Predicting Total Wealth: A Predictive Analysis Using the 1991 SIPP Data

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Introduction

Loading and Inspecting the Data

Let's take a look at the first 6 rows of the data.

```
data <- read.table('data_tr.txt', head = T)[,-1]
head(data)
```

```
##       tw  ira e401  nifa   inc hmort   hval hequity educ male twoearn nohs hs
## 1  53550    0    0   100 28146 60150  69000    8850   12    0       0    0  1
## 2 124635    0    0 61010 32634 20000  78000   58000   16    0       0    0  0
## 3 192949 1800    0  7549 52206 15900 200000  184100   11    1       1    1  0
## 4   -513    0    0  2487 45252     0      0       0   15    0       1    0  0
## 5 212087    0    0 10625 33126 90000 300000  210000   12    0       0    0  1
## 6  24400    0    0  9000 76860 99600 120000   20400   15    0       1    0  0
##   smcol col age fsize marr
## 1     0   0  31     5    1
## 2     0   1  52     5    0
## 3     0   0  50     3    1
## 4     1   0  28     4    1
## 5     0   0  42     3    0
## 6     1   0  49     6    1
```

We can see that the data is in good shape, where categorical variables are already transformed into dummy variables. We can also see that there exists multi-collinearity in education levels (**nohs**, **hs**, **smcol**, **col**) and home-ownership-related variables (**hmort**, **hval**, and **hequity**).

```
summary(data)
```

```
##        tw                ira              e401             nifa
##  Min.   :-502302   Min.   :     0   Min.   :0.0000   Min.   :      0
##  1st Qu.:   3246   1st Qu.:     0   1st Qu.:0.0000   1st Qu.:    200
##  Median :  25225   Median :     0   Median :0.0000   Median :   1687
##  Mean   :  63629   Mean   :  3471   Mean   :0.3714   Mean   :  13611
##  3rd Qu.:  82173   3rd Qu.:     0   3rd Qu.:1.0000   3rd Qu.:   8875
##  Max.   :1887115   Max.   :100000   Max.   :1.0000   Max.   :1425115
##       inc              hmort             hval           hequity
##  Min.   :    -9   Min.   :     0   Min.   :     0   Min.   :-40000
##  1st Qu.: 19413   1st Qu.:     0   1st Qu.:     0   1st Qu.:     0
```

```
##  Median : 31575   Median :  8000   Median : 50000   Median : 10000
##  Mean   : 37177   Mean   : 30207   Mean   : 63965   Mean   : 33757
##  3rd Qu.: 48615   3rd Qu.: 52000   3rd Qu.: 95000   3rd Qu.: 48000
##  Max.   :242124   Max.   :150000   Max.   :300000   Max.   :300000
##       educ            male            twoearn            nohs
##  Min.   : 1.0   Min.   :0.0000   Min.   :0.0000   Min.   :0.0000
##  1st Qu.:12.0   1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.0000
##  Median :12.0   Median :0.0000   Median :0.0000   Median :0.0000
##  Mean   :13.2   Mean   :0.2018   Mean   :0.3808   Mean   :0.1277
##  3rd Qu.:15.0   3rd Qu.:0.0000   3rd Qu.:1.0000   3rd Qu.:0.0000
##  Max.   :18.0   Max.   :1.0000   Max.   :1.0000   Max.   :1.0000
##        hs              smcol             col              age
##  Min.   :0.0000   Min.   :0.0000   Min.   :0.0000   Min.   :25.00
##  1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:32.00
##  Median :0.0000   Median :0.0000   Median :0.0000   Median :40.00
##  Mean   :0.3819   Mean   :0.2422   Mean   :0.2482   Mean   :41.08
##  3rd Qu.:1.0000   3rd Qu.:0.0000   3rd Qu.:0.0000   3rd Qu.:48.00
##  Max.   :1.0000   Max.   :1.0000   Max.   :1.0000   Max.   :64.00
##      fsize            marr
##  Min.   : 1.00   Min.   :0.0000
##  1st Qu.: 2.00   1st Qu.:0.0000
##  Median : 3.00   Median :1.0000
##  Mean   : 2.87   Mean   :0.6075
##  3rd Qu.: 4.00   3rd Qu.:1.0000
##  Max.   :13.00   Max.   :1.0000
```

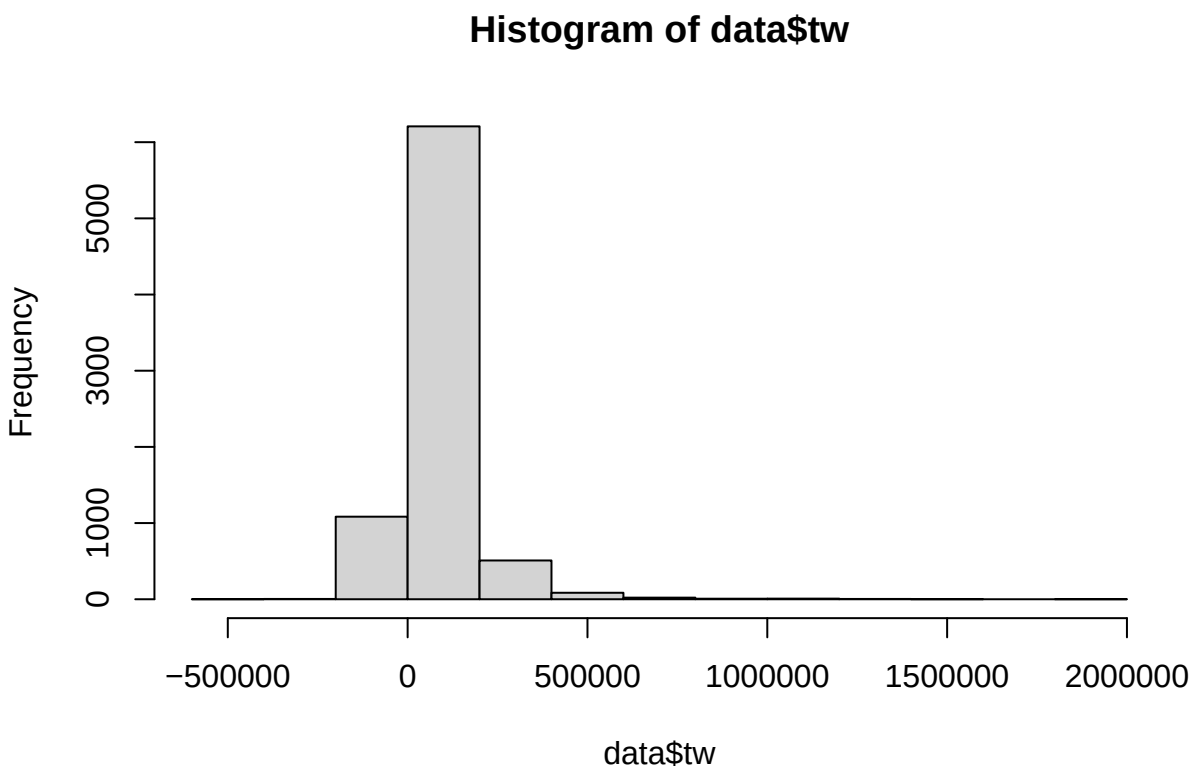
While there exist observations where total wealth is negative, it should be noted that the variable includes home mortgage, so it does not necessarily indicate that there are incorrect data entries.

The variables **ira**, **nohs**, **smcol**, **col**, and **male** exhibited a value of 0 at the 3rd quantile. They are probably a significant number of data points taking on the value of 0. Since **male** is on the list, it should also be noted that most observations are associated with female participants.

Also, the variable **tw**, **nifa**, **hmort**, and **hequity** have means that are much greater than medians, showing signs of large outliers.

In the histogram below, we can visualize the existence of outliers with enormous wealth.

```
hist(data$tw)
```



Using the graph, we can determine that removing the outliers with **tw** above $1,000,000 would be appropriate.

```
data = subset(data, data$tw<1000000)
summary(data)
```

```
##        tw                ira              e401             nifa
##  Min.   :-502302   Min.   :     0   Min.   :0.0000   Min.   :     0
##  1st Qu.:   3213   1st Qu.:     0   1st Qu.:0.0000   1st Qu.:   200
##  Median :  25100   Median :     0   Median :0.0000   Median :  1649
##  Mean   :  61545   Mean   :  3444   Mean   :0.3714   Mean   : 12132
##  3rd Qu.:  81774   3rd Qu.:     0   3rd Qu.:1.0000   3rd Qu.:  8771
##  Max.   : 967800   Max.   :100000   Max.   :1.0000   Max.   :898000
##       inc              hmort             hval           hequity
##  Min.   :    -9   Min.   :     0   Min.   :     0   Min.   :-40000
##  1st Qu.: 19386   1st Qu.:     0   1st Qu.:     0   1st Qu.:     0
##  Median : 31527   Median :  8000   Median : 50000   Median : 10000
##  Mean   : 37043   Mean   : 30152   Mean   : 63743   Mean   : 33592
##  3rd Qu.: 48543   3rd Qu.: 51750   3rd Qu.: 95000   3rd Qu.: 48000
##  Max.   :200997   Max.   :150000   Max.   :300000   Max.   :300000
##       educ            male            twoearn           nohs
##  Min.   : 1.0   Min.   :0.0000   Min.   :0.000   Min.   :0.0000
##  1st Qu.:12.0   1st Qu.:0.0000   1st Qu.:0.000   1st Qu.:0.0000
##  Median :12.0   Median :0.0000   Median :0.000   Median :0.0000
##  Mean   :13.2   Mean   :0.2019   Mean   :0.381   Mean   :0.1278
##  3rd Qu.:15.0   3rd Qu.:0.0000   3rd Qu.:1.000   3rd Qu.:0.0000
##  Max.   :18.0   Max.   :1.0000   Max.   :1.000   Max.   :1.0000
```

```
##        hs              smcol             col              age
##  Min.   :0.0000   Min.   :0.0000   Min.   :0.0000   Min.   :25.00
##  1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:32.00
##  Median :0.0000   Median :0.0000   Median :0.0000   Median :40.00
##  Mean   :0.3822   Mean   :0.2422   Mean   :0.2478   Mean   :41.06
##  3rd Qu.:1.0000   3rd Qu.:0.0000   3rd Qu.:0.0000   3rd Qu.:48.00
##  Max.   :1.0000   Max.   :1.0000   Max.   :1.0000   Max.   :64.00
##      fsize            marr
##  Min.   : 1.00   Min.   :0.0000
##  1st Qu.: 2.00   1st Qu.:0.0000
##  Median : 3.00   Median :1.0000
##  Mean   : 2.87   Mean   :0.6071
##  3rd Qu.: 4.00   3rd Qu.:1.0000
##  Max.   :13.00   Max.   :1.0000
```

Testing and Removing Multi-collinearity

Let's test whether removing different educational level predictors affect my model's performance, gauged by (MSPE). For simplicity sake, I did not use k-fold cross validation.

```
k <- 10
set.seed(123)
rand <- sample(nrow(data), floor(nrow(data)/k))
train <- setdiff(c(1:nrow(data)), rand)
y_rand <- data$tw[rand]

regnohs <- lm(tw ~ 1 + hs + smcol + col, data = data[train,])
reghs <- lm(tw ~ 1 + nohs + smcol + col, data = data[train,])
regsmcol <- lm(tw ~ 1 + nohs + hs + col, data = data[train,])
regcol <- lm(tw ~ 1 + nohs + hs + smcol, data = data[train,])

prnohs <- predict(regnohs, newdata = data[rand,])
prhs <- predict(reghs, newdata = data[rand,])
prsmcol <- predict(regsmcol, newdata = data[rand,])
prcol <- predict(regcol, newdata = data[rand,])

MSEnohs <- mean((y_rand-prnohs)^2)
MSEhs <- mean((y_rand-prhs)^2)
MSEsmcol <- mean((y_rand-prsmcol)^2)
MSEcol <- mean((y_rand-prcol)^2)

c(MSEnohs, MSEhs, MSEsmcol, MSEcol)
```

```
## [1] 9119936474 9119936474 9119936474 9119936474
```

No difference in performance is found between removing different terms for multi-collinearity. For interpretability, we choose to remove **hs** for education level.

More Data Cleaning

Since **hequity** represents home value minus home mortgage, it is intuitively a better predictor of total wealth than **hval** or **hmort** itself. Hence, choosing **hequity** over **hval** and **hmort** is the more sensible choice.

Including years of education (**educ**) along with education levels is redundant. Considering that diplomas are usually much more important than years of education, prioritizing education level over years of education is appropriate.

```
data <- data[, !(names(data) %in% c("hs", "hval", "hmort", "educ"))]
```