HW3

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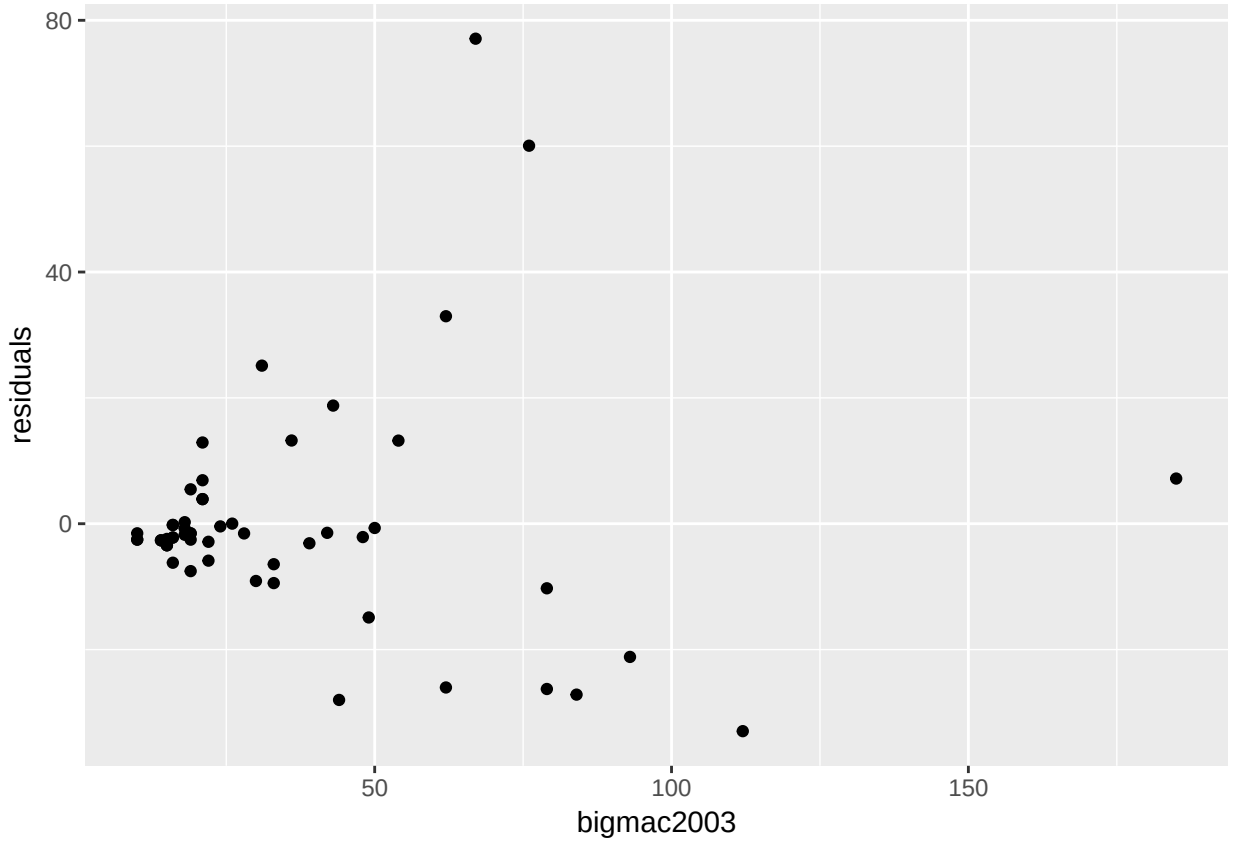
2.2.1. The points above the line x=y represent those cities which had a higher price in 2009 compared to 2003. The points on the line x=y represent those cities with the same price in 2009 compared to 2003. The points below the line x=y represent those cities with a lower price in 2009 compared to 2003.

2.2.2. The city with the smallest increase in price is Mumbai, the city with the largest increase in price is Vilnius.

2.2.3. Since the OLS line slope is less than 1, this does not suggest that prices are lower in 2009 than in 2003, but rather that for every increase in 2003 price by 1 unit, there is a β_1 increase in the 2009 price. It represents the amount of variation in 2009 explained by changes in 2003 price, and this is less than a 1 to 1 ratio, so a 1 dollar increase in 2003 price corresponds to a less than 1 dollar increase in 2009 price.

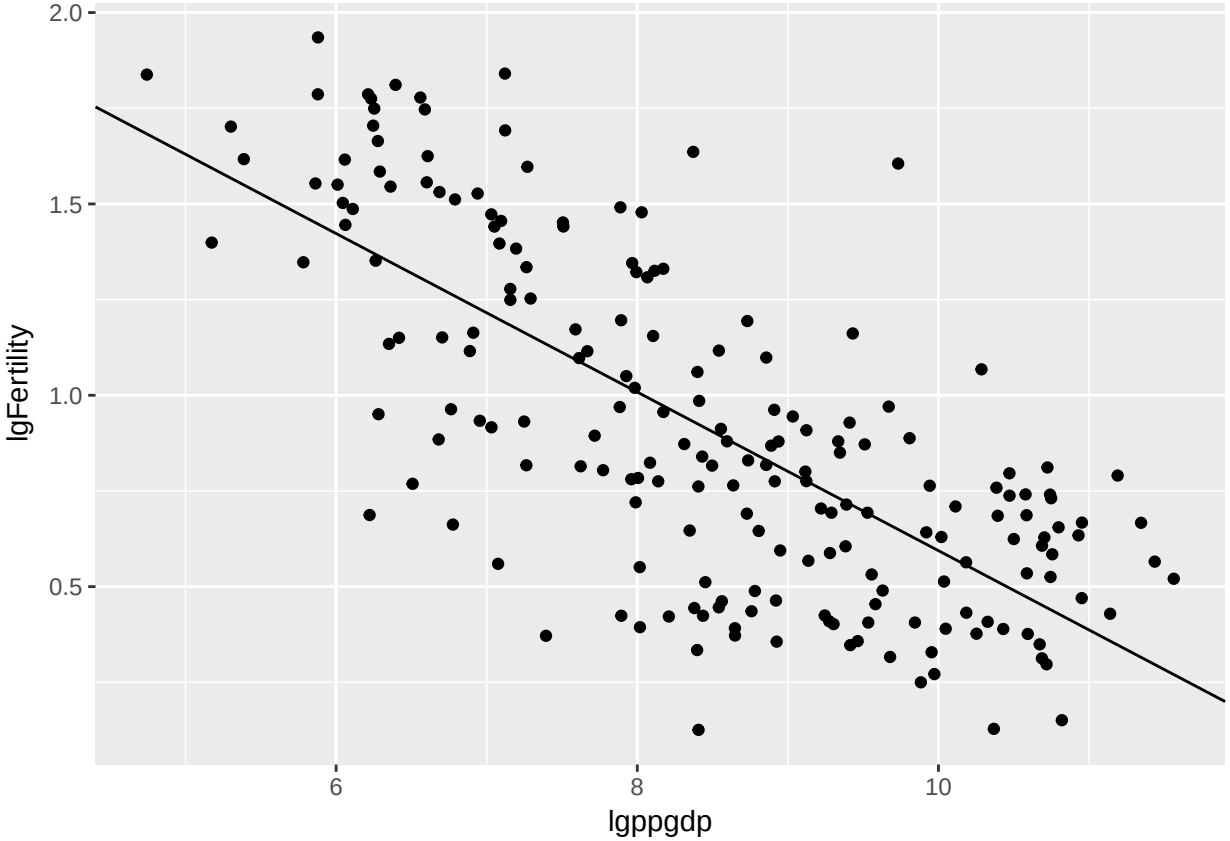
2.2.4. A simple linear regression is not appropriate for this model for a number of reasons. One of these reasons is that the Give two reasons why fitting simple linear regression to the figure in this problem is not likely to be appropriate. First of all, the residual plot is shown below. The variance appears to fan out with higher 2003 prices, and is not constant. In addition to this, this particular model is probably influenced by many other variables. A simple linear model is enough without other explanatory variables.



2.16.1. The simple linear regression model corresponding to the graph in problem 1.1.3 where the dependent variable (y) is the log of fertility and the dependent variable (x) is the log of the per person GDP is represented by the following equation: $y = 2.67 - 0.21x$.

```
##
## Call:
## lm(formula = lgFertility ~ lgppgdp, data = UNdata)
##
## Coefficients:
## (Intercept)      lgppgdp
##      2.6655      -0.2071
```

2.16.2. The graph of log of fertility vs log of ppgdp with the OLS line is show below.



2.16.3 The summary of the model is shown below. The probability given for the slope is for that of a two-tailed t-test, for null hypothesis of the parameter equaling 0. However, we are only interested in a 1-tailed t-test, which means we only need the probability that, given the true slope is 0, it is at least as extreme as the estimate of -0.20715. Thus we can actually devide that probability in half. However, the probability is less than 2e-16, which means that the chance of getting this value if the true parameter value were actually 0 is next to nothing. Thus at almost any significance level (we can use $\alpha = 0.01$), this is statistically significant, and so we can reject the null hypothesis that the slope is 0, and conclude that the alternative hypothesis of the slope being negative is true.

```
##
## Call:
## lm(formula = lgFertility ~ lgppgdp, data = UNdata)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.79828 -0.21639  0.02669  0.23424  0.95596
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
```

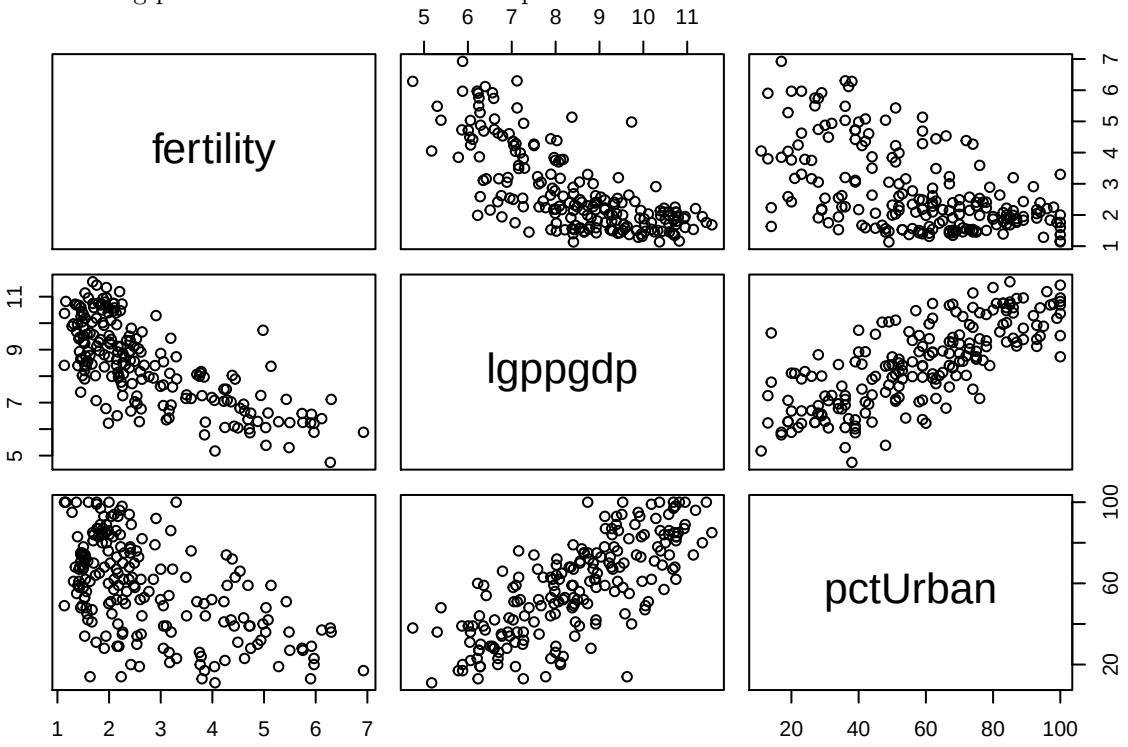
```
## (Intercept)  2.66551    0.12057   22.11   <2e-16 ***
## lgppgdp     -0.20715    0.01401  -14.79   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3071 on 197 degrees of freedom
## Multiple R-squared:  0.526,  Adjusted R-squared:  0.5236
## F-statistic: 218.6 on 1 and 197 DF,  p-value: < 2.2e-16
```

2.16.4 The coefficient of determination, or R^2, is 0.526. This means that 52.6% of the variation in fertility is explained by this model.

2.16.5 The point prediction for log(fertility) is 1.234567. The 95% prediction interval for log(fertility) is between 0.6258791 and 1.843218. The point prediction for fertility is 3.436891, and the 95% prediction interval for fertility is between 1.869889 and 6.316831.

2.16.6 The locality with the highest value of fertility is Niger. The locality with the lowest value of fertility is Bosnia and Herzegovina. The two localities with the largest positive residuals from the regression when both variables are in the log scale are Equatorial Guinea and Angola. The two localities with the smallest positive residuals from the regression when both variables are in the log scales are Bosnia and Herzegovina, and Moldova.

3.2.1 The scatterplot matrix is hown below. Fertility appears to have a medium negative correlation with both log of ppgdp, and with pctUrban. Hard to tell if they are linear or slightly curved. The log of ppgdp has a strong positive linear correlation with pctUrban.



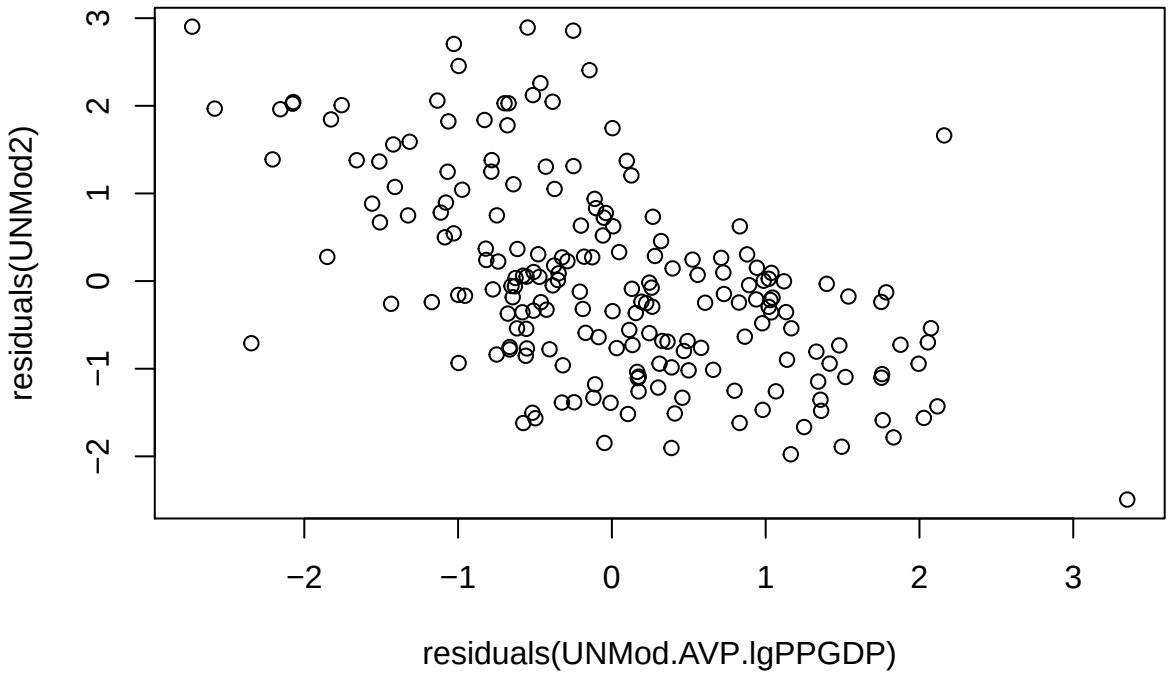
3.2.2. The summaries of each model are shown below. The slope p-values in each model are almost 0, and thus each is statistically significant even at $\alpha = 1$. Thus, the null hypothesis of the parameter being equal to 0 can be rejected for each one, and we can conclude that the slopes are not 0.

```
##
## Call:
## lm(formula = fertility ~ lgppgdp, data = UNdata)
##
```

```
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.16313 -0.64507 -0.06586  0.62479  3.00517
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  8.00967    0.36529   21.93   <2e-16 ***
## lgppgdp     -0.62009    0.04245  -14.61   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.9305 on 197 degrees of freedom
## Multiple R-squared:   0.52,  Adjusted R-squared:  0.5175
## F-statistic: 213.4 on 1 and 197 DF,  p-value: < 2.2e-16
```

```
##
## Call:
## lm(formula = fertility ~ pctUrban, data = UNdata)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2.4932 -0.7795 -0.1475  0.6517  2.9029
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  4.559823   0.213681  21.339   <2e-16 ***
## pctUrban    -0.031045   0.003421  -9.076   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.128 on 197 degrees of freedom
## Multiple R-squared:  0.2948, Adjusted R-squared:  0.2913
## F-statistic: 82.37 on 1 and 197 DF,  p-value: < 2.2e-16
```

3.2.3. The added variable plots are both shown below, followed by the linear model using both variables. No, it is not useful having both variables there. Though each is statistically significant when regressed with fertility on their own, on a model that has both variables, only one is statistically significant. In fact, pctUrban is not even close to being statistically significant at any level. It is a problem of auto-correlation: each variable explains the same variation in the dependent variable.




```
##
## Call:
## lm(formula = fertility ~ lgppgdp + pctUrban, data = UNdata)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.15114 -0.64929 -0.06604  0.63253  2.99102
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  7.9932699  0.3993367  20.016   <2e-16 ***
## lgppgdp     -0.6151425  0.0641565  -9.588   <2e-16 ***
## pctUrban    -0.0004393  0.0042656  -0.103    0.918
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.9328 on 196 degrees of freedom
## Multiple R-squared:   0.52,  Adjusted R-squared:  0.5151
## F-statistic: 106.2 on 2 and 196 DF,  p-value: < 2.2e-16
```

3.2.4. The slope of the added variable plot of each variable is the same as their coefficient in the model that used both: -0.6151425 for PPGDP and -0.0004393 for pctUrban.

```
##
## Call:
## lm(formula = residuals(UNMod2) ~ residuals(UNMod.AVP.lgPPGDP))
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.15114 -0.64929 -0.06604  0.63253  2.99102
##
## Coefficients:
##                                Estimate Std. Error t value Pr(>|t|)
```

```
## (Intercept)                  -1.986e-16  6.596e-02   0.000        1
## residuals(UNMod.AVP.lgPPGDP) -6.151e-01  6.399e-02  -9.613   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.9305 on 197 degrees of freedom
## Multiple R-squared:  0.3193, Adjusted R-squared:  0.3158
## F-statistic:  92.4 on 1 and 197 DF,  p-value: < 2.2e-16
```

```
##
## Call:
## lm(formula = residuals(UNMod1) ~ residuals(UNMod.AVP.pctUrban))
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.15114 -0.64929 -0.06604  0.63253  2.99102
##
## Coefficients:
##                                Estimate Std. Error t value Pr(>|t|)
## (Intercept)                   6.313e-17  6.596e-02   0.000    1.000
## residuals(UNMod.AVP.pctUrban) -4.393e-04  4.255e-03  -0.103    0.918
##
## Residual standard error: 0.9305 on 197 degrees of freedom
## Multiple R-squared:  5.411e-05,  Adjusted R-squared:  -0.005022
## F-statistic: 0.01066 on 1 and 197 DF,  p-value: 0.9179
```

```
##
## Call:
## lm(formula = fertility ~ lgppgdp + pctUrban, data = UNdata)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.15114 -0.64929 -0.06604  0.63253  2.99102
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  7.9932699  0.3993367  20.016   <2e-16 ***
## lgppgdp     -0.6151425  0.0641565  -9.588   <2e-16 ***
## pctUrban    -0.0004393  0.0042656  -0.103    0.918
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.9328 on 196 degrees of freedom
## Multiple R-squared:   0.52,  Adjusted R-squared:  0.5151
## F-statistic: 106.2 on 2 and 196 DF,  p-value: < 2.2e-16
```

3.2.5. The residuals for all of them are shown below, and all are equal. I could not think of another way to show their equality, sorry.

```
resid(AVP.lgPPGDP)
```

```
##           1           2           3           4           5
##  1.806471381 -1.394725716 -0.651064642  2.317282243 -0.087771575
##           6           7           8           9          10
## -0.168576339 -1.298836348 -0.127579044  0.732413953 -0.024338567
##          11          12          13          14          15
```

```
## -0.509310405  0.084087945  0.509329590 -1.820260779 -0.504380849
##           16           17           18           19           20
## -1.161219859  0.458814918 -0.117086980  1.168124662  0.845618678
##           21           22           23           24           25
## -1.029908512 -0.066035443 -1.666325646  0.131655421 -0.446865194
##           26           27           28           29           30
##  0.417614948 -1.027864058  1.615231349 -0.754760019 -1.452652523
##           31           32           33           34           35
##  0.684428961  0.342532633 -0.713876902  0.387480913  0.206012253
##           36           37           38           39           40
##  1.809496787 -0.350132615 -1.258997870 -0.293454577  0.822228188
##           41           42           43           44           45
##  1.328646556  0.359524527 -0.647518298  0.590549704 -0.602124340
##           46           47           48           49           50
## -1.188960997 -0.197095105 -0.404501402  0.768606850  0.653497770
##           51           52           53           54           55
##  0.031471320  0.484252561 -0.209651184  1.972654240 -0.457312014
##           56           57           58           59           60
## -0.488336672 -0.787052560  2.991020553 -0.011802803 -0.381949755
##           61           62           63           64           65
## -0.580683208 -0.340566018  0.503112558  0.542924816  0.283255316
##           66           67           68           69           70
##  1.040907389  0.634861124 -1.586247829  0.012475281  0.443730204
##           71           72           73           74           75
## -0.160781847  0.702051731 -0.321843761  0.769130498  0.781049116
##           76           77           78           79           80
##  0.766435985 -0.866294823 -0.862641086 -0.290783431 -0.434565424
##           81           82           83           84           85
## -0.711849595  0.653257645 -0.983053847 -1.003930375 -1.108469986
##           86           87           88           89           90
##  0.747253639  0.738317934  1.283338436 -0.070719466 -0.481693226
##           91           92           93           94           95
##  0.019101738  0.097385464  0.125796935  0.753204606  0.011549594
##           96           97           98           99          100
##  0.897528398 -1.196568603 -1.157475511 -0.752238503 -0.571101506
##          101          102          103          104          105
## -0.692704752  0.379737823  0.192977908 -0.745908955  0.839729774
##          106          107          108          109          110
## -0.130757434  0.231741470  1.599849442  0.167221705 -1.108066404
##          111          112          113          114          115
##  2.073775022 -0.587935243  1.361949371  0.711213245 -0.897074486
##          116          117          118          119          120
## -0.124301792  0.179091646 -1.973971615 -0.772406925 -0.934868470
##          121          122          123          124          125
## -0.887619293  0.433893414 -1.871378548  0.333302706  0.721286386
##          126          127          128          129          130
## -1.533779547  0.049436520  0.453650216  0.564658133  0.567794773
##          131          132          133          134          135
## -1.142323366  2.556047736  1.841611902 -2.151142213  0.969005743
##          136          137          138          139          140
##  0.300713368 -0.525236893 -0.242116500  0.926691147 -0.053338086
##          141          142          143          144          145
##  0.280026457 -0.231800461 -0.261598459 -0.204458857 -0.760302329
##          146          147          148          149          150
```

```
## -0.519718513  0.071477309  1.136303651 -0.444213869 -1.049251161
##          151          152          153          154          155
## -0.745286020  1.158453172 -0.656755425  0.770220661 -0.074903677
##          156          157          158          159          160
##  0.630200073  0.899666023 -1.152409627  0.120326630  0.358306062
##          161          162          163          164          165
## -0.008312461 -0.643242240 -0.313786278  0.414142702  1.224161239
##          166          167          168          169          170
## -0.114775684 -0.102501044 -0.970691992 -0.607508799  0.869017880
##          171          172          173          174          175
## -0.248674979  0.175725241  0.611167728  0.428000168 -0.285822140
##          176          177          178          179          180
## -0.695678635  1.359836182 -1.404896447 -1.260629400 -0.257528196
##          181          182          183          184          185
##  0.827682927 -0.431675602 -0.919135501 -0.269026475 -0.468984115
##          186          187          188          189          190
##  0.691424937  1.747284197 -1.547767798  0.263270784  0.368059693
##          191          192          193          194          195
##  0.731860991 -0.134036602 -1.245344021  0.685677941  0.289423958
##          196          197          198          199
## -1.877177720  1.431150867  2.703029588 -0.960331139
```

```
resid(AVP.pctUrban)
```

```
##           1           2           3           4           5
##  1.806471381 -1.394725716 -0.651064642  2.317282243 -0.087771575
##           6           7           8           9          10
## -0.168576339 -1.298836348 -0.127579044  0.732413953 -0.024338567
##          11          12          13          14          15
## -0.509310405  0.084087945  0.509329590 -1.820260779 -0.504380849
##          16          17          18          19          20
## -1.161219859  0.458814918 -0.117086980  1.168124662  0.845618678
##          21          22          23          24          25
## -1.029908512 -0.066035443 -1.666325646  0.131655421 -0.446865194
##          26          27          28          29          30
##  0.417614948 -1.027864058  1.615231349 -0.754760019 -1.452652523
##          31          32          33          34          35
##  0.684428961  0.342532633 -0.713876902  0.387480913  0.206012253
##          36          37          38          39          40
##  1.809496787 -0.350132615 -1.258997870 -0.293454577  0.822228188
##          41          42          43          44          45
##  1.328646556  0.359524527 -0.647518298  0.590549704 -0.602124340
##          46          47          48          49          50
## -1.188960997 -0.197095105 -0.404501402  0.768606850  0.653497770
##          51          52          53          54          55
##  0.031471320  0.484252561 -0.209651184  1.972654240 -0.457312014
##          56          57          58          59          60
## -0.488336672 -0.787052560  2.991020553 -0.011802803 -0.381949755
##          61          62          63          64          65
## -0.580683208 -0.340566018  0.503112558  0.542924816  0.283255316
##          66          67          68          69          70
##  1.040907389  0.634861124 -1.586247829  0.012475281  0.443730204
##          71          72          73          74          75
## -0.160781847  0.702051731 -0.321843761  0.769130498  0.781049116
##          76          77          78          79          80
```

```
##  0.766435985 -0.866294823 -0.862641086 -0.290783431 -0.434565424
##           81           82           83           84           85
## -0.711849595  0.653257645 -0.983053847 -1.003930375 -1.108469986
##           86           87           88           89           90
##  0.747253639  0.738317934  1.283338436 -0.070719466 -0.481693226
##           91           92           93           94           95
##  0.019101738  0.097385464  0.125796935  0.753204606  0.011549594
##           96           97           98           99          100
##  0.897528398 -1.196568603 -1.157475511 -0.752238503 -0.571101506
##          101          102          103          104          105
## -0.692704752  0.379737823  0.192977908 -0.745908955  0.839729774
##          106          107          108          109          110
## -0.130757434  0.231741470  1.599849442  0.167221705 -1.108066404
##          111          112          113          114          115
##  2.073775022 -0.587935243  1.361949371  0.711213245 -0.897074486
##          116          117          118          119          120
## -0.124301792  0.179091646 -1.973971615 -0.772406925 -0.934868470
##          121          122          123          124          125
## -0.887619293  0.433893414 -1.871378548  0.333302706  0.721286386
##          126          127          128          129          130
## -1.533779547  0.049436520  0.453650216  0.564658133  0.567794773
##          131          132          133          134          135
## -1.142323366  2.556047736  1.841611902 -2.151142213  0.969005743
##          136          137          138          139          140
##  0.300713368 -0.525236893 -0.242116500  0.926691147 -0.053338086
##          141          142          143          144          145
##  0.280026457 -0.231800461 -0.261598459 -0.204458857 -0.760302329
##          146          147          148          149          150
## -0.519718513  0.071477309  1.136303651 -0.444213869 -1.049251161
##          151          152          153          154          155
## -0.745286020  1.158453172 -0.656755425  0.770220661 -0.074903677
##          156          157          158          159          160
##  0.630200073  0.899666023 -1.152409627  0.120326630  0.358306062
##          161          162          163          164          165
## -0.008312461 -0.643242240 -0.313786278  0.414142702  1.224161239
##          166          167          168          169          170
## -0.114775684 -0.102501044 -0.970691992 -0.607508799  0.869017880
##          171          172          173          174          175
## -0.248674979  0.175725241  0.611167728  0.428000168 -0.285822140
##          176          177          178          179          180
## -0.695678635  1.359836182 -1.404896447 -1.260629400 -0.257528196
##          181          182          183          184          185
##  0.827682927 -0.431675602 -0.919135501 -0.269026475 -0.468984115
##          186          187          188          189          190
##  0.691424937  1.747284197 -1.547767798  0.263270784  0.368059693
##          191          192          193          194          195
##  0.731860991 -0.134036602 -1.245344021  0.685677941  0.289423958
##          196          197          198          199
## -1.877177720  1.431150867  2.703029588 -0.960331139
```

```
resid(UNMod)
```

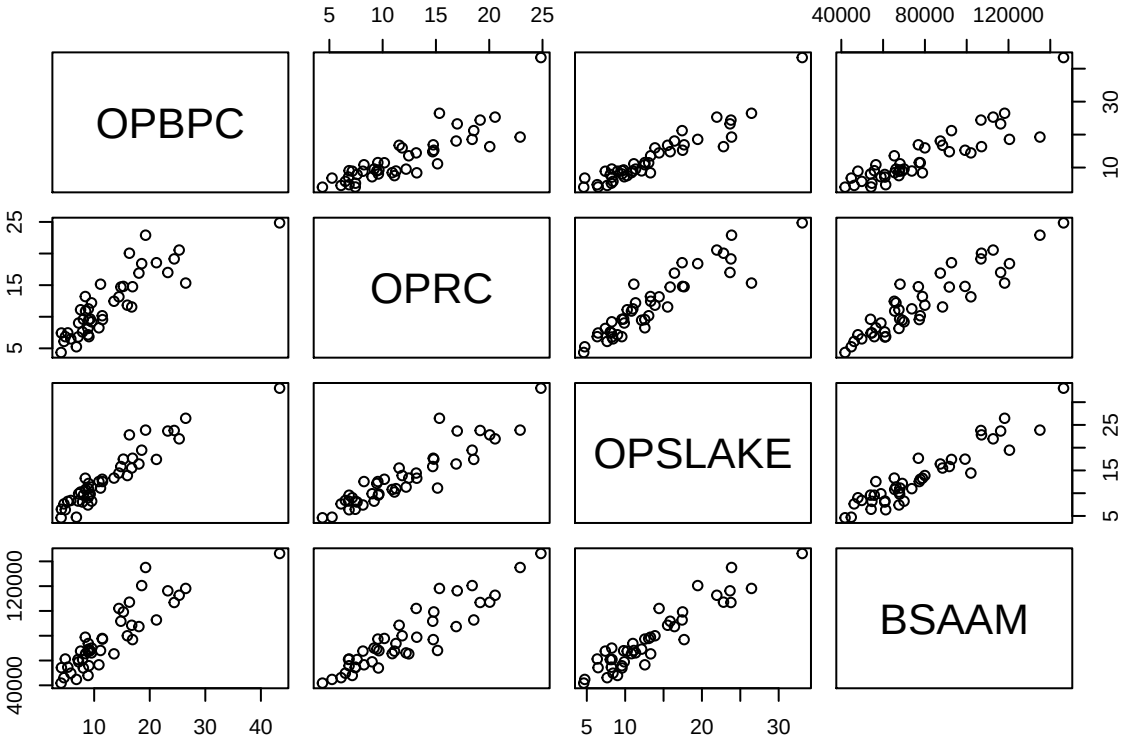
```
##           1           2           3           4           5
##  1.806471381 -1.394725716 -0.651064642  2.317282243 -0.087771575
##           6           7           8           9          10
```

```
## -0.168576339 -1.298836348 -0.127579044  0.732413953 -0.024338567
##           11           12           13           14           15
## -0.509310405  0.084087945  0.509329590 -1.820260779 -0.504380849
##           16           17           18           19           20
## -1.161219859  0.458814918 -0.117086980  1.168124662  0.845618678
##           21           22           23           24           25
## -1.029908512 -0.066035443 -1.666325646  0.131655421 -0.446865194
##           26           27           28           29           30
##  0.417614948 -1.027864058  1.615231349 -0.754760019 -1.452652523
##           31           32           33           34           35
##  0.684428961  0.342532633 -0.713876902  0.387480913  0.206012253
##           36           37           38           39           40
##  1.809496787 -0.350132615 -1.258997870 -0.293454577  0.822228188
##           41           42           43           44           45
##  1.328646556  0.359524527 -0.647518298  0.590549704 -0.602124340
##           46           47           48           49           50
## -1.188960997 -0.197095105 -0.404501402  0.768606850  0.653497770
##           51           52           53           54           55
##  0.031471320  0.484252561 -0.209651184  1.972654240 -0.457312014
##           56           57           58           59           60
## -0.488336672 -0.787052560  2.991020553 -0.011802803 -0.381949755
##           61           62           63           64           65
## -0.580683208 -0.340566018  0.503112558  0.542924816  0.283255316
##           66           67           68           69           70
##  1.040907389  0.634861124 -1.586247829  0.012475281  0.443730204
##           71           72           73           74           75
## -0.160781847  0.702051731 -0.321843761  0.769130498  0.781049116
##           76           77           78           79           80
##  0.766435985 -0.866294823 -0.862641086 -0.290783431 -0.434565424
##           81           82           83           84           85
## -0.711849595  0.653257645 -0.983053847 -1.003930375 -1.108469986
##           86           87           88           89           90
##  0.747253639  0.738317934  1.283338436 -0.070719466 -0.481693226
##           91           92           93           94           95
##  0.019101738  0.097385464  0.125796935  0.753204606  0.011549594
##           96           97           98           99          100
##  0.897528398 -1.196568603 -1.157475511 -0.752238503 -0.571101506
##          101          102          103          104          105
## -0.692704752  0.379737823  0.192977908 -0.745908955  0.839729774
##          106          107          108          109          110
## -0.130757434  0.231741470  1.599849442  0.167221705 -1.108066404
##          111          112          113          114          115
##  2.073775022 -0.587935243  1.361949371  0.711213245 -0.897074486
##          116          117          118          119          120
## -0.124301792  0.179091646 -1.973971615 -0.772406925 -0.934868470
##          121          122          123          124          125
## -0.887619293  0.433893414 -1.871378548  0.333302706  0.721286386
##          126          127          128          129          130
## -1.533779547  0.049436520  0.453650216  0.564658133  0.567794773
##          131          132          133          134          135
## -1.142323366  2.556047736  1.841611902 -2.151142213  0.969005743
##          136          137          138          139          140
##  0.300713368 -0.525236893 -0.242116500  0.926691147 -0.053338086
##          141          142          143          144          145
```

```
##  0.280026457 -0.231800461 -0.261598459 -0.204458857 -0.760302329
##          146          147          148          149          150
## -0.519718513  0.071477309  1.136303651 -0.444213869 -1.049251161
##          151          152          153          154          155
## -0.745286020  1.158453172 -0.656755425  0.770220661 -0.074903677
##          156          157          158          159          160
##  0.630200073  0.899666023 -1.152409627  0.120326630  0.358306062
##          161          162          163          164          165
## -0.008312461 -0.643242240 -0.313786278  0.414142702  1.224161239
##          166          167          168          169          170
## -0.114775684 -0.102501044 -0.970691992 -0.607508799  0.869017880
##          171          172          173          174          175
## -0.248674979  0.175725241  0.611167728  0.428000168 -0.285822140
##          176          177          178          179          180
## -0.695678635  1.359836182 -1.404896447 -1.260629400 -0.257528196
##          181          182          183          184          185
##  0.827682927 -0.431675602 -0.919135501 -0.269026475 -0.468984115
##          186          187          188          189          190
##  0.691424937  1.747284197 -1.547767798  0.263270784  0.368059693
##          191          192          193          194          195
##  0.731860991 -0.134036602 -1.245344021  0.685677941  0.289423958
##          196          197          198          199
## -1.877177720  1.431150867  2.703029588 -0.960331139
```

3.2.6. The t-test values for each of the added variable plots and the model with both variables are shown above. The t-vale for the added variable plot for lgppgdp is -9.613, but the t-value for lgppgdp in the model with both variables is -9.588. They are slightly different because the number of variables is different, meaning the degrees of freedom is different, and thus the standard error calculation is slightly different, and so the t-value will be slightly different.

3.6.1. The scatterplot matrix appears to show that each of these variables have a strong positive linear correlation with each other. The correlation matrix should show that all of these have postive correlations close to 1. The scatterplot matrix and correlation matrix are both shown below, and the correlation matrix does indeed match what was expected.




```
##             OPBPC      OPRC   OPSLAKE     BSAAM
## OPBPC   1.0000000 0.8647073 0.9433474 0.8857478
## OPRC    0.8647073 1.0000000 0.9191447 0.9196270
## OPSLAKE 0.9433474 0.9191447 1.0000000 0.9384360
## BSAAM   0.8857478 0.9196270 0.9384360 1.0000000
```

3.6.2 The regression summary is shown below. The t-values represent where on the standardized t-curve these parameter estimates (the intercept and the coefficients) would be if the true parameter value were actually 0, and thus allow a t-test to be performed for a null hypothesis of whether or not the parameter actually equals 0 or not.

```
##
## Call:
## lm(formula = BSAAM ~ OPBPC + OPRC + OPSLAKE, data = Waterdata)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -15964.1  -6491.8   -404.4   4741.9  19921.2
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 22991.85    3545.32   6.485  1.1e-07 ***
## OPBPC          40.61     502.40   0.081  0.93599
## OPRC         1867.46     647.04   2.886  0.00633 **
## OPSLAKE      2353.96     771.71   3.050  0.00410 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 8304 on 39 degrees of freedom
## Multiple R-squared:  0.9017, Adjusted R-squared:  0.8941
## F-statistic: 119.2 on 3 and 39 DF,  p-value: < 2.2e-16
```