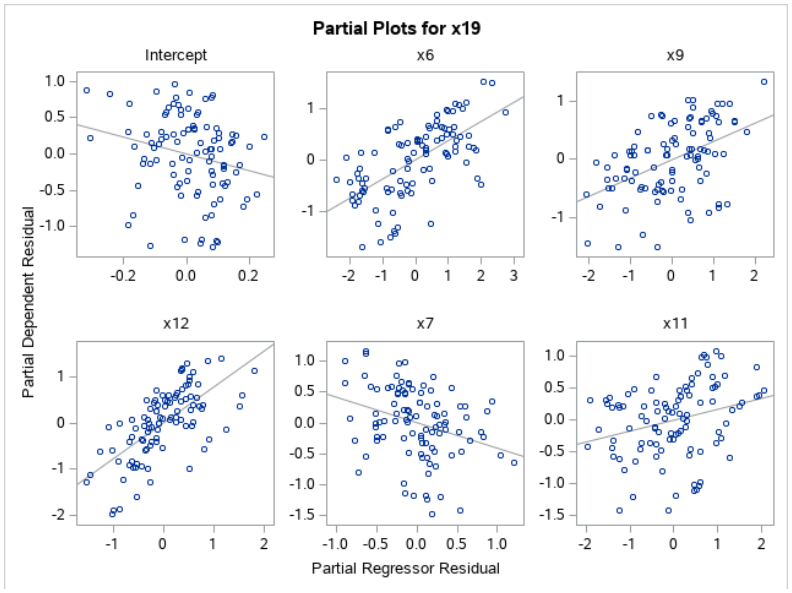

FIG 4.12

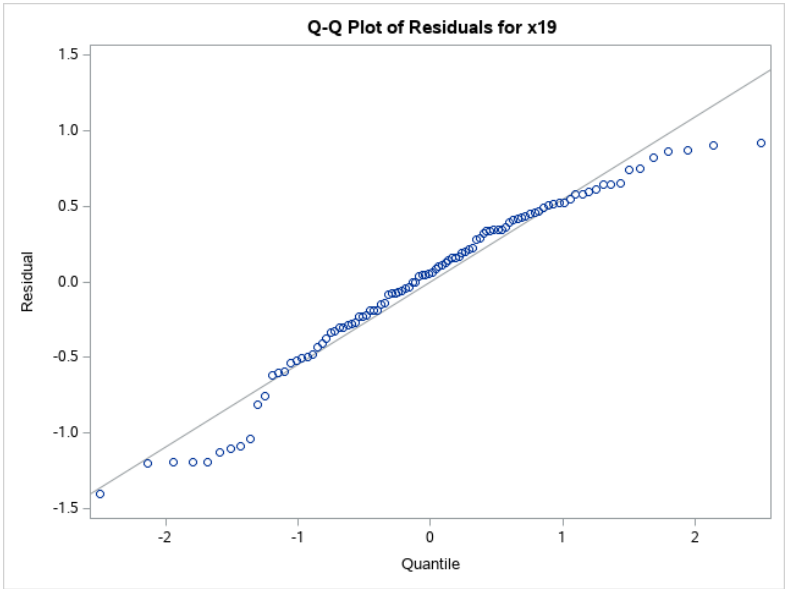

FIG 4.13