Key

STAT 217: Interpretation After Transformations 10/30

1. The data come from the United Nations website showing CO2 consumption per capita (in metric tons) between the years of 1990 to 2010. We will examine this relationship.

```
lm.co2 <- lm(log(c02)~Year, data=c02)
summary(lm.co2)
```

```
##
## Call:
## lm(formula = log(c02) ~ Year, data = c02)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -7.8655 -1.1302  0.3162  1.3536  3.6870
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -26.891870   8.696339  -3.092  0.00200 **
## Year          0.013737   0.004348   3.160  0.00159 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.707 on 4269 degrees of freedom
##   (1 observation deleted due to missingness)
## Multiple R-squared:  0.002333,Adjusted R-squared:  0.002099
## F-statistic: 9.983 on 1 and 4269 DF,  p-value: 0.001591
```

(a) Provide two interpretations of b_1 on the original scale. Your first interpretation should use the multiplicative factor wording. Your second interpretation should use the percent increase/decrease wording.

① For an increase of one year, the true median CO_2 consumption per capita is estimated to change by a multiplicative factor of $e^{0.013737}$ (1.0138).

② For an increase of one year, the true median CO_2 consumption per capita is estimated to increase by 1.38%.

(b) Provide a 95% confidence interval for β_1 on the original scale. Show your work.

$0.013737 \pm 1.960\,(0.004348) = (0.005215, 0.02226)$

↑ from t_{4269}

Original Scale CI $= (e^{0.005215}, e^{0.02226}) = (1.0052, 1.0225)$

this is 95% CI for the multiplicative change (estimated at 1.0138)

2. Biological Pest Control. In a study of the effectiveness of biological control of the exotic weed tansy ragwort, researches manipulated the exposure to the ragwort flea beetle on 15 plots that had been planted with high density of ragwort. Harvesting the plots the next season, they measured the average dry mass of ragwort remaining (grams/plant) and the flea beetle load (beetles/gram of ragwort dry mass) to see if the ragwort plants in plots with high flea beetle loads were smaller as a result of herbivory by the beetles.

```
lm.log <- lm(log(Mass)~I(log(Load)), data=pest)
summary(lm.log)
```

```
##
## Call:
## lm(formula = log(Mass) ~ I(log(Load)), data = pest)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.54217 -1.04130  0.06406  1.40544  2.24600
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)     7.988      1.383   5.774 6.45e-05 ***
## I(log(Load))   -1.685      0.264  -6.383 2.41e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.646 on 13 degrees of freedom
## Multiple R-squared:  0.7581,Adjusted R-squared:  0.7395
## F-statistic: 40.74 on 1 and 13 DF,  p-value: 2.407e-05
```

(a) Provide two interpretations of b_1 on the original scale. Your first interpretation should use the multiplicative factor wording. Your second interpretation should use the percent increase/decrease wording.

① For a doubling of beetle load, the true median ragwort mass is estimated to change by a multiplicative factor of $2^{-1.685} = 0.311$.

② For a doubling of beetle load, the true median ragwort mass is estimated to decrease by 68.9%.

(b) What is the predicted mass of a plant with a load of 20 beetles per gram?

$\log(\hat{mass}) = 7.988 - 1.658 \log(\hat{load})$

$\log(\hat{mass}) = 7.988 - 1.658 \log(20)$

$\log(\hat{mass}) = 3.021$ $\rightarrow \hat{mass} = e^{3.021}$

$= 20.51$ grams/plant

(c) Provide a 95% confidence interval for β_1 on the original scale. Show your work.

$-1.685 \pm 2.16\ (0.264) = (-2.255, -1.115)$

from t_{13}

original scale $CI = (2^{-2.255}, 2^{-1.115}) = (0.209, 0.462)$

CI for the multiplicative