Brad Anderson | ESM 201 Winter 2018

**Assignment 1**

In order to compare and contrast the population trajectories between a developing nation and a developed nation and explore the explanatory variables affecting them, single and multiple linear regression was utilized. For both Uganda, a developing nation, and France, a developed nation, a simple linear model was created to explore the per capita growth rates (dN/Ndt) as a function of population size (Nt) and a multiple linear regression model was created to explore significant explanatory variables affecting the per capita growth rates (dN/Ndt).

**Uganda**

Figure 1 shows the per capita growth rate from 1961 to 2006. After exploring multiple lines of fit, a single linear model seemed most appropriate given that the overall trend is growth. According to this model of current growth, Uganda will not reach the carrying capacity (K) because the per capita growth rate is increasing at the same time total population increases. The diagnostic plot for the model shows that assumptions are met, though the scale-location plot indicates that the residuals are not spread totally equally along the ranges of predictors. Though the model shows the per capita growth rate (dN/Ndt) is significantly predicted by population size (Nt),with a low R2 of 0.22 and an large variability in dN/Ndt suggests non-linear models are worth exploring.

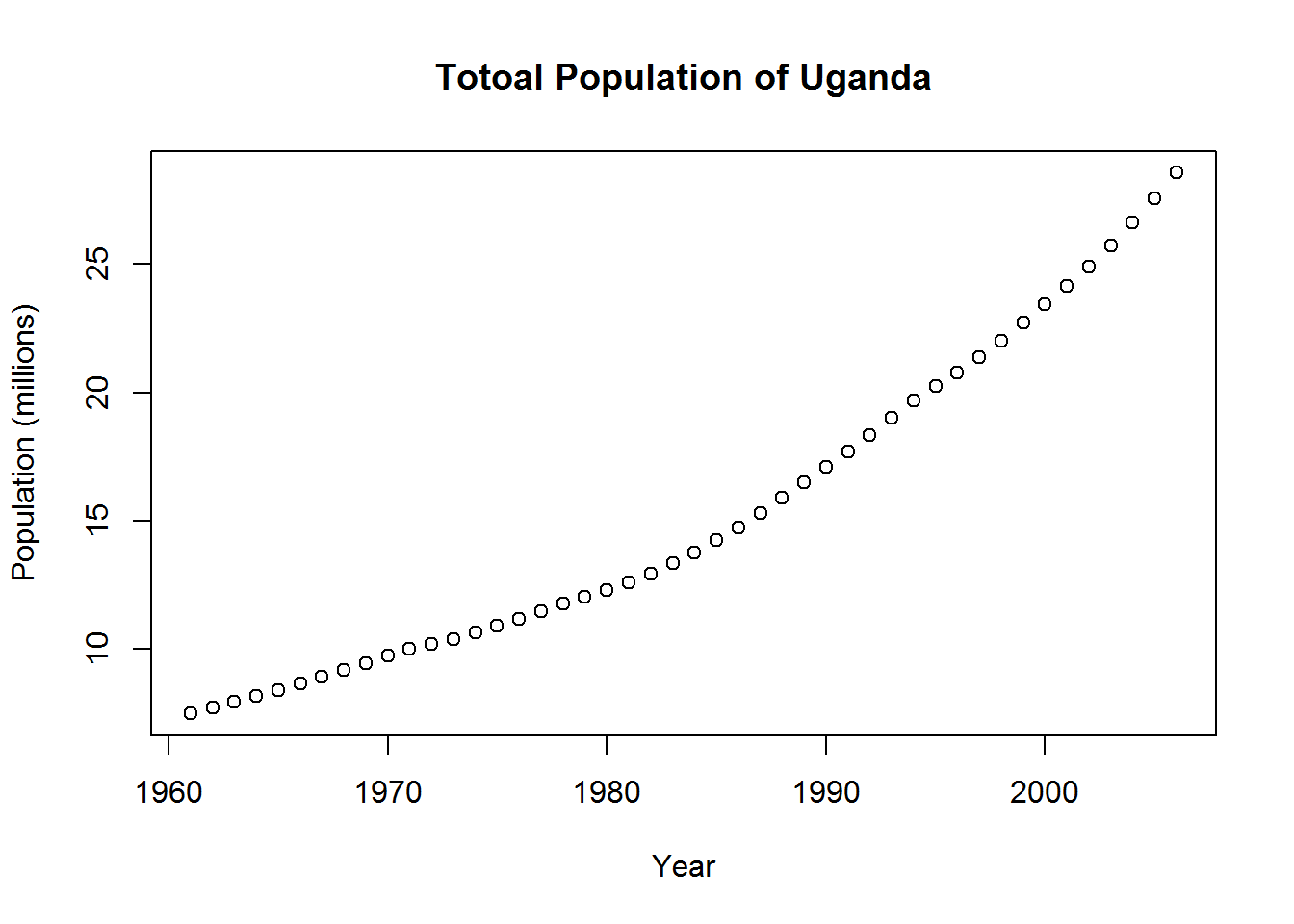


Figure : **Population Growth of Uganda, 1961 - 2006**

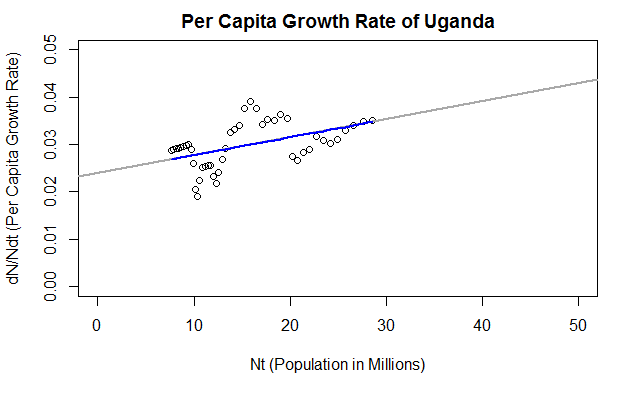


Figure : **Population Growth in Uganda 1961 to 2006.** Per capita growth rate (dN/Ndt) is significantly predicted by population size (Nt) (n = 46) (F(1,43) = 13.24, p < 0.001, R2 = 0.22).

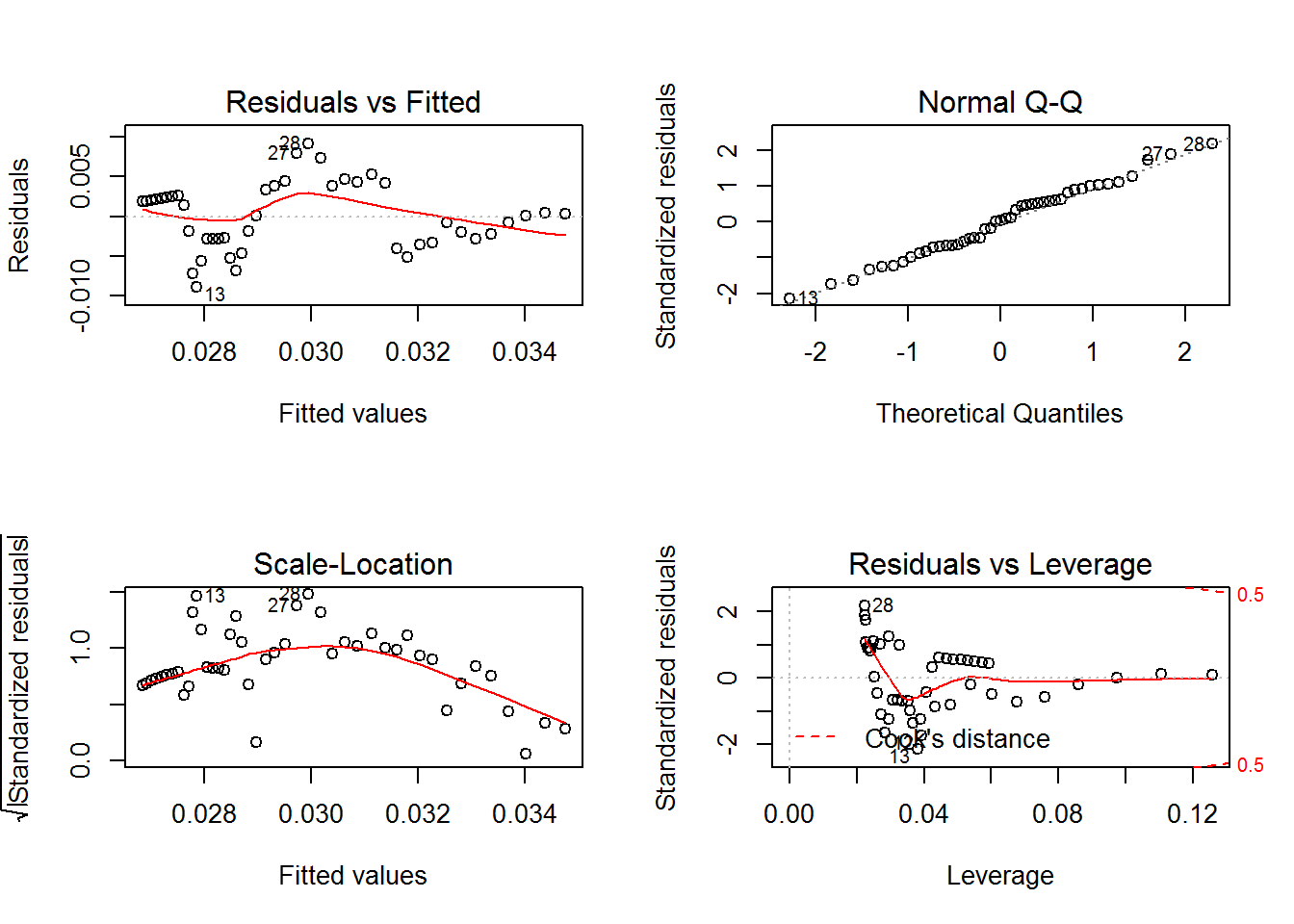


Figure : **Diagnostic plots for Uganda dN/Ndt model**

In order to explore the explanatory variables the population trajectory of Uganda between a multiple linear regression model was created. The model (dN/Ndt = -0.023 ∗ Food per Capita + 0.012 \* Years of Education + -0.002 Population Size explains a significant amount of variance in per capita population growth (dN/Ndt) (F(3, 38) = 7.722, *p* < 0.001, *R2* = 0.33). The diagnostic plots show that the four assumptions are met –linearity, independence, homoscedasticity, and normality.

|  |  |
| --- | --- |
|  | |
|  | *Dependent variable:* |
|  |  |
|  | dN/Ndt |
|  | |
| Food per Capita | -0.023\*\*\* |
|  | (0.008) |
|  |  |
| Years of Education | 0.012\*\* |
|  | (0.004) |
|  |  |
| Population | -0.002\*\* |
|  | (0.001) |
|  |  |
| Constant | 0.278\*\*\* |
|  | (0.083) |
|  |  |
|  | |
| Observations | 42 |
| R2 | 0.379 |
| Adjusted R2 | 0.330 |
| Residual Std. Error | 0.004 (df = 38) |
| F Statistic | 7.722\*\*\* (df = 3; 38) |
|  | |
| *Note:* | *p<0.1;****p<0.05;***p<0.01 |

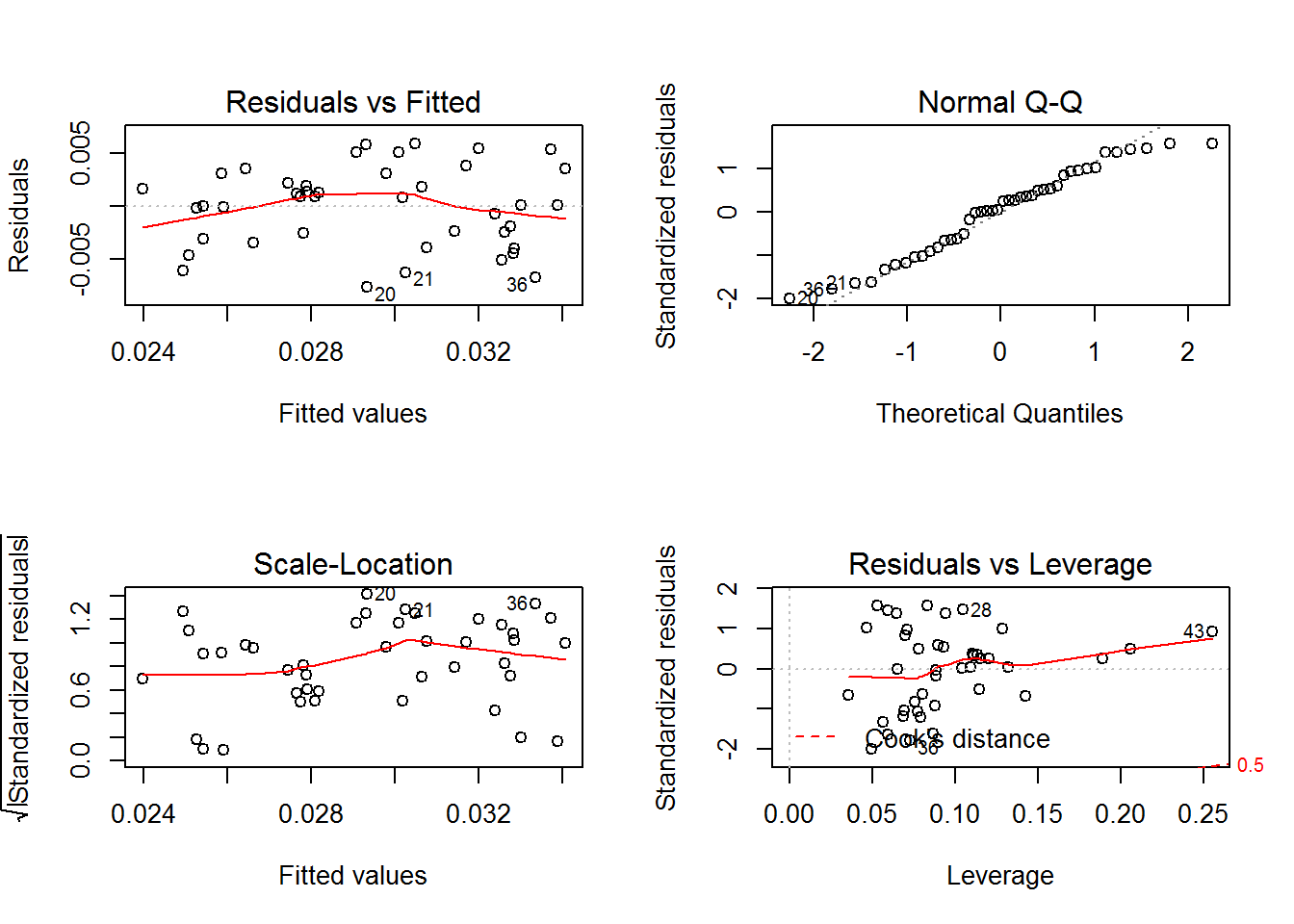


Figure : **Diagnostic Plots for Uganda Multiple Regression Model**

The diagnostic plots for the multiple regression model show a pretty good fit.

**France**

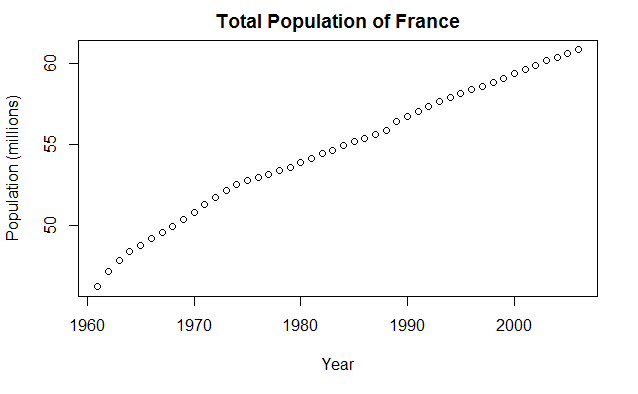


Figure : **Population Growth of France, 1961 – 2006**

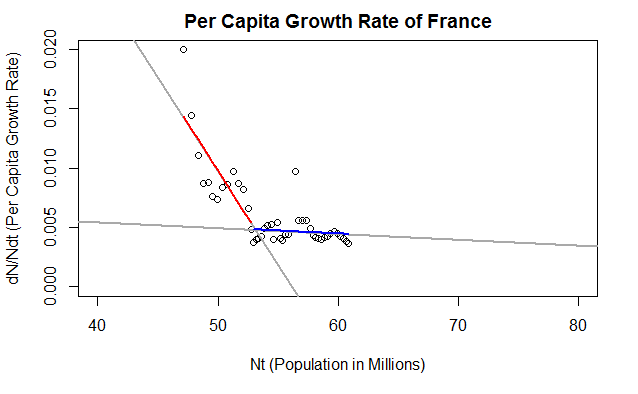


Figure : **Per Capita Growth Rate of France**

France should reach the carrying capacity (K) when the population reaches approximately 75 million people. The second linear model (blue) shows that K is much larger, but I think it is more appropriate to base K off the growth trend for the last 10 years of data as it fits current growth patterns better. The diagnostic plot for the model shows that a linear model is questionable –the Residuals vs Fitted plot is not convincing and there is an outlier that is beyond Cook’s distance.

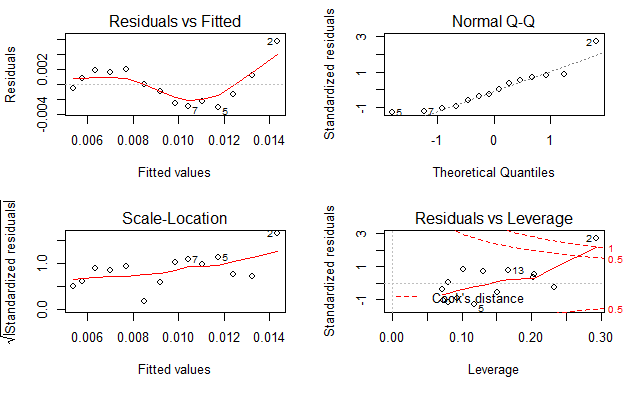


Figure : **Diagnostics for Linear Model of French Growth Rate from 1961 to 1975 (Red)**

The Residuals vs Fitted plot indicates that there may be a non-linear relationship and the Residuals vs Leverage shows that there is an outlier observation.

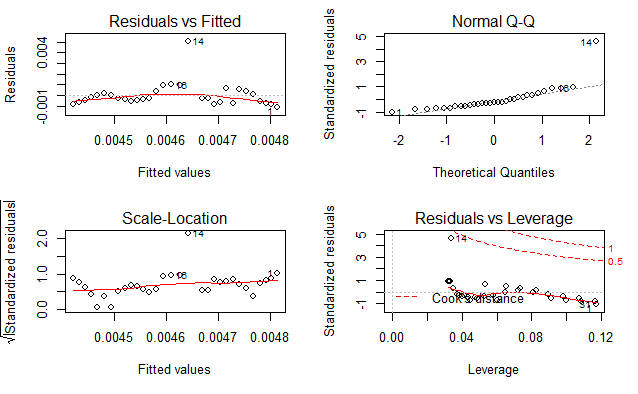


Figure : **Diagnostics for Linear Model of French Growth Rate from 1976 to 2006 (Blue)**

These plots look much better than the previous model, likely due to more variability in dN/Ndt during this time period.

Table 1: Professor salaries. Professor salary (n = 397) is significantly predicted (F(4, 392) = 79.18, p < 0.001, R2 = 0.44) by rank (p < 0.001) and discipline (p < 0.001), but not by sex (p = 0.24). Stars (\*\*\*) indicate p < 0.001. Source: Fox J. and Weisberg,

|  |  |
| --- | --- |
|  | |
|  | *Dependent variable:* |
|  |  |
|  | dNNdt |
|  | |
| Food per Capita | -0.006 |
|  | (0.008) |
|  |  |
| Years of Education | 0.003\*\*\* |
|  | (0.001) |
|  |  |
| Population | -0.002\*\*\* |
|  | (0.001) |
|  |  |
| Constant | 0.172\* |
|  | (0.092) |
|  |  |
|  | |
| Observations | 42 |
| R2 | 0.740 |
| Adjusted R2 | 0.719 |
| Residual Std. Error | 0.002 (df = 38) |
| F Statistic | 35.983\*\*\* (df = 3; 38) |
|  | |
| *Note:* | *p<0.1;****p<0.05;***p<0.01 |

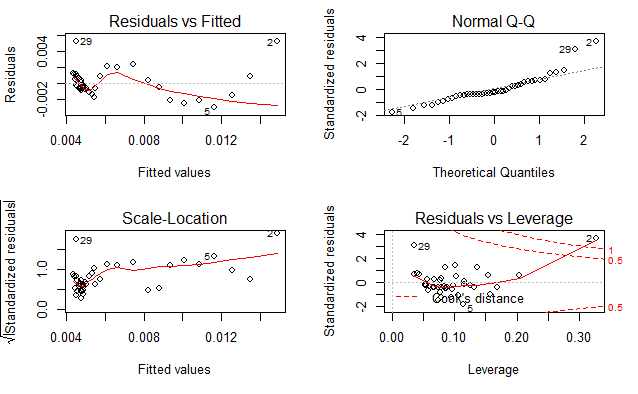


Figure : **Diagnostics for Linear Multi-Regression Model of French Growth**