Analysis of Swiss Fertility Concerning Socio-economic Factors

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Abstract

In this research paper, we fit a linear model for Fertility rates among populations of 40 regions within Switzerland, considering six possible explanatory variables. Provided data is visualized and discussed, leading to how our transformations of given data are considered and why categorical variables are introduced.A finalized model is presented in which all included variables are statistically significant. Influentiality and leverage of certain data are considered. Assumptions regarding our model are checked and validated. Lastly, the impact each remaining explanatory variable has on fertility rates is analyzed.

Overview of Provided Data

To begin, we first describe our provided dataset. Our given data describes fertility rates among Swiss families as a response to six numeric variables. Below is provided a table describing the nature of these six variables in three columns: variable name, type (Either "N" for numeric, or "C" for categorical), and a brief description.

Variables	**Var**	**Description**
Fertility	N	Common standardized fertility measure
Agriculture	N	% of males involved in agriculture as occupation
Examination	N	% of draftees receiving highest mark on army examination
Education	N	% with education beyond primary school for draftees
Catholic	N	% Catholic (as opposed to Protestant)
Infant Mortality	N	% of live births who lived less than one year

Table 1: Provided Variables

Intuitively, one could argue that Education, Examination, and Infant Mortality are most likely to impact Fertility the most: greater education is often associated with greater earnings potential, leading to improved medical care; healthier men are more likely to bond with women and form families, including fathering healthy children; and lastly, a low infant mortality rate is proportional with greater fertility. We can also intuitively hypothesize that infant mortality may be confounded by education and examination - poorly educated people may not be able to afford effective medical care, for example - and agriculture may be confounded by education. It will be worthwhile to study the colinearity of such variables later.

Additionally, consideration for the Catholicism of a region garners special attention: to what degree does an exact percentage impact fertility rates? Are Catholicism and educational achievement colinear?

Pair-Plot of Provided Variables

To investigate colinearity and confounding, we plot each explanatory variable against another utilizing RStudio's `pairs` command:

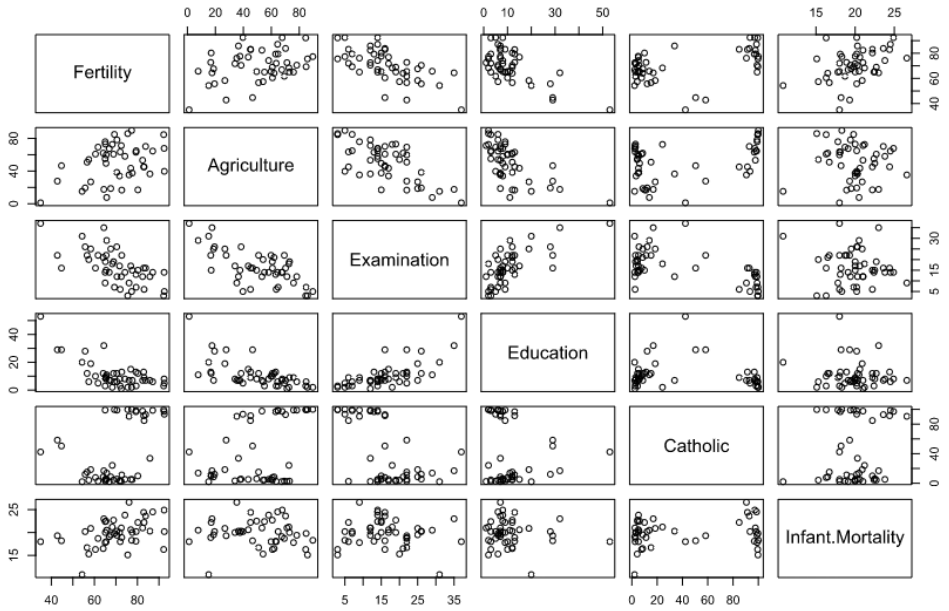

Figure 1: Pairs Plot of Explanatory Variables

Perhaps most striking is the strong bimodality of the Catholic variable across all comparisons: generally speaking, highly Catholic regions are typically less educated, less physically fit, and more agrarian. For this reason, creating a new categorical variable (catholic vs. non-catholic, say, at some arbitrary cut-off percentage) would not likely disrupt the fit of our model.

Also,

Fitting A Linear Model

In order to determine possible data transformations, interactions, and variable selection, an initial linear fit of all explanatory variables is necessary. A multiple linear regression in RStudio yields the following output:

```
Call:
lm(formula = swiss$Fertility ~ swiss$Agriculture + swiss$Examination +
    swiss$Education + swiss$Catholic + swiss$Infant.Mortality)

Residuals:
     Min       1Q   Median       3Q      Max
-15.2743  -5.2617   0.5032   4.1198  15.3213

Coefficients:
                        Estimate Std. Error t value Pr(>|t|)
(Intercept)             66.91518   10.70604   6.250 1.91e-07 ***
swiss$Agriculture       -0.17211    0.07030  -2.448  0.01873 *
swiss$Examination       -0.25801    0.25388  -1.016  0.31546
swiss$Education         -0.87094    0.18303  -4.758 2.43e-05 ***
swiss$Catholic           0.10412    0.03526   2.953  0.00519 **
swiss$Infant.Mortality   1.07705    0.38172   2.822  0.00734 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 7.165 on 41 degrees of freedom
Multiple R-squared:  0.7067,    Adjusted R-squared:  0.671
F-statistic: 19.76 on 5 and 41 DF,  p-value: 5.594e-10
```

Figure 2: Summary Statistics for Base Model

We can see from our resulting fit that Examination does not immediately seem statistically significant - that is, we cannot confidently state that it's parameter value in a linear model isn't zero. Furthermore, one can notice that the relationship between Fertility and Examination in Figure 1 does not seem linear - it tends to behave similarly to an inverse function. For these reasons, a transformation of the Examination variable is considered: we attempt to fit another linear model with the new Examination variable `1/DenomExam`.

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0.1. Subsection One

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Treatments	Response 1	Response 2
Treatment 1	0.0003262	0.562
Treatment 2	0.0015681	0.910
Treatment 3	0.0009271	0.296

Table 2: Table caption

0.2. Subsection Two

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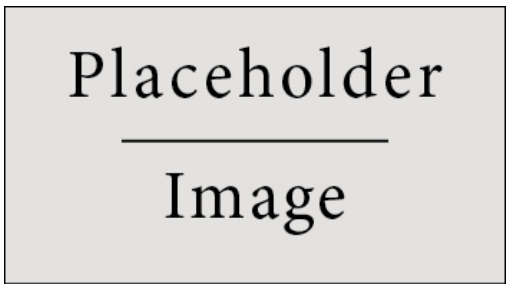

Figure 3: Figure caption

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