**THE UNIVERSITY OF BRITISH COLUMBIA**

**FORESTRY 430 and 533**

FINAL EXAMINATION: December 12, 2006 Instructor: Val LeMay

Time: 2 hours

90 Marks FRST 430 100 Marks FRST 533 **(extra questions)**

This examination (Open Book) consists of **3** questions, plus SAS outputs for some questions. A t-table and an F-table are attached at the end of the exam. Show hypotheses for all tests, state the alpha level that you used. ALSO, if you have made any assumptions concerning the question, please state these. **There are 2 extra part-questions for FRST 533 students only.**

**(30) 1.** A forest inventory specialist arranges for pairs of very large scale (objects appear large) photographs to be taken from an airplane at regular intervals over the landscape. Each pair of photographs is set up for three dimensional (stereo) viewing. Within a 12 m radius of a central point on the pair of photographs, heights are measured on every tree and averaged (**aveht**, metres), and all trees are counted and used to calculate stems per ha (**sph**). For a subset of these photographs (32 of them), the centre points of the photographs are also located on the ground and the diameter at 1.3 m above ground (dbh, centimetres) is measured for all trees within a 12 m radius, and averaged (**avedbh**). The specialist wants to obtain predicted **avedbh** for the other photographs for which no ground measures were taken. You are hired to fit a regression model to predict **avedbh** from **aveht** and **sph** using the 32 observations. After some testing, you decide to use the natural logarithm of avedbh (**lnavedbh**), the natural logarithm of aveht (**lnaveht**), and the reciprocal of sph (**recsph**) (**see Output 1**). Based on the output: NOTE: Show all hypotheses, alpha levels, and give full evidence.

(a) Were the assumptions of multiple linear regression met for this equation? (If assumptions are not met, then complete the rest of

the assessment, but note that this should be interpreted with caution.)

(b) How good is this equation, based on the coefficient of determination ($R^2$) and Root MSE (also called $SE_E$))? (State the values and explain what they mean).

(c) Is the regression significant?

(d) Is each of the variables in the model significant?

(e) What is the fitted equation to predict **avedbh**?

(f) To illustrate to the biologist how to use the fitted equation, calculate the **predicted avedbh** for a pair of photographs with an **aveht=15 m** and **sph=300 stems/ha.**

**(30)** 2. Zoo keepers are interested in the best food for lion cubs (baby lions). Three countries participate in the study. In each country, they feed four different kinds of food (Mixture, Gazelles, Rodents, Artificial) to eight lion cubs in their zoos. The type of food is randomly assigned to each cub, within each country. After a period of time, the **weight** of each cub is recorded. The data are put into an EXCEL file, and they hire you to do the analysis for them. They want to know if the average weights of cubs differ for the different food types. You use the procedure GLM and SAS to analyze these data, after some preliminary analysis, you use the natural logarithm of weight (**lnweight**) to try to mean the assumptions of analysis of variance **(Output 2).**

(a) List the sources (each component in the model, and the total), the degrees of freedom for each source, whether these are fixed- or random-effect factors, and the expected mean squares for each source.

(b) What would you call this experimental design and why?

(c) Are the assumptions of analysis of variance met using the lnweight variable? Briefly give evidence of why or why not. (Continue with the analysis even if assumptions are not met, but indicate where caution is needed).

(d) Are there differences in average cub weight for different foods?

i. State the hypothesis

ii. Select the appropriate F-test, based on the expected mean squares you listed in part (a) of this question, and test this hypothesis.

iii. If there is a difference in mean cub weight for different food types, which food_types differ?

***(e) (5 points) FOR 533 only: If the experiment was run again, using the same cubs, but a second factor was added, Gender (Male versus Female) and crossed with the food factor:***

***i. Show the analysis of variance table (sources, degrees of freedom), for this new experiment.***

***ii. What name would you give this experimental design?***

**(30)** 3. After graduating from university, you get a job working as an environmental scientist for a paper making plant. One of your first tasks in the new job is to analyze and report on the results of a recent experiment. The experimental design is described as:

"We are interested in testing the impacts of different water treatment processes and different chemical additives on the quality of waste water (as measured by amount of nitrogen and other properties) from the paper making plant. In our laboratory, we simulated three different processes, including the process currently used, and three different chemical additives, including the currently used additive. Eighteen tanks of waste water were used in the experiment. We processed each tank of waste water using a randomly assigned combination of a particular process and chemical additive. From each tank, four vials of water were taken, and water quality was measured on each vial. We ultimately would like to know which chemical additive and which process is best, in terms of water quality."

(a) For this design:

i. What are the response variables?

ii. What are the factors? How many levels are there in each factor? Are these fixed or random-effects? What is a treatment?

iii. Were any factors nested or were there any split-plots?

iv. Was there any blocking?

v. What is the experimental unit? How many are there in total? How many experimental units were there per treatment?

vi. Was there any subsampling? If so, how many are there in each experimental unit?

vii. How many observations are there in total?

(b) What would you call this design?

(c) For this design:

i. Show an analysis of variance table with the 1) sources; and 2) degrees of freedom (give specific values for this design).

(d) What hypotheses would you test for this experiment? For each hypothesis, show the hypothesis statement, and give the numerator and denominator means squares for the F test.

***(e) FRST 533 only: How would you modify this design and analysis if you believe that the water quality before processing might differ among tanks? (5 points)***

**OUTPUT 1**

**DATA:**

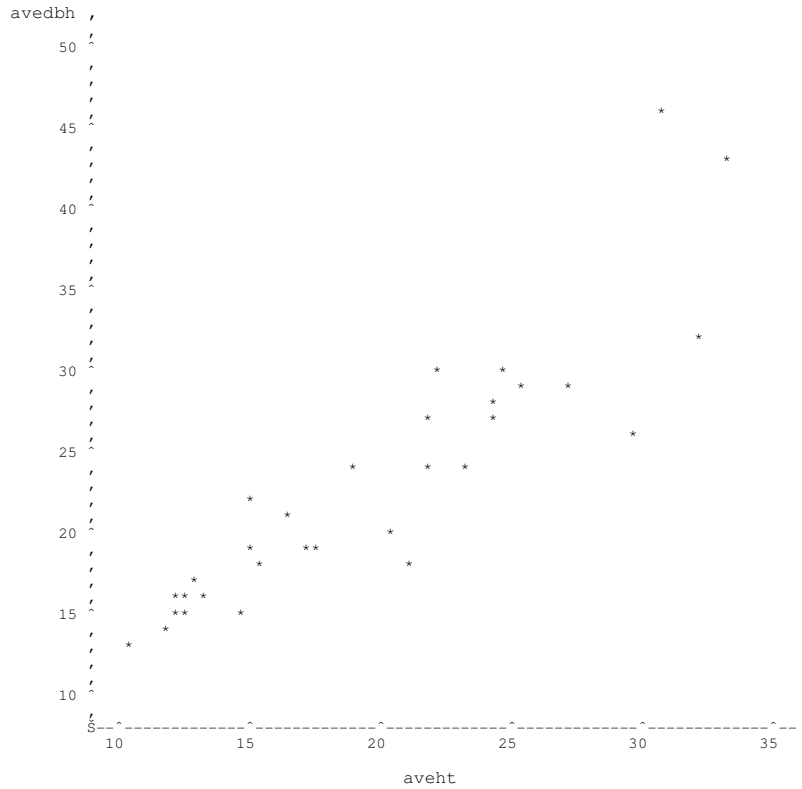
| plotno | avedbh | sph | aveht |
|---|---|---|---|
| 5 | 29.6 | 684 | 24.7 |
| 6 | 27.9 | 944 | 24.3 |
| 7 | 25.7 | 1187 | 29.5 |
| 9 | 32 | 420 | 32.1 |
| 17 | 17.6 | 1400 | 15.4 |
| 18 | 20.8 | 1273 | 16.4 |
| 24 | 42.8 | 278 | 33.2 |
| 25 | 20.2 | 1767 | 20.3 |
| 27 | 28.5 | 634 | 25.3 |
| 28 | 23.8 | 844 | 23.3 |
| 33 | 26.7 | 667 | 24.4 |
| 35 | 29.4 | 572 | 27.3 |
| 39 | 46.4 | 331 | 30.8 |
| 41 | 26.7 | 564 | 21.7 |
| 45 | 15.3 | 2585 | 14.6 |
| 46 | 29.6 | 1052 | 22 |
| 49 | 19.4 | 1654 | 17.1 |
| 50 | 24.3 | 843 | 18.8 |
| 51 | 24.4 | 713 | 21.9 |
| 52 | 19.1 | 1885 | 17.4 |
| 53 | 13.2 | 2386 | 10.3 |
| 54 | 15.8 | 1273 | 12.1 |
| 55 | 15.9 | 883 | 12.4 |
| 56 | 14.1 | 3117 | 11.8 |
| 57 | 18.9 | 1262 | 14.9 |
| 58 | 18.2 | 1577 | 15.2 |
| 59 | 15.9 | 1781 | 13.2 |
| 60 | 21.6 | 1272 | 15 |
| 61 | 15.4 | 1886 | 12.4 |
| 62 | 17.4 | 1052 | 12.9 |
| 63 | 17.5 | 628 | 21 |
| 64 | 15.3 | 1051 | 12.2 |

**SAS CODE:**

```
* file imported from EXCEL to a SAS temporary file called
plots;


data plots2;
set plots;
lnavedbh=log(avedbh);
lnaveht=log(aveht);
lnsph=log(sph);
recsph=1/sph;
avehtsq=aveht**2;
run;

proc plot data=plots2;
plot avedbh* aveht='*';
plot avedbh*recsph='*';
run;

* predict avedbh from aveht and sph;

proc reg data=plots2;
MODEL1: model lnavedbh=lnaveht recsph;
output out=pout1 r=resid1 p=pred1;
run;

proc plot data=pout1;
plot resid1*pred1='*'/ vref=0;
run;

proc univariate data=pout1 normal plot;
var resid1;
histogram / normal;
run;
```

The SAS System 13:49

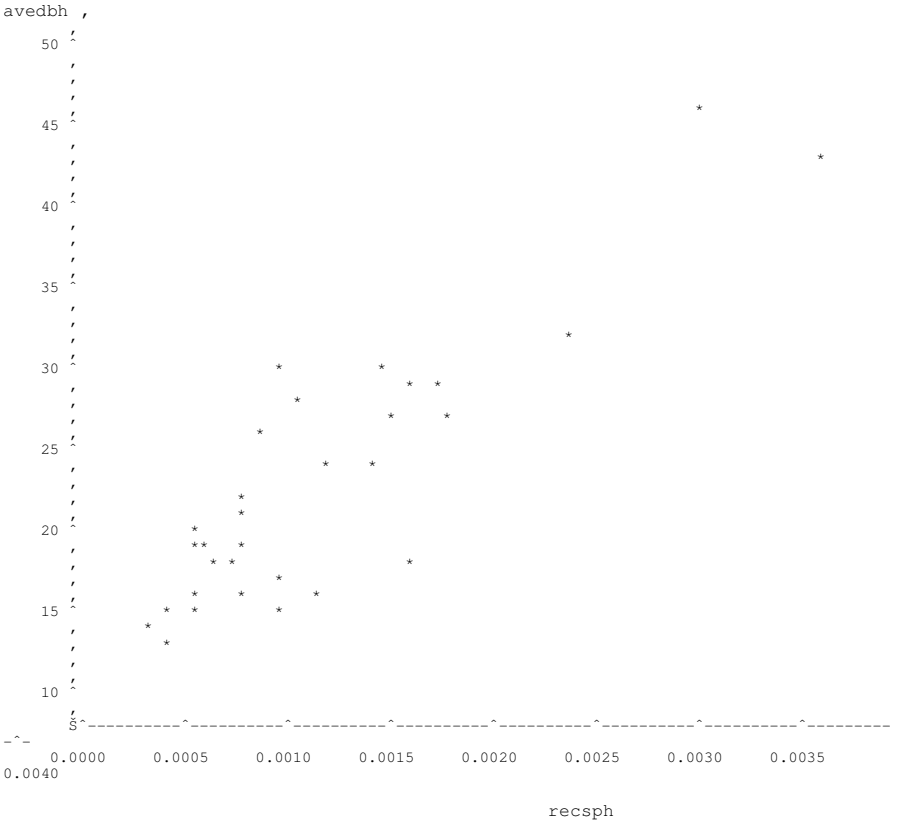
Plot of avedbh*aveht. Symbol used is '*'.




NOTE: 1 obs hidden.

The SAS System

Plot of avedbh*recsph. Symbol used is '*'.




NOTE: 1 obs hidden.

The SAS System

The REG Procedure
Model: MODEL1
Dependent Variable: lnavedbh

Number of Observations Read 32
Number of Observations Used 32

Analysis of Variance

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 2 | 2.74527 | 1.37263 | 120.52 | <.0001 |
| Error | 29 | 0.33030 | 0.01139 | | |
| Corrected Total | 31 | 3.07556 | | | |

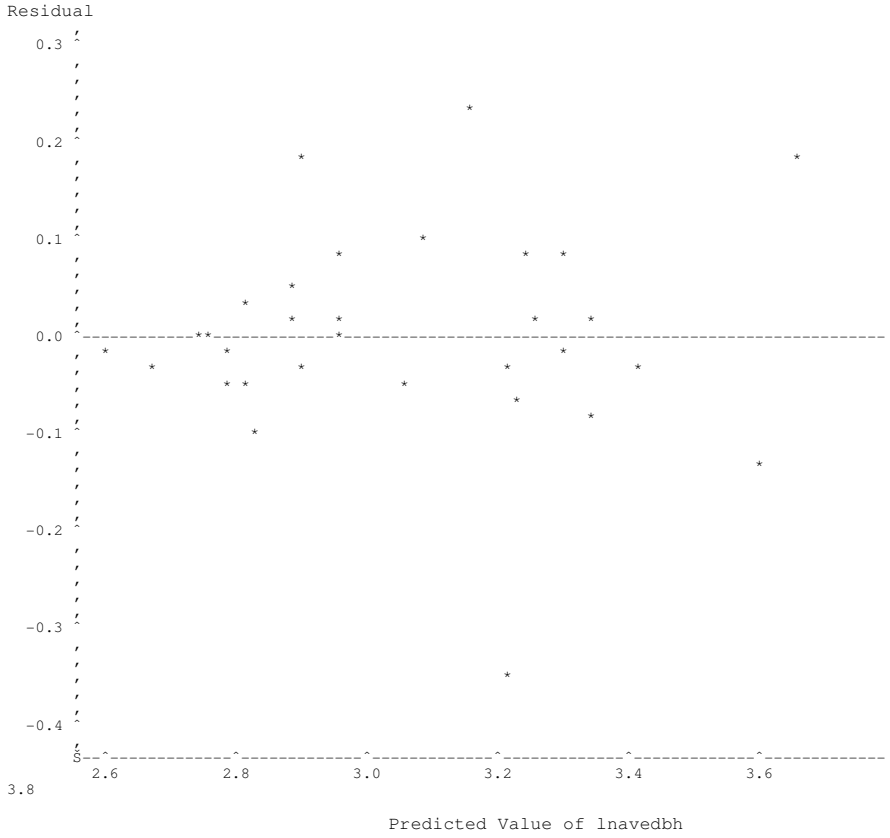
| | | | |
|---|---|---|---|
| Root MSE | 0.10672 | R-Square | 0.8926 |
| Dependent Mean | 3.07593 | Adj R-Sq | 0.8852 |
| Coeff Var | 3.46958 | | |

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | 1.04017 | 0.22063 | 4.71 | <.0001 |
| lnaveht | 1 | 0.64575 | 0.08609 | 7.50 | <.0001 |
| recsph | 1 | 133.08111 | 38.72435 | 3.44 | 0.0018 |

The SAS System

Plot of resid1*pred1. Symbol used is '*'.



The SAS System

The UNIVARIATE Procedure
Variable: resid1 (Residual)

Moments

| | | | |
|---|---|---|---|
| N | 32 | Sum Weights | 32 |
| Mean | 0 | Sum Observations | 0 |
| Std Deviation | 0.10322178 | Variance | 0.01065474 |
| Skewness | -0.7405539 | Kurtosis | 4.09207457 |
| Uncorrected SS | 0.33029679 | Corrected SS | 0.33029679 |
| Coeff Variation | . | Std Error Mean | 0.0182472 |

Basic Statistical Measures

| Location | | Variability | |
|---|---|---|---|
| Mean | 0.00000 | Std Deviation | 0.10322 |
| Median | -0.01020 | Variance | 0.01065 |
| Mode | . | Range | 0.58094 |
| | | Interquartile Range | 0.08551 |

Tests for Location: Mu0=0

| Test | -Statistic- | | -----p Value------ | |
|---|---|---|---|---|
| Student's t | t | 0 | Pr > \|t\| | 1.0000 |
| Sign | M | -2 | Pr >= \|M\| | 0.5966 |
| Signed Rank | S | -17 | Pr >= \|S\| | 0.7561 |

Tests for Normality

| Test | --Statistic--- | | -----p Value------ | |
|---|---|---|---|---|
| Shapiro-Wilk | W | 0.898661 | Pr < W | 0.0057 |
| Kolmogorov-Smirnov | D | 0.151349 | Pr > D | 0.0616 |
| Cramer-von Mises | W-Sq | 0.169786 | Pr > W-Sq | 0.0128 |
| Anderson-Darling | A-Sq | 1.034366 | Pr > A-Sq | 0.0090 |

Quantiles (Definition 5)

| Quantile | Estimate |
|---|---|
| 100% Max | 0.2250530 |
| 99% | 0.2250530 |
| 95% | 0.1817454 |
| 90% | 0.0978950 |
| 75% Q3 | 0.0437953 |
| 50% Median | -0.0102045 |
| 25% Q1 | -0.0417138 |
| 10% | -0.0912731 |
| 5% | -0.1313165 |
| 1% | -0.3558896 |
| 0% Min | -0.3558896 |

Extreme Observations

| -------Lowest------ | | ------Highest------ | |
|---|---|---|---|
| Value | Obs | Value | Obs |
| -0.3558896 | 31 | 0.0872228 | 2 |
| -0.1313165 | 4 | 0.0978950 | 18 |
| -0.0950753 | 15 | 0.1791699 | 28 |
| -0.0912731 | 3 | 0.1817454 | 13 |
| -0.0612851 | 10 | 0.2250530 | 16 |

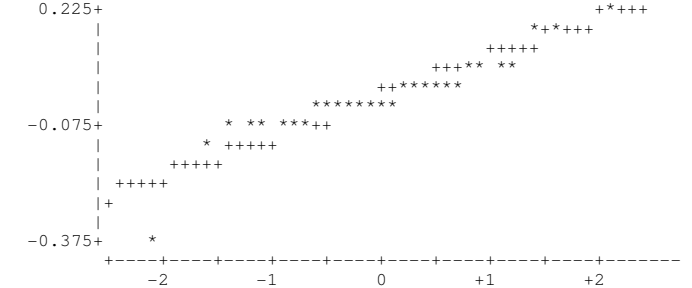
| Stem | Leaf | # | Boxplot |
|---|---|---|---|
| 2 | 3 | 1 | 0 |
| 1 | 88 | 2 | 0 |
| 1 | 0 | 1 | \| |
| 0 | 5889 | 4 | \| |
| 0 | 111224 | 6 | +--+--+ |
| -0 | 3333222110 | 10 | *-----* |
| -0 | 96555 | 5 | \| |
| -1 | 30 | 2 | \| |
| -1 | | | |
| -2 | | | |
| -2 | | | |
| -3 | | | |
| -3 | 6 | 1 | * |

----+----+----+----+
Multiply Stem.Leaf by 10**-1

The SAS System

The UNIVARIATE Procedure
Variable: resid1 (Residual)

Normal Probability Plot



## OUTPUT 2

**DATA:**

| Country | Food_Type | Cub | Weight |
|---|---|---|---|
| 1 | Mixture | 1 | 49 |
| 1 | Mixture | 2 | 55 |
| 1 | Gazelles | 1 | 43 |
| 1 | Gazelles | 2 | 51 |
| 1 | Rodents | 1 | 39 |
| 1 | Rodents | 2 | 29 |
| 1 | Artificial | 1 | 84 |
| 1 | Artificial | 2 | 92 |
| 2 | Mixture | 1 | 62 |
| 2 | Mixture | 2 | 66 |
| 2 | Gazelles | 1 | 27 |
| 2 | Gazelles | 2 | 33 |
| 2 | Rodents | 1 | 44 |
| 2 | Rodents | 2 | 52 |
| 2 | Artificial | 1 | 63 |
| 2 | Artificial | 2 | 57 |
| 3 | Mixture | 1 | 38 |
| 3 | Mixture | 2 | 42 |
| 3 | Gazelles | 1 | 45 |
| 3 | Gazelles | 2 | 49 |
| 3 | Rodents | 1 | 55 |
| 3 | Rodents | 2 | 43 |
| 3 | Artificial | 1 | 70 |
| 3 | Artificial | 2 | 60 |

**SAS CODE:**

```
PROC IMPORT OUT= WORK.lions
  DATAFILE= "E:\frst430\lemay\y06-07\final\question2.XLS"
  DBMS=EXCEL REPLACE;
  SHEET="van_lar_p350$";
  GETNAMES=YES;          MIXED=NO;
  SCANTEXT=YES;          USEDATE=YES;
  SCANTIME=YES;
RUN;

options ls=64 ps=50 nodate pageno=1;
run;

data lions2;
set lions;
lnweight=log(weight);
run;

proc sort data=lions2;
by country food_type;
run;

proc means data=lions2;
var weight lnweight;
by country food_type;
run;

* using original measures of weight;
PROC GLM data=lions2;
CLASS country food_type;
MODEL lnweight=country food_type country*food_type;
test h=food_type e=country*food_type;
LSMEANS food_type/tdiff pdiff;
LSMEANS food_type/e=country*food_type tdiff pdiff;
OUTPUT OUT=GLMOUT2 PREDICTED=PREDICT2 RESIDUAL=RESID2;
RUN;
PROC PLOT DATA=GLMOUT2;
PLOT RESID2*PREDICT2='*';
RUN;
PROC UNIVARIATE DATA=GLMOUT2 PLOT NORMAL;
VAR RESID2;
RUN;
```

---------- Country=1 Food_Type=Artificial ----------

The MEANS Procedure

| Variable | Label | N | Mean | Std Dev | Minimum |
|---|---|---|---|---|---|
| Weight | Weight | 2 | 88.0000000 | 5.6568542 | 84.0000000 |
| lnweight | | 2 | 4.4763027 | 0.0643268 | 4.4308168 |

| Variable | Label | Maximum |
|---|---|---|
| Weight | Weight | 92.0000000 |
| lnweight | | 4.5217886 |

---------- Country=1 Food_Type=Gazelles ----------

| Variable | Label | N | Mean | Std Dev | Minimum |
|---|---|---|---|---|---|
| Weight | Weight | 2 | 47.0000000 | 5.6568542 | 43.0000000 |
| lnweight | | 2 | 3.8465129 | 0.1206505 | 3.7612001 |

| Variable | Label | Maximum |
|---|---|---|
| Weight | Weight | 51.0000000 |
| lnweight | | 3.9318256 |

---------- Country=1 Food_Type=Mixture ----------

| Variable | Label | N | Mean | Std Dev | Minimum |
|---|---|---|---|---|---|
| Weight | Weight | 2 | 52.0000000 | 4.2426407 | 49.0000000 |
| lnweight | | 2 | 3.9495767 | 0.0816799 | 3.8918203 |

| Variable | Label | Maximum |
|---|---|---|
| Weight | Weight | 55.0000000 |
| lnweight | | 4.0073332 |



---------- Country=1 Food_Type=Rodents ----------

The MEANS Procedure

| Variable | Label | N | Mean | Std Dev | Minimum |
|---|---|---|---|---|---|
| Weight | Weight | 2 | 34.0000000 | 7.0710678 | 29.0000000 |
| lnweight | | 2 | 3.5154287 | 0.2094916 | 3.3672958 |

| Variable | Label | Maximum |
|---|---|---|
| Weight | Weight | 39.0000000 |
| lnweight | | 3.6635616 |

---------- Country=2 Food_Type=Artificial ----------

| Variable | Label | N | Mean | Std Dev | Minimum |
|---|---|---|---|---|---|
| Weight | Weight | 2 | 60.0000000 | 4.2426407 | 57.0000000 |
| lnweight | | 2 | 4.0930930 | 0.0707697 | 4.0430513 |

| Variable | Label | Maximum |
|---|---|---|
| Weight | Weight | 63.0000000 |
| lnweight | | 4.1431347 |

---------- Country=2 Food_Type=Gazelles ----------

| Variable | Label | N | Mean | Std Dev | Minimum |
|---|---|---|---|---|---|
| Weight | Weight | 2 | 30.0000000 | 4.2426407 | 27.0000000 |
| lnweight | | 2 | 3.3961722 | 0.1418956 | 3.2958369 |

| Variable | Label | Maximum |
|---|---|---|
| Weight | Weight | 33.0000000 |
| lnweight | | 3.4965076 |

---------- Country=2 Food_Type=Mixture ----------

The MEANS Procedure

| Variable | Label | N | Mean | Std Dev | Minimum |
|---|---|---|---|---|---|
| Weight | Weight | 2 | 64.0000000 | 2.8284271 | 62.0000000 |
| lnweight | | 2 | 4.1583946 | 0.0442086 | 4.1271344 |

| Variable | Label | Maximum |
|---|---|---|
| Weight | Weight | 66.0000000 |
| lnweight | | 4.1896547 |

---------- Country=2 Food_Type=Rodents ----------

| Variable | Label | N | Mean | Std Dev | Minimum |
|---|---|---|---|---|---|
| Weight | Weight | 2 | 48.0000000 | 5.6568542 | 44.0000000 |
| lnweight | | 2 | 3.8677167 | 0.1181251 | 3.7841896 |

| Variable | Label | Maximum |
|---|---|---|
| Weight | Weight | 52.0000000 |
| lnweight | | 3.9512437 |

---------- Country=3 Food_Type=Artificial ----------

| Variable | Label | N | Mean | Std Dev | Minimum |
|---|---|---|---|---|---|
| Weight | Weight | 2 | 65.0000000 | 7.0710678 | 60.0000000 |
| lnweight | | 2 | 4.1714199 | 0.1090010 | 4.0943446 |

| Variable | Label | Maximum |
|---|---|---|
| Weight | Weight | 70.0000000 |
| lnweight | | 4.2484952 |



---------- Country=3 Food_Type=Gazelles ----------

The MEANS Procedure

| Variable | Label | N | Mean | Std Dev | Minimum |
|---|---|---|---|---|---|
| Weight | Weight | 2 | 47.0000000 | 2.8284271 | 45.0000000 |
| lnweight | | 2 | 3.8492414 | 0.0602157 | 3.8066625 |

| Variable | Label | Maximum |
|---|---|---|
| Weight | Weight | 49.0000000 |
| lnweight | | 3.8918203 |

---------- Country=3 Food_Type=Mixture ----------

| Variable | Label | N | Mean | Std Dev | Minimum |
|---|---|---|---|---|---|
| Weight | Weight | 2 | 40.0000000 | 2.8284271 | 38.0000000 |
| lnweight | | 2 | 3.6876279 | 0.0707697 | 3.6375862 |

| Variable | Label | Maximum |
|---|---|---|
| Weight | Weight | 42.0000000 |
| lnweight | | 3.7376696 |

---------- Country=3 Food_Type=Rodents ----------

| Variable | Label | N | Mean | Std Dev | Minimum |
|---|---|---|---|---|---|
| Weight | Weight | 2 | 49.0000000 | 8.4852814 | 43.0000000 |
| lnweight | | 2 | 3.8842667 | 0.1740424 | 3.7612001 |

| Variable | Label | Maximum |
|---|---|---|
| Weight | Weight | 55.0000000 |
| lnweight | | 4.0073332 |

The GLM Procedure

Class Level Information

| Class | Levels | Values |
|---|---|---|
| Country | 3 | 1 2 3 |
| Food_Type | 4 | Artificial Gazelles Mixture Rodents |

| | |
|---|---|
| Number of Observations Read | 24 |
| Number of Observations Used | 24 |



The GLM Procedure

Dependent Variable: lnweight

| Source | DF | Sum of Squares | Mean Square |
|---|---|---|---|
| Model | 11 | 1.93021294 | 0.17547390 |
| Error | 12 | 0.16110968 | 0.01342581 |
| Corrected Total | 23 | 2.09132262 | |

| Source | F Value | Pr > F |
|---|---|---|
| Model | 13.07 | <.0001 |
| Error | | |
| Corrected Total | | |

| R-Square | Coeff Var | Root MSE | lnweight Mean |
|---|---|---|---|
| 0.922963 | 2.964954 | 0.115870 | 3.907979 |

| Source | DF | Type I SS | Mean Square |
|---|---|---|---|
| Country | 2 | 0.01971854 | 0.00985927 |
| Food_Type | 3 | 1.09801990 | 0.36600663 |
| Country*Food_Type | 6 | 0.81247451 | 0.13541242 |

| Source | F Value | Pr > F |
|---|---|---|
| Country | 0.73 | 0.5002 |
| Food_Type | 27.26 | <.0001 |
| Country*Food_Type | 10.09 | 0.0004 |

| Source | DF | Type III SS | Mean Square |
|---|---|---|---|
| Country | 2 | 0.01971854 | 0.00985927 |
| Food_Type | 3 | 1.09801990 | 0.36600663 |
| Country*Food_Type | 6 | 0.81247451 | 0.13541242 |

| Source | F Value | Pr > F |
|---|---|---|
| Country | 0.73 | 0.5002 |
| Food_Type | 27.26 | <.0001 |
| Country*Food_Type | 10.09 | 0.0004 |



The GLM Procedure

Tests of Hypotheses Using the Type III MS for Country*Food_Type as an Error Term

| Source | DF | Type III SS | Mean Square |
|---|---|---|---|
| Food_Type | 3 | 1.09801990 | 0.36600663 |

Tests of Hypotheses Using the Type III MS for Country*Food_Type as an Error Term

| Source | F Value | Pr > F |
|---|---|---|
| Food_Type | 2.70 | 0.1386 |

The GLM Procedure
Least Squares Means

| Food_Type | lnweight LSMEAN | LSMEAN Number |
|---|---|---|
| Artificial | 4.24693853 | 1 |
| Gazelles | 3.69730883 | 2 |
| Mixture | 3.93186640 | 3 |
| Rodents | 3.75580402 | 4 |

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

Dependent Variable: lnweight

| i/j | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | | 8.216004 | 4.709778 | 7.341603 |
| | | <.0001 | 0.0005 | <.0001 |
| 2 | -8.216 | | -3.50623 | -0.8744 |
| | <.0001 | | 0.0043 | 0.3991 |
| 3 | -4.70978 | 3.506226 | | 2.631825 |
| | 0.0005 | 0.0043 | | 0.0219 |
| 4 | -7.3416 | 0.874401 | -2.63182 | |
| | <.0001 | 0.3991 | 0.0219 | |

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



The GLM Procedure
Least Squares Means
Standard Errors and Probabilities Calculated Using the Type III
MS for Country*Food_Type as an Error Term

| Food_Type | lnweight LSMEAN | LSMEAN Number |
|---|---|---|
| Artificial | 4.24693853 | 1 |
| Gazelles | 3.69730883 | 2 |
| Mixture | 3.93186640 | 3 |
| Rodents | 3.75580402 | 4 |

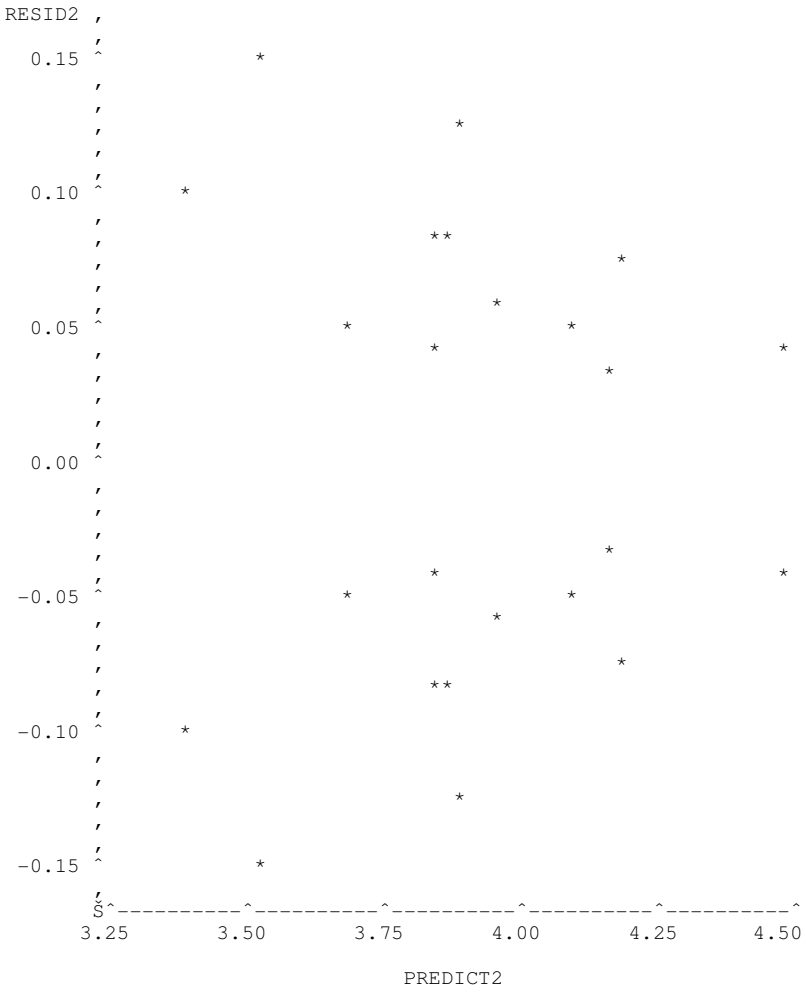
Least Squares Means for Effect Food_Type
t for H0: LSMean(i)=LSMean(j) / Pr > |t|

Dependent Variable: lnweight

| i/j | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | | 2.587031 | 1.483001 | 2.311702 |
| | | 0.0414 | 0.1886 | 0.0601 |
| 2 | -2.58703 | | -1.10403 | -0.27533 |
| | 0.0414 | | 0.3119 | 0.7923 |
| 3 | -1.483 | 1.10403 | | 0.828701 |
| | 0.1886 | 0.3119 | | 0.4390 |
| 4 | -2.3117 | 0.275329 | -0.8287 | |
| | 0.0601 | 0.7923 | 0.4390 | |

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

Plot of RESID2*PREDICT2. Symbol used is '*'.






The UNIVARIATE Procedure
Variable: RESID2

Moments

| | | | |
|---|---|---|---|
| N | 24 | Sum Weights | 24 |
| Mean | 0 | Sum Observations | 0 |
| Std Deviation | 0.0836945 | Variance | 0.00700477 |
| Skewness | 0 | Kurtosis | -1.1763693 |
| Uncorrected SS | 0.16110968 | Corrected SS | 0.16110968 |
| Coeff Variation | . | Std Error Mean | 0.01708407 |

Basic Statistical Measures

| Location | | Variability | |
|---|---|---|---|
| Mean | 0.00000 | Std Deviation | 0.08369 |
| Median | 0.00000 | Variance | 0.00700 |
| Mode | -0.05004 | Range | 0.29627 |
| | | Interquartile Range | 0.13483 |

Tests for Location: Mu0=0

| Test | -Statistic- | | -----p Value------ | |
|---|---|---|---|---|
| Student's t | t | 0 | Pr > \|t\| | 1.0000 |
| Sign | M | 0 | Pr >= \|M\| | 1.0000 |
| Signed Rank | S | 1 | Pr >= \|S\| | 0.9779 |

Tests for Normality

| Test | --Statistic--- | | -----p Value------ | |
|---|---|---|---|---|
| Shapiro-Wilk | W | 0.949646 | Pr < W | 0.2662 |
| Kolmogorov-Smirnov | D | 0.152867 | Pr > D | >0.1500 |
| Cramer-von Mises | W-Sq | 0.115026 | Pr > W-Sq | 0.0695 |
| Anderson-Darling | A-Sq | 0.568954 | Pr > A-Sq | 0.1300 |

The UNIVARIATE Procedure
Variable: RESID2

Quantiles (Definition 5)

| Quantile | Estimate |
|---|---|
| 100% Max | 0.1481329 |
| 99% | 0.1481329 |
| 95% | 0.1230665 |
| 90% | 0.1003353 |
| 75% Q3 | 0.0674159 |
| 50% Median | 0.0000000 |
| 25% Q1 | -0.0674159 |
| 10% | -0.1003353 |
| 5% | -0.1230665 |
| 1% | -0.1481329 |
| 0% Min | -0.1481329 |

Extreme Observations

| Lowest | Obs | Highest | Obs |
|---|---|---|---|
| -0.1481329 | 8 | 0.0835270 | 16 |
| -0.1230665 | 24 | 0.0853128 | 4 |
| -0.1003353 | 11 | 0.1003353 | 12 |
| -0.0853128 | 3 | 0.1230665 | 23 |
| -0.0835270 | 15 | 0.1481329 | 7 |

| Stem | Leaf | # | Boxplot |
|---|---|---|---|
| 1 | 5 | 1 | |
| 1 | 02 | 2 | |
| 0 | 5556889 | 7 | +-----+ |
| 0 | 34 | 2 | *--+--* |
| -0 | 43 | 2 | \| \| |
| -0 | 9886555 | 7 | +-----+ |
| -1 | 20 | 2 | |
| -1 | 5 | 1 | |

Multiply Stem.Leaf by 10**-1



The UNIVARIATE Procedure
Variable: RESID2

Normal Probability Plot