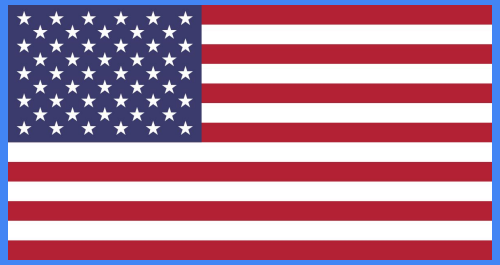


Single Payer Health in the U.S.

Multiple Linear Regression

My Multiple Linear Regression model in R

- Downloaded .csv files from the OECD and loaded this data into an R table
- Used years 2010-2019. Data from 2020 onward was less complete
  - Plus stopping at 2019 avoids added complications that could be attributed to COVID-19
- Included the following countries:
  - Nations where government is the single or dominant payer
    - Canada, Denmark, France, Norway, Sweden, United Kingdom
  - Other government-intensive, non-single payer nations
    - Australia, Germany, Netherlands, Switzerland
  - The United States
- Response variables
  - Avoidable mortality deaths per 100,000
  - Life expectancy at birth

Multiple Linear Regression: Independent Variables

- Categorical variable for health system
  - Single, Other, America
- Sugar, fruit and vegetable supply per capita
  - This data was more complete than survey data on daily consumption. The assumption here is supply equals (or is proportional to) demand
- Percentage of population who are daily tobacco smokers
- Alcohol consumption in liters per capita
- Percentage of the population who is obese, self-reported
  - Measured statistics were not as complete as the self-reported
- Percentage of the population subjected to air pollution exceeding the WHO Air Quality Guideline value of 10 micrograms per cubic meter.
- Percentage of the population who feels safe walking around their neighborhood at night
- External deaths per 100 thousand
  - Includes traffic accidents, accidental falls, accidental poisoning (drug overdoses), suicides, and homicides

Avoidable Mortality results

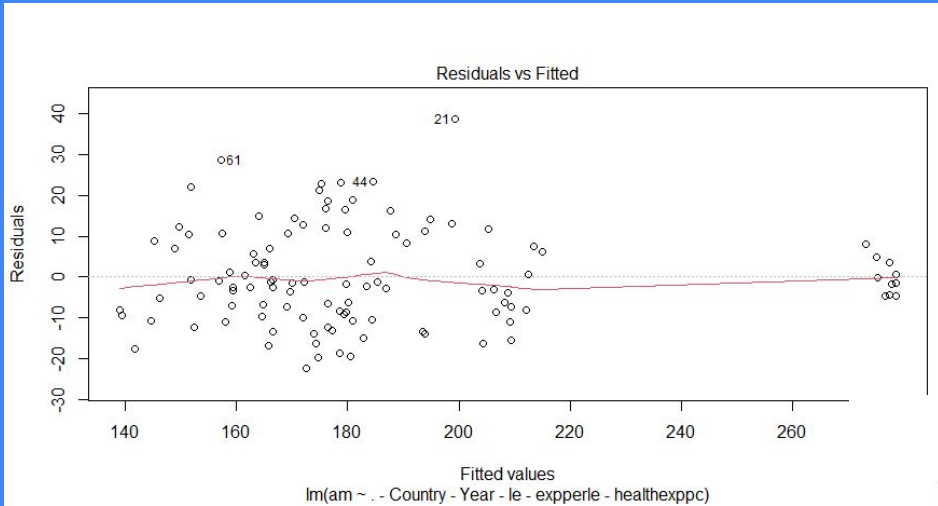
90 fewer avoidable deaths for single payer nations relative to the U.S., while controlling for other factors

R 4.1.2 · ~/Fall2022_ADEC743002/Code/

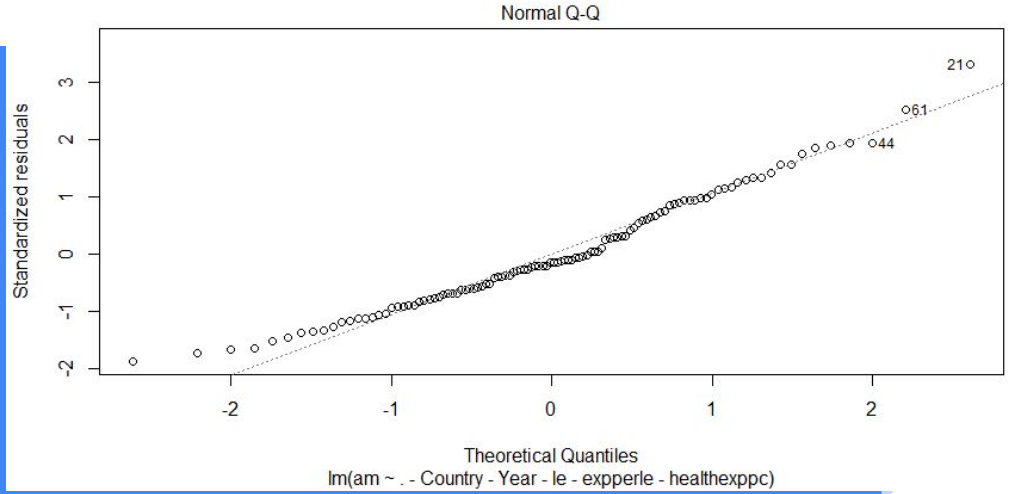
```
> lmod<-lm(am ~ . - Country - Year -le - expperle - healthexppc, health16)
> summary(lmod)

Call:
lm(formula = am ~ . - Country - Year - le - expperle - healthexppc,
    data = health16)

Residuals:
    Min      1Q  Median      3Q     Max
-22.495  -8.518  -1.706   8.243  38.674

Coefficients:
                 Estimate Std. Error t value Pr(>|t|)
(Intercept)      222.50557   42.76336   5.203 1.08e-06 ***
sugkilospc         0.34260    0.08446   4.056 0.000100 ***
frukilospc        -0.07786    0.16637  -0.468 0.640849
vegkilospc        -0.47887    0.15305  -3.129 0.002311 **
pctdailysmokers   -2.50212    0.68688  -3.643 0.000433 ***
alcliterspc        8.10939    2.86630   2.829 0.005660 **
obspct             1.69480    0.72673   2.332 0.021742 *
pollutpoppct       0.35131    0.08481   4.142 7.30e-05 ***
feelsafepct        0.42338    0.28029   1.510 0.134135
extdeathper100k   -0.47872    0.32766  -1.461 0.147208
systemOther     -123.01891   16.15945  -7.613 1.68e-11 ***
systemSingle     -90.13260   14.17943  -6.357 6.55e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 12.52 on 98 degrees of freedom
Multiple R-squared:  0.8928,    Adjusted R-squared:  0.8808
F-statistic: 74.19 on 11 and 98 DF,  p-value: < 2.2e-16
```

Adjusted R-squared of 0.88 means 88% of the variability in avoidable mortality is explained by the independent variables included

Avoidable Mortality residual plots



Reasonably constant variance and normal distribution of residuals centered close to 0



Life Expectancy results

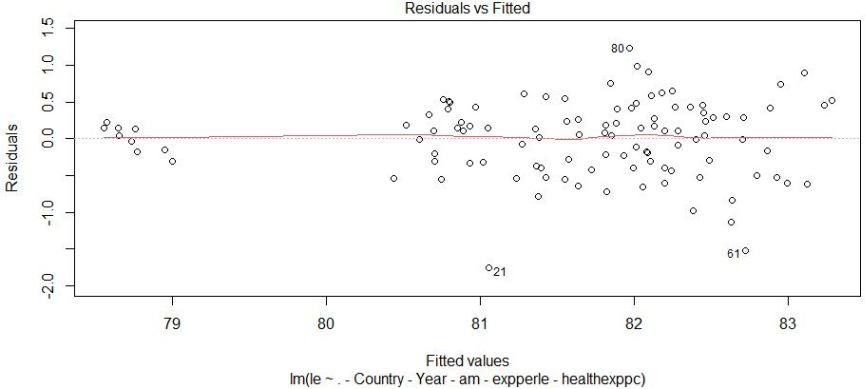
4 more years of life expectancy in single payer nations relative to the U.S., while controlling for other factors

R 4.1.2 · ~/Fall2022_ADEC743002/Code/

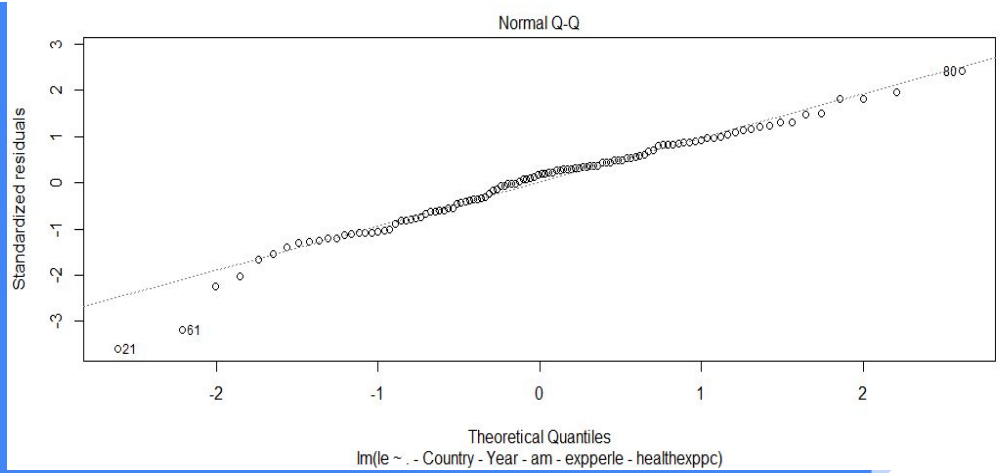
```
Call:
lm(formula = le ~ . - Country - Year - am - expperle - healthexppc,
    data = health16)

Residuals:
     Min       1Q   Median       3Q      Max
-1.76027 -0.31635  0.09481  0.32353  1.22739

Coefficients:
                  Estimate Std. Error t value Pr(>|t|)
(Intercept)     76.121625   1.803435  42.209  < 2e-16 ***
sugkilospc      -0.017373   0.003562  -4.877 4.16e-06 ***
frukilospc       0.002510   0.007016   0.358   0.7213
vegkilospc       0.028665   0.006454   4.441 2.35e-05 ***
pctdailysmokers  0.132379   0.028968   4.570 1.42e-05 ***
alcliterspc     -0.329499   0.120879  -2.726   0.0076 **
obspct          -0.010538   0.030648  -0.344   0.7317
pollutpoppct    -0.015532   0.003577  -4.342 3.44e-05 ***
feelsafepct     -0.003436   0.011821  -0.291   0.7719
extdeathper100k  0.032428   0.013818   2.347   0.0209 *
systemOther      5.212340   0.681483   7.649 1.42e-11 ***
systemSingle     3.993997   0.597981   6.679 1.46e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5279 on 98 degrees of freedom
Multiple R-squared:  0.835,     Adjusted R-squared:  0.8165
F-statistic: 45.09 on 11 and 98 DF,  p-value: < 2.2e-16
```

Adjusted R-squared of 0.8165 means 81% of the variability in life expectancy is explained by the independent variables included

Life Expectancy residual plots



Passable constant variance with small cluster on left-hand side, and normal distribution of residuals centered close to zero



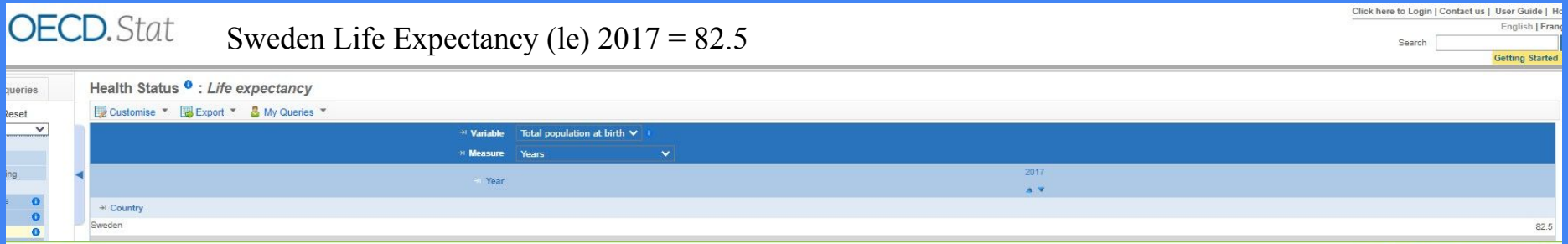
Final Thoughts

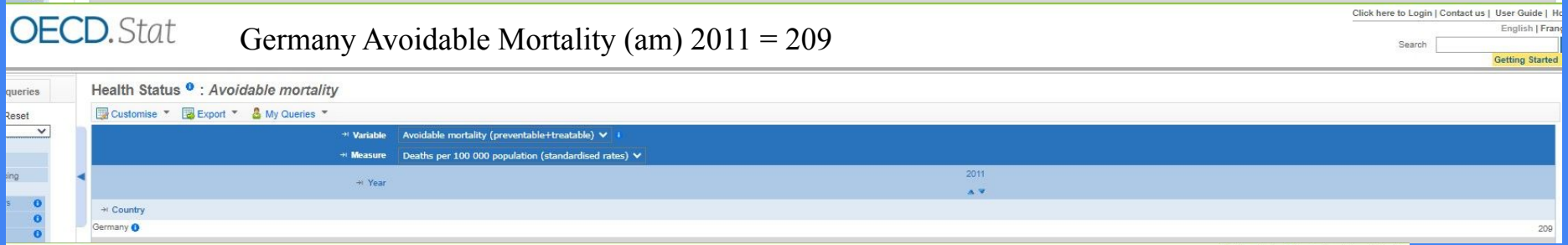
- Single payer nations outperform the United States on mortality metrics to a significant degree, while controlling for other behavioral and metabolic factors. Both models have high R-squared measures and decent residual diagnostics. This research bolsters the objective utilitarian case in favor of single payer health care in the United States.

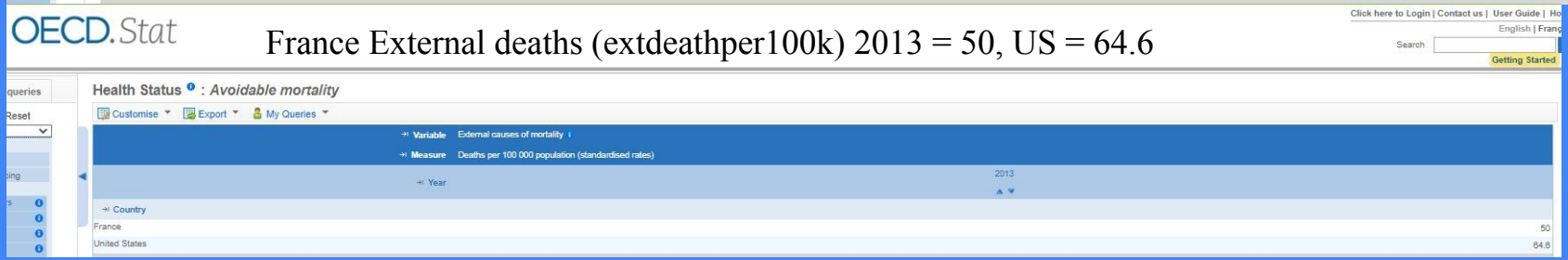
- Other government-intensive non-single payer nations outperform both single payer and United States. This leaves room to explore further options for reform.
  - This may be a more politically realistic avenue

Data validation spot-check

Double-check OECD.Stat and my health16 table in R





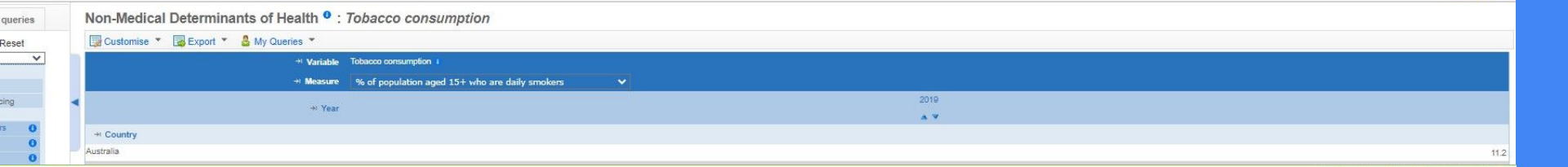


R 4.1.2 · ~/Fall2022_ADEC743002/Code/

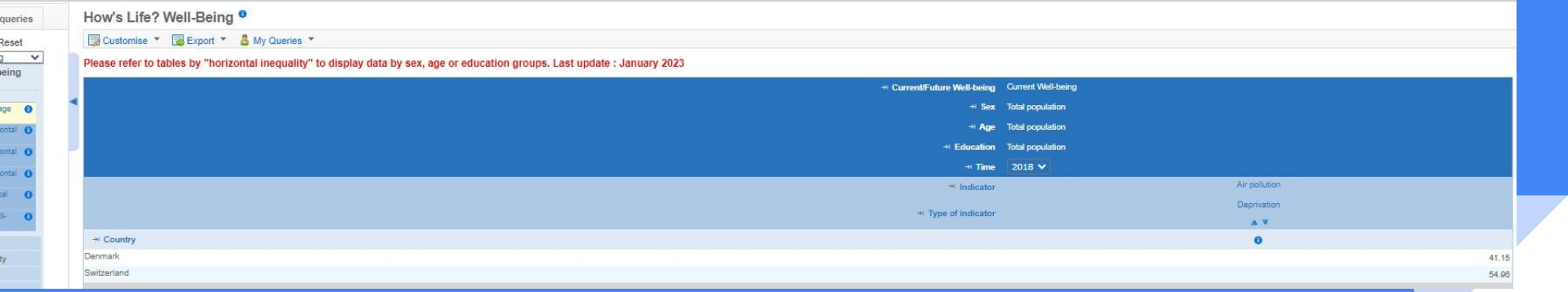
```
> health16[Country=="Sweden"&Year==2017]
   Country Year  am   le sugkilospc frukilospc vegkilospc pctdailysmokers alcliterspc obspct pollutpoppct feelsafepct
1:  Sweden 2017 153 82.5       48.1       63.6       86.1            10.4           7   13.1        2.949    74.66777
   healthexppc expperle extdeathper100k system
1:    5219.411 63.26559            45.5 Single
> health16[Country=="Germany"&Year==2011]
   Country Year  am   le sugkilospc frukilospc vegkilospc pctdailysmokers alcliterspc obspct pollutpoppct feelsafepct
1: Germany 2011 209 80.6       48.8       64.4       85.5            18.1        11.3   16.2       99.612    77.37844
   healthexppc expperle extdeathper100k system
1:    4566.663 56.65835            35.4  Other
> health16[Country=="France"&Year==2013]
   Country Year  am   le sugkilospc frukilospc vegkilospc pctdailysmokers alcliterspc obspct pollutpoppct feelsafepct
1:  France 2013 170 82.4       39.2       79.3       96.9            27.1        11.6   14.5       92.082    67.05515
   healthexppc expperle extdeathper100k system
1:    4541.522 55.11556             50 Single
> health16[Country=="United States"&Year==2013]
         Country Year  am   le sugkilospc frukilospc vegkilospc pctdailysmokers alcliterspc obspct pollutpoppct feelsafepct
1: United States 2013 276 78.8       65.8       92.3      113.5            13.7         8.8   28.8       21.474    74.86162
   healthexppc expperle extdeathper100k  system
1:    8522.161 108.1493            64.6 America
>
```

Netherlands vegetable supply (vegkilospc) 2014 = 57.1

Australia smoker % (pctdailysmokers) 2019 = 11.2



Denmark Air Pollution (pollutpoppct) 2018 = 41.15, Switzerland = 54.96



R 4.1.2 · ~/Fall2022_ADEC743002/Code/

```
> health16[Country=="Netherlands"&Year==2014]
       Country Year  am   le sugkilospc frukilospc vegkilospc pctdailysmokers alcliterspc obspct pollutpoppct feelsafepct
1: Netherlands 2014 162 81.8       43.8      106.6       57.1             19.1         8.4   13.3       99.702    80.89344
   healthexppc expperle extdeathper100k system
1:    4934.568 60.32479            39.8  Other
> health16[Country=="Australia"&Year==2019]
     Country Year  am   le sugkilospc frukilospc vegkilospc pctdailysmokers alcliterspc obspct pollutpoppct feelsafepct
1: Australia 2019 156 82.9       41.2       65.5       86.2             11.2         9.9   19.5        0.004    64.31097
   healthexppc expperle extdeathper100k system
1:    5126.653 61.84141            47.9  Other
> health16[Country=="Denmark"&Year==2018]
   Country Year  am le sugkilospc frukilospc vegkilospc pctdailysmokers alcliterspc obspct pollutpoppct feelsafepct healthexppc
1: Denmark 2018 180 81         56       61.7      104.2             17.2         9.7   15.6       41.147    87.05844    5306.704
   expperle extdeathper100k system
1: 65.51486            34.1 Single
> health16[Country=="Switzerland"&Year==2018]
       Country Year  am   le sugkilospc frukilospc vegkilospc pctdailysmokers alcliterspc obspct pollutpoppct feelsafepct
1: Switzerland 2018 130 83.8       45.3       83.8       92.8             19.8         8.5   10.8       54.964    89.24173
   healthexppc expperle extdeathper100k system
1:    6601.596   78.778            40.7  Other
>
```