```
pop15       -0.385898   0.195369   -1.98   0.0609
pop75       -1.327742   0.926063   -1.43   0.1657
dpi         -0.000459   0.000724   -0.63   0.5326
ddpi         0.884394   0.295341    2.99   0.0067

Residual standard error: 2.77 on 22 degrees of freedom
Multiple R-Squared: 0.507,      Adjusted R-squared: 0.418
F-statistic: 5.66 on 4 and 22 DF,  p-value: 0.00273
```

In the first regression on the subset of underdeveloped countries, we find no relation between the predictors and the response. The p-value is 0.523. We know from our previous examination of these data that this result is not attributable to outliers or unsuspected transformations. In contrast, there is a strong relationship in the developed countries. The strongest predictor is growth with a suspicion of some relationship to proportion under 15. This latter effect has been reduced from prior analyses because we have reduced the range of this predictor by the subsetting operation. The graphical analysis has shown a relationship in the data that a purely numerical analysis might easily have missed.

Higher dimensional plots can also be useful for detecting structure that cannot be seen in two dimensions. These are interactive in nature so you need to try them to see how they work. We can make three-dimensional plots where color, point size and rotation are used to give the illusion of a third dimension. We can also link two or more plots so that points which are *brushed* in one plot are highlighted in another.

These tools look good but it is not clear whether they actually are useful in practice. Certainly there are communication difficulties, as these plots cannot be easily printed. R itself does not have such tools, but GGobi is a useful free tool for exploring higher dimensional data that can be called from R. See `www.ggobi.org`.

Nongraphical techniques for checking the structural form of the model usually involve proposing alternative transformations or recombinations of the variables. This approach is explored in the chapter on transformation.

Excercises

1. Using the `sat` dataset, fit a model with the total SAT score as the response and expend, salary, ratio and takers as predictors. Perform regression diagnostics on this model to answer the following questions. Display any plots that are relevent. Do not provide any plots about which you have nothing to say.

   (a) Check the constant variance assumption for the errors.
   (b) Check the normality assumption.
   (c) Check for large leverage points.
   (d) Check for outliers.
   (e) Check for influential points.
   (f) Check the structure of the relationship between the predictors and the response.

2. Using the `teengamb` dataset, fit a model with `gamble` as the response and the other variables as predictors. Answer the questions posed in the previous question.