HW4-Spandan-Maaheshwari

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Problem 1 ->

```
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.2 --
## v ggplot2 3.3.6      v purrr   0.3.5
## v tibble  3.1.8      v dplyr   1.0.10
## v tidyr   1.2.1      v stringr 1.4.1
## v readr   2.1.3      v forcats 0.5.2
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(modelr)

df_life_expectancy = read.csv("/Users/SPANDAN/DS 5110/countries-etc-datapoints/ddf--datapoints--life_exp
df_infmort = read.csv("/Users/SPANDAN/DS 5110/countries-etc-datapoints/ddf--datapoints--infant_mortality
df_murder = read.csv("/Users/SPANDAN/DS 5110/countries-etc-datapoints/ddf--datapoints--murder_per_10000
df_gdp = read.csv("/Users/SPANDAN/DS 5110/countries-etc-datapoints/ddf--datapoints--gdppercapita_us_infl
df_doctors = read.csv("/Users/SPANDAN/DS 5110/countries-etc-datapoints/ddf--datapoints--medical_doctors_
df_poverty = read.csv("/Users/SPANDAN/DS 5110/countries-etc-datapoints/ddf--datapoints--poverty_percent_

ddf_gap <- df_life_expectancy %>%
  inner_join(df_infmort) %>%
  inner_join(df_murder) %>%
  inner_join(df_gdp) %>%
  inner_join(df_doctors) %>%
  inner_join(df_poverty) %>%
  rename(lifeexp=life_expectancy_years,
         infmort=infant_mortality_rate_per_1000_births,
         murder=murder_per_100000_people,
         gdp=gdppercapita_us_inflation_adjusted,
         doctors=medical_doctors_per_1000_people,
         poverty=poverty_percent_people_below_550_a_day)
```

```
## Joining, by = c("geo", "time")
## Joining, by = c("geo", "time")
## Joining, by = c("geo", "time")
## Joining, by = c("geo", "time")
## Joining, by = c("geo", "time")
```

```
ddf_gap
```

```
##     geo time lifeexp infmort  murder         gdp doctors poverty
## 1   alb 1996   74.39    27.9  8.2304   1869.8659  1.3806    51.5
## 2   alb 2002   75.32    21.0  7.3977   2572.7214  1.1695    54.1
## 3   arg 1986   71.81    28.1  5.8861   7214.2707  2.9840     4.9
## 4   arg 1992   72.59    22.8  4.7049   7157.3283  2.6484    14.9
## 5   arg 1995   73.35    20.8  4.2226   7666.5300  2.6800    20.5
## 6   arm 1999   71.94    27.9  2.5811   1316.5304  0.6928    83.2
## 7   arm 2001   72.61    25.3  1.7616   1547.2510  2.6187    84.4
## 8   arm 2002   72.74    24.2  2.2469   1761.1340  2.5633    83.5
## 9   arm 2003   72.92    23.0  1.8164   2018.3675  2.4563    83.0
## 10  arm 2008   73.85    17.9  1.6886   3627.7967  2.7432    53.6
## 11  arm 2012   74.74    14.6  1.5139   3603.5959  2.8968    56.5
## 12  arm 2013   75.15    13.8  1.0987   3705.3574  2.9031    54.6
## 13  arm 2014   75.31    13.2  0.9638   3819.2178  2.8928    52.3
## 14  arm 2015   75.32    12.6  1.1228   3923.7165  2.9143    48.3
## 15  aus 1981   74.69    10.4  1.9024  30419.5325  1.8000     1.7
## 16  aus 1985   75.50     9.3  1.9815  32045.3160  1.9000     1.7
## 17  aus 1989   76.43     8.0  1.7915  35191.1144  2.1000     1.7
## 18  aus 1995   78.19     5.7  1.6125  38095.1295  2.4000     1.7
## 19  aus 2001   79.95     5.0  1.5830  44585.1985  2.4942     1.3
## 20  aus 2008   81.52     4.4  1.0859  51841.2730  3.0056     0.7
## 21  aus 2010   81.96     4.1  1.0112  52022.1256  3.3429     0.7
## 22  aus 2014   82.54     3.2  1.0222  54679.4202  3.4314     0.7
## 23  aut 1994   76.56     6.2  1.1104  35643.0281  3.4028     0.7
## 24  aut 1995   76.85     5.7  1.0256  36537.9935  3.4932     2.0
## 25  aut 1997   77.58     5.0  0.8900  38084.7025  3.6383     0.7
## 26  aut 2000   78.29     4.6  0.8752  42001.2108  3.8492     0.2
## 27  aut 2003   79.03     4.3  0.6067  43052.6026  4.1173     0.6
## 28  aut 2004   79.41     4.1  0.6926  43956.5829  4.2095     0.3
## 29  aut 2005   79.64     4.0  0.7927  44637.8560  4.3355     0.4
## 30  aut 2006   80.10     4.0  0.7984  45951.7346  4.4684     0.3
## 31  aut 2007   80.22     3.8  0.6086  47510.2938  4.5528     0.7
## 32  aut 2008   80.44     3.8  0.4923  48053.4824  4.6169     0.9
## 33  aut 2009   80.35     3.7  0.6338  46123.4911  4.7060     1.0
## 34  aut 2010   80.58     3.6  0.4284  46858.0433  4.8016     0.8
## 35  aut 2011   80.79     3.4  0.5090  48065.3165  4.8398     1.0
## 36  aut 2012   81.02     3.3  0.3690  48172.2381  4.8859     1.0
## 37  aut 2013   81.21     3.2  0.4011  47901.3661  4.9744     0.6
## 38  aut 2014   81.39     3.0  0.4017  47842.7489  5.0359     0.7
## 39  aut 2015   81.48     2.9  0.5085  47789.3850  5.1035     0.9
## 40  aze 1995   65.01    75.2  9.1619   1234.9966  3.7576    62.5
## 41  bel 1985   74.56     9.9  1.9276  28374.6544  2.8000     0.7
## 42  bel 1988   75.58     8.9  1.5230  30818.8548  3.1000     0.7
## 43  bel 1992   76.36     7.6  1.6195  33518.2313  3.4000     1.2
## 44  bel 1995   76.87     6.3  1.5509  34767.0166  3.5000     1.0
## 45  bel 1997   77.40     5.5  1.7474  36403.2508  3.7000     0.7
## 46  bel 2000   77.84     4.8  1.7060  39588.5980  2.8204     0.7
## 47  bel 2003   78.53     4.2  1.4013  40634.5855  2.8454     0.7
## 48  bel 2004   78.97     4.2  1.6191  41903.9764  2.8522     0.2
## 49  bel 2005   79.17     4.1  1.4932  42641.6775  2.8521     0.5
## 50  bel 2006   79.58     4.0  1.3060  43442.5679  2.8664     0.4
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## 51  bel 2007   79.58     3.9  1.4526  44710.3850  2.8855     0.3
## 52  bel 2008   79.64     3.8  1.0994  44556.8206  2.9021     0.3
## 53  bel 2009   79.83     3.7  1.1191  43306.5991  2.9078     0.3
## 54  bel 2010   80.07     3.6  0.9811  44141.8781  2.9085     0.4
## 55  bel 2011   80.18     3.5  1.1880  44309.6254  2.9219     0.5
## 56  bel 2012   80.26     3.5  1.0923  44361.2085  2.9393     0.4
## 57  bel 2013   80.48     3.4  0.9396  44355.3694  2.9585     0.4
## 58  bel 2014   80.93     3.4  0.9874  44855.9579  2.9723     0.2
## 59  bel 2015   80.94     3.3  0.9779  45503.3520  3.0138     0.2
## 60  bgr 1992   71.44    19.1  4.4269   4086.2004  3.1164     0.7
## 61  bgr 2006   72.68    12.9  1.5271   6034.8202  3.6805    22.6
## 62  bgr 2007   73.03    12.3  1.5713   6477.9851  3.6800    11.4
## 63  bgr 2008   73.35    11.8  1.4323   6920.6184  3.6488     8.5
## 64  bgr 2009   73.60    11.5  1.7277   6726.8869  3.7401     8.4
## 65  bgr 2010   73.82    11.2  1.2343   6809.8990  3.7661    11.0
## 66  bgr 2011   74.11    10.9  1.1160   7014.8356  3.8467    11.2
## 67  bgr 2012   74.48    10.5  1.2310   7081.0261  3.8995    11.1
## 68  bgr 2013   74.76    10.1  1.0181   7143.4624  3.9630    11.1
## 69  bgr 2014   74.47     9.7  1.0782   7320.2884  3.9750     8.7
## 70  blr 1998   68.25    13.6 11.5205   2544.5268  3.2260    75.8
## 71  blr 1999   67.98    12.6 10.3659   2642.1303  3.2903    71.4
## 72  blr 2000   68.82    11.4 10.4126   2808.5750  3.2998    65.2
## 73  blr 2001   68.35    10.3 10.1425   2956.4153  3.2801    49.0
## 74  bra 1981   65.32    72.7 13.5154   7796.8543  0.7670    60.3
## 75  bra 1984   65.79    64.0 15.7264   7442.9724  0.9270    66.6
## 76  bra 1985   66.04    61.4 15.2901   7862.7035  1.4670    61.5
## 77  can 1971   72.85    17.7  2.3073  23060.5089  1.5000     4.5
## 78  can 1975   73.58    14.2  2.7053  25848.9689  1.7000     2.0
## 79  can 1981   75.52     9.7  2.2554  30004.4526  1.8000     1.2
## 80  can 1987   76.73     7.5  2.1140  32982.9119  2.1000     0.7
## 81  can 1991   77.56     6.6  2.2030  32596.4321  2.1000     0.5
## 82  can 1994   77.88     6.0  1.6874  34110.7011  2.1000     0.5
## 83  can 1997   78.51     5.4  1.4291  35996.7102  2.1000     1.0
## 84  can 1998   78.69     5.4  1.5293  36697.5499  1.8611     1.0
## 85  can 2004   80.08     5.2  1.6049  42757.0040  1.8971     0.7
## 86  che 1982   76.41     7.8  1.3143  54420.9719  2.6000     0.7
## 87  che 1992   78.21     6.1  1.4322  62244.7970  3.0000     1.0
## 88  che 2000   80.14     4.6  0.8316  67807.9268  3.5298     0.5
## 89  che 2002   80.69     4.6  0.9298  67860.2448  3.5900     0.2
## 90  che 2006   81.72     4.2  0.6038  72823.8372  3.8589     0.4
## 91  che 2007   81.93     4.1  0.5758  75143.7022  3.8518     0.3
## 92  che 2008   82.19     4.0  0.5309  75793.6330  3.8298     0.3
## 93  che 2009   82.22     3.9  0.7192  73189.1926  3.8476     0.2
## 94  che 2010   82.48     3.9  0.4470  74605.7210  3.8166     0.3
## 95  che 2011   82.80     3.8  0.4874  75029.7578  3.8355     0.1
## 96  che 2012   82.88     3.7  0.4374  74984.1371  3.9102     0.0
## 97  che 2013   83.03     3.6  0.5209  75499.7067  4.0303     0.1
## 98  chl 1990   73.16    16.0  3.2044   5933.2071  1.1000    46.1
## 99  chl 1992   74.91    13.7  3.0568   6879.7795  0.9949    39.8
## 100 chl 1994   75.02    11.7  2.9978   7459.1773  1.1030    37.0
## 101 col 1992   71.00    27.4 88.1732   4559.3262  1.1057    47.0
## 102 cri 1990   76.50    14.3  4.8327   4884.6025  1.2600    39.9
## 103 cri 1993   76.72    13.5  5.6918   5403.2687  0.8830    35.0
## 104 cri 1994   76.43    13.2  5.8811   5504.4782  0.8450    30.2
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## 105 cri 1995   76.25    13.0  5.2485   5591.1948  0.8540    31.8
## 106 cyp 2004   77.63     4.2  1.2707  29566.8295  1.9121     0.1
## 107 cyp 2005   77.92     3.9  1.7711  30558.4275  1.8965     0.1
## 108 cyp 2006   78.43     3.7  1.7640  31469.4619  1.8374     0.0
## 109 cyp 2007   78.79     3.5  1.3657  32377.0715  2.0147     0.1
## 110 cyp 2008   79.31     3.3  1.1341  32725.6302  2.0507     0.0
## 111 cyp 2009   79.69     3.1  1.8450  31216.7645  2.1064     0.1
## 112 cyp 2010   80.12     3.0  0.4611  31023.6383  2.1562     0.1
## 113 cyp 2011   80.52     2.9  2.5993  30363.5101  2.2484     0.0
## 114 cyp 2012   80.90     2.8  2.0558  28873.6258  2.2960     0.1
## 115 cyp 2013   81.13     2.7  1.1877  27044.3091  2.4076     0.2
## 116 cyp 2014   81.30     2.6  0.9527  26834.0116  2.4993     0.2
## 117 cyp 2015   81.46     2.5  1.4239  27897.9582  2.6236     0.1
## 118 cze 1992   72.32    11.5  1.8632  12318.2205  2.6702     0.7
## 119 cze 1993   72.87    10.7  2.1235  12313.0403  2.8564     0.4
## 120 cze 1996   73.87     7.9  1.5105  14047.8433  2.9742     1.2
## 121 cze 2002   75.54     5.1  1.1671  15577.3922  3.4870     0.7
## 122 cze 2004   75.98     4.6  1.0535  16930.1897  3.5067     1.2
## 123 cze 2005   76.27     4.4  0.7725  18011.3867  3.4910     0.6
## 124 cze 2006   76.78     4.2  0.8251  19193.7548  3.5534     0.7
## 125 cze 2007   77.02     3.9  0.9956  20151.1781  3.5544     0.6
## 126 cze 2008   77.18     3.8  0.6758  20520.7800  3.5415     0.5
## 127 cze 2009   77.45     3.6  0.7605  19424.2731  3.5032     0.7
## 128 cze 2010   77.68     3.4  0.6675  19808.0711  3.5166     0.8
## 129 cze 2011   77.89     3.2  0.7379  20118.5878  3.5606     0.6
## 130 cze 2012   78.13     3.2  0.7459  19929.7641  3.6502     0.8
## 131 cze 2013   78.38     3.0  0.7974  19826.7919  3.6628     0.5
## 132 cze 2014   78.79     2.9  0.6582  20343.6838  3.9345     0.7
## 133 cze 2015   78.85     2.8  0.6596  21381.7031  3.9516     0.3
## 134 deu 1991   75.72     6.5  1.1059  33836.4179  2.7732     0.2
## 135 deu 1994   76.49     5.5  1.1487  34358.3387  3.0112     0.5
## 136 deu 1995   76.74     5.3  1.1368  34783.2896  3.0745     0.5
## 137 deu 1998   77.78     4.6  0.8457  36251.1938  3.1871     0.2
## 138 deu 2000   78.29     4.4  0.7119  37930.4862  3.2785     0.2
## 139 deu 2001   78.62     4.3  0.6660  38509.6069  3.3290     0.2
## 140 deu 2002   78.73     4.2  0.7105  38368.6183  3.3600     0.2
## 141 deu 2003   78.85     4.1  0.6425  38073.7607  3.3896     0.2
## 142 deu 2004   79.37     4.0  0.6211  38535.1710  3.4104     0.2
## 143 deu 2005   79.66     3.9  0.5431  38835.3824  3.4314     0.2
## 144 deu 2006   79.93     3.8  0.5497  40362.2942  3.4748     0.0
## 145 deu 2007   80.06     3.7  0.5593  41622.3558  3.5287     0.2
## 146 deu 2008   80.17     3.6  0.4948  42102.8533  3.5863     0.2
## 147 deu 2009   80.25     3.6  0.5140  39804.9213  3.6638     0.2
## 148 deu 2010   80.40     3.5  0.5611  41531.9342  3.7567     0.2
## 149 deu 2011   80.53     3.4  0.4918  43969.2593  3.8491     0.2
## 150 deu 2013   80.64     3.3  0.4598  44139.0324  4.0087     0.2
## 151 deu 2015   80.65     3.1  0.5057  45321.4030  4.1342     0.2
## 152 dnk 1992   75.37     6.5  1.2631  45803.3899  2.5974     1.0
## 153 dnk 1995   75.47     5.4  1.0462  49122.8692  2.6827     0.2
## 154 dnk 2000   77.02     4.6  1.1259  55850.6308  2.9119     0.2
## 155 dnk 2003   77.47     4.4  1.1055  56256.7557  3.0830     0.4
## 156 dnk 2004   77.84     4.2  0.6282  57608.7372  3.2276     0.4
## 157 dnk 2005   78.32     4.1  1.0043  58792.6605  3.3333     0.5
## 158 dnk 2006   78.34     3.9  0.7007  60892.7716  3.4192     0.3
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## 159 dnk 2007   78.39     3.7  0.8137  61174.5416  3.4527     0.5
## 160 dnk 2008   78.80     3.6  0.7984  60504.7770  3.5768     0.7
## 161 dnk 2009   79.02     3.5  0.8018  57229.0399  3.6488     1.0
## 162 dnk 2010   79.29     3.3  0.7315  58041.3984  3.7211     0.2
## 163 dnk 2011   79.81     3.2  0.7886  58575.6078  3.7808     0.6
## 164 dnk 2012   80.14     3.2  0.3117  58487.7936  3.8243     0.2
## 165 dnk 2013   80.39     3.1  0.3807  58788.0842  3.8335     0.6
## 166 dnk 2014   80.70     3.0  0.6359  59437.9473  3.8632     0.7
## 167 dnk 2015   80.87     2.9  0.5724  60402.1292  3.9257     0.4
## 168 egy 2015   70.21    20.3  0.1664   2703.7421  0.8217    61.9
## 169 esp 1990   77.00     9.3  0.9294  22512.7610  2.0305     2.7
## 170 esp 1995   78.02     6.9  0.8207  23737.4844  4.0880     4.2
## 171 esp 2000   79.39     5.4  0.9151  28408.8068  3.1158     1.5
## 172 esp 2003   79.64     5.1  0.9379  30037.6249  3.1928     2.0
## 173 esp 2004   80.22     5.0  1.2612  30445.7489  3.4135     2.1
## 174 esp 2005   80.46     4.8  0.8038  31028.9968  2.7605     2.1
## 175 esp 2006   80.87     4.6  0.7610  31760.6025  2.8206     2.3
## 176 esp 2007   81.01     4.4  0.6682  32301.9690  2.8747     1.5
## 177 esp 2008   81.25     4.2  0.7396  32072.7646  2.9847     1.7
## 178 esp 2009   81.66     4.1  0.6359  30593.6098  3.0395     2.2
## 179 esp 2010   81.98     3.9  0.6110  30502.7197  3.0292     2.3
## 180 esp 2011   82.12     3.8  0.6528  30146.9992  3.0473     2.8
## 181 esp 2012   82.31     3.7  0.5684  29235.8287  3.1396     3.0
## 182 esp 2013   82.62     3.7  0.5876  28910.7558  3.1425     3.3
## 183 esp 2014   82.74     3.6  0.5628  29398.6103  3.1657     2.9
## 184 esp 2015   82.64     3.5  0.5574  30549.7918  3.2166     3.2
## 185 est 1993   68.29    14.5 25.4507   6742.5264  3.2202    25.5
## 186 est 2003   71.98     6.9  9.9289  12486.1124  3.1153    13.5
## 187 est 2004   72.45     6.3  6.7401  13411.0395  3.1791     9.1
## 188 est 2005   72.91     5.8  7.6050  14768.0566  3.1430     6.0
## 189 est 2006   73.10     5.3  6.2504  16299.1545  3.1762     3.7
## 190 est 2007   73.23     4.8  6.2796  17613.7530  3.2508     2.4
## 191 est 2008   74.27     4.4  5.7825  16762.2845  3.3348     2.3
## 192 est 2009   74.98     4.0  5.0241  14370.5135  3.2767     3.3
## 193 est 2010   75.99     3.6  3.9593  14790.8212  3.2422     4.2
## 194 est 2011   76.21     3.2  4.2511  15940.1585  3.2929     3.8
## 195 est 2012   76.43     2.9  4.4099  16497.2088  3.2822     3.7
## 196 est 2013   77.02     2.7  3.6086  16778.9008  3.3318     3.7
## 197 est 2014   77.16     2.5  2.7047  17325.5189  3.3564     3.3
## 198 est 2015   77.72     2.3  2.7448  17633.5918  3.4152     2.0
## 199 fin 1991   75.51     5.3  2.8253  31224.3842  2.9820     0.2
## 200 fin 1995   76.70     4.3  2.8489  31901.8429  2.2000     0.2
## 201 fin 2000   77.79     3.5  2.5913  40403.5496  2.8541     0.2
## 202 fin 2003   78.73     3.3  1.7212  42706.9211  2.9215     0.2
## 203 fin 2004   78.80     3.2  2.3053  44283.1625  2.9509     0.1
## 204 fin 2005   79.10     3.1  1.8748  45358.5616  2.9913     0.2
## 205 fin 2006   79.50     2.9  1.8394  47004.6158  3.0262     0.2
## 206 fin 2007   79.54     2.9  2.0952  49285.2720  3.0351     0.1
## 207 fin 2008   79.75     2.7  2.1241  49440.9682  3.0618     0.2
## 208 fin 2009   79.96     2.6  1.7660  45231.9617  3.0861     0.1
## 209 fin 2010   80.17     2.5  1.8028  46459.9733  3.2653     0.1
## 210 fin 2011   80.50     2.4  1.8108  47423.2104  3.1221     0.1
## 211 fin 2012   80.70     2.2  1.3435  46538.5774  3.2854     0.2
## 212 fin 2013   80.94     2.1  1.3952  45906.7993  3.2966     0.1
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## 213 fin 2014   81.26     2.0  1.4032  45550.4981  3.3922     0.1
## 214 fra 1978   74.00    11.0  1.0059  25772.3035  1.7000     2.2
## 215 fra 1984   75.46     8.8  1.3056  28020.4619  2.5000     3.0
## 216 fra 1989   76.80     7.7  1.0995  31761.2475  3.0000     1.7
## 217 fra 1994   77.79     5.8  1.1027  33338.3391  3.2660     0.2
## 218 fra 2000   79.10     4.4  0.8343  38309.4427  3.3547     0.2
## 219 fra 2003   79.57     4.0  0.7233  38985.5359  3.4238     0.4
## 220 fra 2004   80.24     3.9  0.7042  39794.6355  3.4395     0.2
## 221 fra 2005   80.40     3.8  0.6736  40152.6929  3.4410     0.2
## 222 fra 2006   80.68     3.7  0.6735  40850.3555  3.4357     0.2
## 223 fra 2007   80.98     3.6  0.5701  41582.7997  3.4189     0.1
## 224 fra 2008   81.10     3.5  0.6563  41456.4834  3.4156     0.1
## 225 fra 2009   81.17     3.5  0.7117  40058.6798  3.3693     0.3
## 226 fra 2010   81.41     3.5  0.6171  40638.3340  3.3736     0.3
## 227 fra 2011   81.62     3.5  0.6256  41329.0354  3.1622     0.2
## 228 fra 2012   81.85     3.5  0.6065  41258.2747  3.1745     0.3
## 229 fra 2013   82.13     3.6  0.6071  41282.9908  3.1948     0.2
## 230 fra 2014   82.46     3.6  0.4400  41480.7696  3.2115     0.1
## 231 gbr 1969   71.69    18.4  0.7706  17341.0488  0.9000     4.7
## 232 gbr 1974   72.41    16.0  1.4589  19901.0866  1.1000     0.7
## 233 gbr 1979   73.38    12.7  1.2530  22344.5219  1.3000     1.0
## 234 gbr 1991   76.02     7.4  0.7319  28291.2429  1.6349     1.2
## 235 gbr 1994   76.70     6.3  1.0285  30001.2731  1.6984     1.0
## 236 gbr 1995   76.73     6.1  1.0087  30679.5370  1.7573     2.0
## 237 gbr 1999   77.59     5.7  0.7719  34610.8610  1.9106     0.7
## 238 gbr 2004   79.00     5.2  0.4893  39018.9510  2.3357     1.2
## 239 gbr 2005   79.28     5.1  0.4259  39984.1674  2.4120     1.1
## 240 gbr 2006   79.40     5.0  0.4296  40798.0653  2.4590     0.8
## 241 gbr 2007   79.67     4.9  0.3973  41465.5455  2.4844     0.8
## 242 gbr 2008   79.80     4.7  0.3402  41024.8111  2.5543     0.9
## 243 gbr 2009   80.17     4.6  0.3058  38986.1445  2.6279     0.6
## 244 gbr 2010   80.42     4.4  0.2802  39435.8399  2.6265     0.6
## 245 gbr 2011   80.75     4.2  0.2922  39731.4893  2.6603     0.7
## 246 gbr 2012   80.92     4.1  0.2334  40039.7002  2.6667     0.5
## 247 gbr 2013   80.91     3.9  0.2187  40623.3597  2.6774     0.4
## 248 gbr 2014   81.08     3.7  0.1904  41376.7542  2.7149     0.6
## 249 gbr 2015   80.97     3.5  0.1920  42017.1411  2.7465     0.7
## 250 geo 1996   72.06    37.1  0.3969   1242.1104  3.0644    41.1
## 251 geo 1997   72.45    35.9  1.6562   1417.5141  3.6517    64.9
## 252 geo 1998   72.62    34.5  3.8326   1498.1390  3.8036    64.7
## 253 geo 1999   72.98    32.9  3.3273   1573.1597  3.8719    72.2
## 254 geo 2000   73.08    31.2  2.9703   1633.5391  3.8371    74.1
## 255 geo 2001   72.96    29.3  3.8053   1738.8029  3.7156    76.5
## 256 geo 2004   72.92    23.6  2.5222   2202.5718  3.8009    59.3
## 257 geo 2005   73.37    21.9  1.2146   2429.1725  3.8164    61.7
## 258 geo 2006   73.71    20.2  1.1574   2673.1483  3.8683    62.6
## 259 geo 2007   73.77    18.6  0.9462   3025.1418  3.9027    64.9
## 260 geo 2009   72.76    16.0  0.5756   3020.9987  4.2219    60.3
## 261 geo 2010   72.76    14.9  0.3212   3233.2959  4.4466    61.2
## 262 geo 2011   72.89    13.8  0.3580   3500.5275  4.5004    59.5
## 263 geo 2012   72.92    12.8  0.7892   3751.0035  4.4868    55.4
## 264 geo 2013   73.10    12.0  0.8728   3898.5547  4.5145    49.9
## 265 geo 2014   73.12    11.3  1.9210   4069.4245  4.7754    46.2
## 266 geo 2015   73.00    10.6  1.6978   4185.8139  5.0055    45.3
```

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## 267 grc 1995   78.17     9.1  1.1702  19909.5296  3.8342     4.2
## 268 grc 2000   78.84     6.9  0.9715  23275.4443  4.2637     2.5
## 269 grc 2003   79.14     5.5  0.9716  26349.2773  4.6551     1.6
## 270 grc 2004   79.11     5.2  0.8121  27614.4059  4.8013     1.7
## 271 grc 2005   79.27     4.8  0.9169  27698.5106  3.3840     1.6
## 272 grc 2006   79.61     4.6  0.7263  29176.3929  3.4833     1.9
## 273 grc 2007   79.42     4.4  1.0202  30054.8894  3.6707     1.7
## 274 grc 2008   79.76     4.3  1.1854  29874.7434  3.7576     1.2
## 275 grc 2009   80.00     4.2  1.2949  28514.8101  3.8709     1.4
## 276 grc 2010   80.25     4.1  1.3364  26917.7590  3.9442     2.4
## 277 grc 2011   80.30     4.0  1.4289  24495.7111  4.0414     4.6
## 278 grc 2012   80.35     3.9  1.3024  22830.5268  4.1343     6.2
## 279 grc 2013   80.77     3.8  1.1858  22251.2573  4.2155     7.0
## 280 grc 2014   80.95     3.7  0.8619  22565.6805  5.2167     6.9
## 281 grc 2015   80.82     3.6  0.7520  22615.3946  5.2527     6.8
## 282 hrv 2009   76.40     4.8  1.0951  14103.1261  2.7211     4.7
## 283 hrv 2010   76.75     4.6  1.1679  13923.6286  2.8428     6.2
## 284 hrv 2011   77.03     4.3  0.9263  13928.5019  2.8958     7.1
## 285 hrv 2012   77.30     4.1  0.9517  13658.5155  2.9731     7.3
## 286 hrv 2013   77.82     4.0  0.8483  13621.4761  3.0178     7.3
## 287 hrv 2014   77.80     3.8  0.7033  13662.8611  3.1258     6.1
## 288 hrv 2015   77.58     3.6  0.6458  14111.6646  3.1728     5.5
## 289 hun 1991   69.55    16.2  3.6319   8857.5195  3.2673     5.5
## 290 hun 1993   69.22    14.2  3.7250   8549.7296  3.2911     2.1
## 291 hun 1994   69.59    13.0  3.1130   8813.7597  3.3427     6.7
## 292 hun 1999   71.04    10.2  2.3144   9990.7685  3.5501     5.2
## 293 hun 2004   72.93     7.5  1.6708  12574.7106  3.3345     3.0
## 294 hun 2005   72.94     7.2  1.5098  13134.4299  2.7816     4.7
## 295 hun 2006   73.35     6.8  1.6462  13685.1740  3.0406     1.9
## 296 hun 2007   73.47     6.5  1.4639  13739.5847  2.8121     1.8
## 297 hun 2008   74.00     6.2  1.6847  13909.3231  3.1049     1.5
## 298 hun 2009   74.20     5.9  1.0656  12997.5792  3.0399     1.5
## 299 hun 2010   74.59     5.7  1.1744  13113.5260  2.8896     2.5
## 300 hun 2011   74.93     5.5  1.1917  13389.9596  2.9811     2.8
## 301 hun 2012   75.20     5.4  1.1686  13261.1970  3.1062     4.4
## 302 hun 2013   75.67     5.4  0.9531  13558.7975  3.2284     4.3
## 303 hun 2014   75.95     5.3  0.6718  14165.7083  3.3443     3.2
## 304 hun 2015   75.52     5.3  1.0217  14745.4900  3.1178     2.7
## 305 irl 1994   75.72     6.2  0.6944  27224.3701  1.9981     0.7
## 306 irl 1995   75.61     6.1  0.7671  29694.6470  2.1054     1.0
## 307 irl 1996   75.92     6.1  0.9313  31644.8861  2.1058     1.0
## 308 irl 2000   76.58     5.9  1.0297  44101.1074  2.2304     0.5
## 309 irl 2003   78.20     5.1  0.8854  48236.9627  2.5803     0.4
## 310 irl 2004   78.53     4.7  0.5714  50546.4910  2.7454     0.3
## 311 irl 2005   78.99     4.4  0.8956  52276.2443  3.5427     0.2
## 312 irl 2006   79.25     4.1  0.9800  53466.0662  3.6638     0.6
## 313 irl 2007   79.63     3.9  1.0494  54708.0706  3.8986     0.4
## 314 irl 2008   79.72     3.8  0.8055  51202.3593  4.0144     0.6
## 315 irl 2009   79.79     3.6  1.0301  48110.5515  4.0388     1.2
## 316 irl 2011   80.75     3.4  0.5684  48669.7857  4.0938     1.2
## 317 irl 2012   80.85     3.4  0.8299  48573.3772  3.9423     0.9
## 318 irl 2013   81.12     3.2  0.5436  48971.3697  3.9314     1.4
## 319 isl 2004   81.22     2.6  1.4167  41692.0963  3.6276     0.4
## 320 isl 2005   81.43     2.4  1.0417  43635.0155  3.6339     0.2
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## 321 isl 2006   81.67     2.3  0.3399  44859.8326  3.6537     0.3
## 322 isl 2007   81.92     2.2  0.6190  47835.3826  3.6894     0.2
## 323 isl 2008   82.03     2.1  0.3107  47889.3849  3.7182     0.1
## 324 isl 2009   82.09     1.9  0.3341  44491.7345  3.6761     0.2
## 325 isl 2010   82.36     1.9  0.5811  43024.9235  3.5654     0.2
## 326 isl 2011   82.58     1.8  1.0085  43700.7930  3.4560     0.4
## 327 isl 2012   82.63     1.7  0.3320  44032.4252  3.5074     0.2
## 328 isl 2013   82.65     1.6  0.3734  45420.9910  3.5697     0.1
## 329 isl 2014   82.66     1.6  0.3448  45853.9634  3.6306     0.1
## 330 isl 2015   82.68     1.6  0.7436  47533.6992  3.7826     0.1
## 331 isr 1979   74.82    16.1  1.9315  18003.3184  2.6940     4.7
## 332 isr 1992   76.90     8.7  1.2415  22723.6871  4.3503     2.2
## 333 isr 1997   78.11     6.4  0.5413  25963.2504  4.3826     3.2
## 334 isr 2001   78.87     5.4  5.7982  27127.2217  3.8398     2.5
## 335 isr 2005   80.12     4.5  3.2351  27547.8254  3.7540     6.0
## 336 isr 2007   80.59     4.1  2.0690  29688.6714  3.6293     4.7
## 337 isr 2010   81.83     3.7  2.1587  30693.5931  3.5191     4.2
## 338 isr 2012   82.15     3.4  1.8024  31695.0064  3.5075     4.5
## 339 isr 2014   81.91     3.3  1.6464  32977.9609  3.4669     3.5
## 340 ita 1991   77.06     8.0  2.7321  31324.5305  4.8488     1.2
## 341 ita 1993   77.68     7.3  1.6130  31276.1062  5.4781     3.7
## 342 ita 1995   78.08     6.4  1.4175  32863.9562  5.6730     3.0
## 343 ita 1998   78.80     5.3  1.1932  34465.1191  5.9177     3.5
## 344 ita 2000   79.56     4.7  0.9749  36329.2489  3.4586     3.0
## 345 ita 2003   80.12     4.0  1.0343  36942.9394  3.6149     1.8
## 346 ita 2004   80.72     3.8  1.0059  37227.1479  3.6809     1.5
## 347 ita 2005   80.91     3.7  0.8304  37347.6359  3.7017     1.8
## 348 ita 2006   81.20     3.7  0.8192  37902.3071  3.6985     1.4
## 349 ita 2007   81.38     3.6  0.8766  38272.2041  3.7751     1.6
## 350 ita 2008   81.52     3.5  0.7709  37653.7480  3.7806     1.7
## 351 ita 2009   81.65     3.5  0.7806  35503.1510  3.7898     1.9
## 352 ita 2010   82.00     3.4  0.6989  36000.5201  3.8160     2.5
## 353 ita 2011   82.07     3.3  0.7058  36192.8664  3.8846     2.5
## 354 ita 2012   82.19     3.2  0.6980  35019.4719  3.8514     2.9
## 355 ita 2013   82.46     3.1  0.6059  33978.5518  3.9044     2.8
## 356 ita 2014   82.71     3.0  0.5581  33666.6919  3.9048     2.8
## 357 ita 2015   82.59     2.9  0.5641  33961.4362  3.8479     3.5
## 358 jor 2008   76.63    18.8  2.0824   3787.1955  2.2231    23.9
## 359 jor 2010   77.62    17.8  2.6746   3690.1133  2.2326    18.1
## 360 jpn 2008   82.90     2.5  0.4016  45165.7879  2.1394     1.4
## 361 jpn 2010   83.14     2.4  0.2939  44507.6764  2.2059     0.5
## 362 kaz 1996   64.44    44.0 19.6156   3814.4993  3.7066    56.6
## 363 kaz 2001   65.50    35.7 15.6857   5106.6342  3.4399    64.9
## 364 kaz 2002   65.55    33.9 13.1803   5606.8530  3.5830    62.0
## 365 kaz 2003   65.31    32.1 14.6321   6107.7093  3.6168    56.3
## 366 kaz 2013   70.34    14.6  6.2235  10368.4993  3.9508     5.8
## 367 kaz 2014   71.15    13.5  5.8198  10646.0345  3.9800     6.7
## 368 kgz 1998   66.24    45.5  8.9395    614.8924  2.9836    78.1
## 369 kgz 2000   66.86    41.6  9.1724    654.3120  2.8043    94.2
## 370 kgz 2001   67.03    39.8  7.8813    682.6240  2.6959    94.3
## 371 kgz 2002   67.02    38.2  7.5565    676.2697  2.5862    93.3
## 372 kgz 2003   67.00    36.7  7.0680    716.2643  2.5735    93.0
## 373 kgz 2004   67.07    35.3  7.2367    757.3742  2.5610    77.6
## 374 kgz 2005   67.08    34.2  8.2954    747.5656  2.5167    82.9
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## 375 kgz 2006   67.23    33.0  7.1585    762.5201  2.4489    70.2
## 376 kgz 2007   67.65    31.7  6.3901    819.8063  2.3580    71.1
## 377 kgz 2008   68.44    30.1  5.9068    880.2788  2.3528    63.8
## 378 kgz 2009   69.32    28.4  6.7218    894.8180  2.3409    63.1
## 379 kgz 2010   69.70    26.5  6.6324    880.0378  2.3394    66.1
## 380 kgz 2011   70.28    24.6  6.1863    921.1770  2.2860    66.3
## 381 kgz 2012   70.63    22.9  4.7889    905.1657  2.2623    69.3
## 382 kgz 2013   70.97    21.4  4.0168    984.2390  2.2614    69.5
## 383 kgz 2014   71.31    20.1  3.7755   1003.5104  2.2130    66.7
## 384 kor 2006   79.24     4.5  1.4243  20131.0715  1.8047     1.2
## 385 kor 2008   80.06     3.9  1.2322  21664.6064  1.8407     1.2
## 386 kor 2010   80.62     3.5  1.1091  23087.2256  1.9839     1.5
## 387 kor 2012   81.19     3.3  0.9829  24197.9414  2.0798     1.2
## 388 lka 1985   68.50    25.2  7.9856   1076.1429  0.1810    81.0
## 389 ltu 2004   72.09     8.4  5.8995   9616.6126  3.2930    19.2
## 390 ltu 2005   71.41     8.1  5.2361  10529.8064  3.2993    12.3
## 391 ltu 2006   71.05     7.7  5.4271  11491.6849  3.4223     7.3
## 392 ltu 2007   70.73     7.2  4.8124  12918.3177  3.4535     4.5
## 393 ltu 2008   71.59     6.7  4.8622  13394.8792  3.4530     4.6
## 394 ltu 2009   73.07     6.1  4.1292  11537.9424  3.4323     8.9
## 395 ltu 2010   73.31     5.6  3.9357  11957.0842  3.4144     8.4
## 396 ltu 2011   73.73     5.0  4.5732  12967.1510  4.0238     5.5
## 397 ltu 2012   74.01     4.5  3.9301  13646.0199  4.1384     5.8
## 398 ltu 2013   74.03     4.0  4.2016  14275.3422  4.2042     4.9
## 399 ltu 2014   74.58     3.6  3.4461  14903.7140  4.2507     5.0
## 400 ltu 2015   74.66     3.3  3.6595  15350.4615  4.2993     4.3
## 401 lux 1985   74.09     9.4  1.4756  47869.4835  1.8000     0.2
## 402 lux 1991   75.60     6.8  1.9545  70667.2385  2.0000     0.0
## 403 lux 1994   76.26     5.6  0.9997  74763.8712  2.2000     0.0
## 404 lux 1997   76.92     4.6  0.5088  78075.5306  2.4000     0.2
## 405 lux 2000   78.00     3.9  1.2369  93462.9248  2.5000     0.0
## 406 lux 2003   78.74     3.3  1.0421  97678.4605  2.7000     0.5
## 407 lux 2004   79.05     3.0  0.2599  99778.4688  2.7300     0.1
## 408 lux 2005   79.41     2.8  1.4390 101380.7746  2.5994     0.1
## 409 lux 2006   79.69     2.6  1.2910 104943.4403  2.6160     0.0
## 410 lux 2007   80.12     2.4  1.0899 111968.3495  2.7227     0.0
## 411 lux 2008   80.49     2.2  1.0811 108577.3523  2.7359     0.1
## 412 lux 2009   80.66     2.0  0.7495 101939.6135  2.7170     0.2
## 413 lux 2010   80.80     1.9  1.9320 104965.3061  2.7683     0.1
## 414 lux 2011   80.98     1.8  0.5234 105264.7485  2.7614     0.2
## 415 lux 2012   81.14     1.6  0.1882 102404.6121  2.8047     0.3
## 416 lux 2013   81.33     1.6  0.1521 103721.7471  2.8327     0.3
## 417 lux 2014   81.38     1.6  0.5897 105658.5197  2.8891     0.3
## 418 lux 2015   81.44     1.5  0.7106 107638.2123  2.9222     0.6
## 419 lva 1995   66.87    19.7 17.1492   5140.9845  3.3482    22.1
## 420 lva 1996   69.15    19.1 14.7577   5331.5936  3.4803    23.6
## 421 lva 2004   71.18    11.4  8.5264   9744.6579  3.5486    15.4
## 422 lva 2005   70.83    10.7  9.1384  10908.8066  2.9432    14.1
## 423 lva 2006   70.26    10.1  8.6454  12318.1303  3.0196     7.8
## 424 lva 2007   70.85     9.6  7.4479  13662.3348  3.1464     4.9
## 425 lva 2008   72.09     9.1  6.7766  13344.6528  3.2424     6.1
## 426 lva 2009   72.84     8.6  5.1911  11635.1436  3.1485     9.6
## 427 lva 2010   73.20     8.2  5.1826  11348.4062  3.0757     9.6
## 428 lva 2011   73.83     7.8  4.9162  12283.2934  3.0837     8.7
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## 429 lva 2012   74.17     7.6  4.9829  12950.7570  3.0913     7.5
## 430 lva 2013   74.17     7.4  4.9535  13394.9502  3.1408     6.1
## 431 lva 2014   74.57     7.2  5.6624  13780.6583  3.1724     5.6
## 432 lva 2015   74.91     6.9  4.2595  14346.9484  3.1656     3.9
## 433 mda 1997   67.87    30.8 13.0107   1562.5123  3.6020    74.6
## 434 mda 1998   68.59    29.8 11.4833   1460.8795  3.6662    83.1
## 435 mda 1999   68.64    28.1 11.1206   1413.8917  3.2450    88.1
## 436 mda 2000   68.60    26.0 11.5616   1446.6315  2.4553    90.3
## 437 mda 2001   68.87    23.7 10.8598   1538.3122  2.2925    85.2
## 438 mda 2002   69.11    21.5  9.8095   1662.1454  2.3103    75.9
## 439 mda 2003   69.20    19.5  8.6900   1776.8432  2.2824    68.3
## 440 mda 2004   69.12    18.0  7.0075   1913.0577  2.1814    68.9
## 441 mda 2005   68.68    16.9  7.5017   2061.5471  2.3783    74.3
## 442 mda 2006   68.93    16.0  6.7266   2166.5146  2.3768    40.4
## 443 mda 2007   69.29    15.5  6.1130   2236.6869  2.3871    31.5
## 444 mda 2008   69.58    15.2  6.5855   2415.7430  2.3545    32.8
## 445 mda 2009   69.58    14.9  5.6858   2273.6667  2.3912    31.5
## 446 mda 2010   69.75    14.7  6.1380   2437.5300  2.3808    28.9
## 447 mda 2011   70.94    14.5  4.8440   2580.8413  2.4142    25.6
## 448 mda 2012   71.53    14.3  4.9849   2565.9577  2.4135    24.6
## 449 mda 2013   72.08    14.1  5.5474   2798.7692  2.5028    19.6
## 450 mda 2014   71.87    13.9  4.1947   2940.4890  2.4746    18.3
## 451 mda 2015   71.82    13.6  4.0237   2953.7227  2.4836    16.1
## 452 mex 1992   72.00    33.7 21.9682   8104.2911  1.3000    46.1
## 453 mex 1994   72.54    30.4 19.8195   8373.5135  1.5000    45.5
## 454 mkd 2009   75.47     9.6  1.2184   4398.8890  2.5926    35.1
## 455 mkd 2010   75.86     8.7  1.8673   4542.8997  2.6759    32.4
## 456 mkd 2011   76.26     7.5  1.2671   4645.2816  2.7257    31.3
## 457 mkd 2012   76.30     6.5  1.5040   4620.0980  2.7744    29.2
## 458 mkd 2013   76.75     5.8  0.7256   4751.1501  2.7956    28.2
## 459 mlt 2007   79.64     5.9  0.7055  20610.0609  3.3510     1.0
## 460 mlt 2008   79.89     5.8  1.1597  21161.6409  3.3553     0.5
## 461 mlt 2009   80.19     5.7  0.6665  20485.5568  1.9169     0.8
## 462 mlt 2010   80.42     5.6  0.9507  21107.3644  2.1530     0.5
## 463 mlt 2011   80.73     5.6  0.5138  21303.7646  2.2384     0.5
## 464 mlt 2012   80.86     5.5  1.5236  21702.9923  2.3566     0.4
## 465 mlt 2013   81.11     5.3  1.1530  22435.9352  2.4595     0.2
## 466 mlt 2014   81.26     5.2  0.7264  23925.6580  2.6592     0.1
## 467 mlt 2015   81.23     5.1  0.6064  25897.9594  2.8598     0.3
## 468 mus 2012   74.22    12.8  2.3457   8580.0857  1.3738    17.2
## 469 mys 2008   74.30     6.9  0.8856   8850.0092  0.9216    16.7
## 470 mys 2011   74.88     6.7  0.6030   9372.0075  1.2777     8.6
## 471 nld 1990   77.00     6.8  0.8875  35702.5548  2.5032     1.7
## 472 nld 1999   77.96     5.2  1.2497  44885.0907  2.3768     0.5
## 473 nld 2004   79.11     4.6  1.1241  47575.4793  2.6469     0.8
## 474 nld 2005   79.50     4.5  1.0393  48437.8796  2.6997     0.4
## 475 nld 2006   79.85     4.3  0.7929  50033.8834  2.7791     0.2
## 476 nld 2007   80.22     4.2  0.8708  51808.7651  2.7724     0.2
## 477 nld 2008   80.34     4.0  0.8894  52727.5193  2.8490     0.5
## 478 nld 2009   80.62     3.8  0.9027  50533.5069  2.9057     0.3
## 479 nld 2010   80.81     3.7  0.8577  50950.0343  2.9516     0.2
## 480 nld 2011   80.95     3.6  0.8012  51499.5958  3.1243     0.3
## 481 nld 2012   81.04     3.5  0.8302  50780.7030  3.2463     0.2
## 482 nld 2013   81.29     3.3  0.7710  50565.3021  3.3058     0.2
```

```
## 483 nld 2014   81.55     3.3  0.7088  51100.8398  3.3468     0.4
## 484 nld 2015   81.55     3.2  0.6033  51871.5765  3.4917     0.4
## 485 nor 1979   75.35     8.4  0.8960  46536.3015  1.9000     1.0
## 486 nor 1986   76.02     8.3  1.5477  58641.9787  2.3000     0.5
## 487 nor 1991   77.00     6.4  1.4540  61789.4107  2.6000     0.5
## 488 nor 1995   77.86     4.6  0.9985  70409.7193  2.8000     0.7
## 489 nor 2000   78.56     4.0  1.1298  81653.3449  2.9000     0.5
## 490 nor 2003   79.50     3.5  0.9381  83941.3656  2.1015     0.3
## 491 nor 2004   79.82     3.4  0.7732  86759.1420  2.2115     0.5
## 492 nor 2005   80.13     3.2  0.6321  88432.6201  2.2960     0.4
## 493 nor 2006   80.42     3.1  0.9355  89828.4252  2.3597     0.5
## 494 nor 2007   80.55     3.0  0.6686  91565.7334  2.4069     0.4
## 495 nor 2008   80.67     2.9  0.5883  90862.3997  2.4077     0.4
## 496 nor 2009   80.77     2.7  0.6042  88174.1579  2.4756     0.2
## 497 nor 2010   80.91     2.6  0.7417  87693.7901  2.4949     0.3
## 498 nor 2011   80.82     2.5  2.6045  87413.1770  2.5441     0.2
## 499 nor 2012   81.47     2.3  0.5664  88604.5746  2.5532     0.2
## 500 nor 2013   81.50     2.3  0.9274  88444.8950  2.5991     0.4
## 501 nor 2014   81.91     2.2  0.5874  89175.4995  2.6832     0.3
## 502 nor 2015   82.27     2.0  0.3885  90029.3556  2.6474     0.3
## 503 pol 1992   71.32    14.3  2.8356   5631.9108  2.1919     5.0
## 504 pol 1995   72.13    12.6  2.6726   6539.8990  2.3251    17.0
## 505 pol 1999   73.24     8.6  2.0834   8069.7291  2.2693     9.0
## 506 pol 2004   75.00     6.7  1.2664   9610.4212  2.2771    13.3
## 507 pol 2005   75.17     6.6  1.2063   9950.5070  2.1267     9.4
## 508 pol 2006   75.29     6.3  1.2234  10572.0797  2.1671     6.8
## 509 pol 2007   75.35     6.0  1.1260  11321.9962  2.1776     4.2
## 510 pol 2008   75.58     5.8  1.0265  11801.5475  2.1482     3.2
## 511 pol 2009   75.87     5.3  0.8692  12126.1461  2.1593     3.2
## 512 pol 2010   76.40     5.0  0.7496  12599.5336  2.1707     3.0
## 513 pol 2011   76.68     4.7  0.8716  13224.5691  2.1997     3.0
## 514 pol 2012   76.78     4.6  0.7883  13437.2399  2.2242     3.1
## 515 pol 2013   77.09     4.5  0.9029  13632.4980  2.2340     3.0
## 516 pol 2014   77.56     4.5  0.7175  14095.4312  2.3020     2.8
## 517 pol 2015   77.53     4.5  0.5875  14646.3221  2.3252     2.6
## 518 prt 2003   77.58     4.3  1.4684  21525.4233  3.3497     3.4
## 519 prt 2007   79.28     3.3  0.9425  22819.5035  3.6483     1.7
## 520 prt 2008   79.53     3.3  1.2815  22859.3694  3.7405     2.2
## 521 prt 2009   79.73     3.2  0.9212  22124.5800  3.8479     1.6
## 522 prt 2010   80.05     3.1  1.1032  22498.6909  3.9756     2.0
## 523 prt 2011   80.38     3.1  0.8120  22149.6306  4.1178     2.7
## 524 prt 2012   80.63     3.1  0.9702  21337.2857  4.2361     4.6
## 525 prt 2013   80.92     3.1  0.8348  21256.7594  4.3932     4.5
## 526 prt 2014   81.21     3.0  0.8377  21540.9878  4.5567     3.7
## 527 rou 1992   69.76    29.1  4.7270   4349.9288  1.8660    18.1
## 528 rou 1994   69.47    27.9  4.1954   4603.0224  1.7353    82.6
## 529 rou 1995   69.37    27.3  3.9297   4899.8556  1.7680    36.2
## 530 rou 1997   69.06    26.0  3.5056   4872.4316  1.7910    42.0
## 531 rou 2006   72.69    16.7  1.7351   7369.4925  2.2104    40.3
## 532 rou 2007   73.20    15.3  1.6667   8020.1927  2.2915    33.7
## 533 rou 2008   73.26    14.0  1.9666   8913.9798  2.4133    26.9
## 534 rou 2009   73.37    13.0  1.8038   8492.6175  2.4414    25.6
## 535 rou 2010   73.65    12.1  1.8619   8209.9195  2.4804    28.0
## 536 rou 2011   74.46    11.5  1.5535   8415.9992  2.5153    31.4
```

```
## 537 rou 2012   74.56    10.9  1.7132   8629.1430  2.5887    31.5
## 538 rou 2013   74.88    10.5  1.4227   8965.6485  2.6240    31.2
## 539 rus 1993   65.47    22.1 28.8427   7070.5352  2.2569    26.3
## 540 rus 1996   66.04    22.0 24.7091   5714.6260  2.3372    26.1
## 541 rus 1997   67.13    21.6 22.1855   5804.2148  2.3448    21.1
## 542 rus 1998   67.43    21.1 21.1769   5505.6973  2.3702    26.2
## 543 srb 2012   74.70     6.2  1.4751   5886.8946  2.4961    23.1
## 544 srb 2013   75.01     6.0  1.8593   6086.7265  2.4945    26.3
## 545 srb 2014   75.06     6.0  1.3486   6018.1660  2.4611    26.1
## 546 srb 2015   75.10     5.9  1.1746   6155.4482  2.4603    25.3
## 547 svk 2004   74.36     8.8  1.5258  12407.7472  3.3061     5.3
## 548 svk 2005   74.31     8.4  1.3872  13228.2720  3.0224     3.2
## 549 svk 2008   74.89     7.6  1.1379  16773.0611  3.3561     2.4
## 550 svk 2009   75.17     7.3  0.9604  15836.8834  3.2953     2.5
## 551 svk 2010   75.63     7.0  0.9763  16727.2913  3.3510     2.2
## 552 svk 2012   76.22     6.5  0.9087  17480.2712  3.3598     3.0
## 553 svk 2013   76.56     6.3  0.9980  17578.6368  3.3855     2.9
## 554 svk 2014   76.77     6.1  0.7324  18044.9569  3.4214     3.6
## 555 svn 1993   73.57     7.1  1.3301  13795.9033  2.0300     0.6
## 556 svn 1997   75.15     5.4  1.9487  16448.4257  2.1470     0.7
## 557 svn 1999   75.56     4.8  1.2459  17920.0016  2.1350     0.7
## 558 svn 2004   77.02     3.7  1.6518  21177.1023  2.3058     0.3
## 559 svn 2005   77.68     3.5  1.0686  21943.3616  2.3519     0.4
## 560 svn 2006   77.97     3.3  0.5409  23130.3839  2.3672     0.3
## 561 svn 2007   78.23     3.2  0.8409  24606.9330  2.3925     0.2
## 562 svn 2008   78.64     3.0  0.4985  25430.3497  2.3994     0.1
## 563 svn 2009   79.08     2.8  0.5168  23299.2048  2.4167     0.2
## 564 svn 2010   79.46     2.7  0.3519  23509.5434  2.4367     0.1
## 565 svn 2011   79.85     2.6  0.7987  23662.8314  2.4965     0.2
## 566 svn 2012   79.94     2.4  0.6083  22989.9303  2.5406     0.2
## 567 svn 2013   80.20     2.3  0.8061  22722.4374  2.6252     0.2
## 568 svn 2014   80.90     2.2  0.9119  23328.4751  2.7628     0.2
## 569 svn 2015   80.79     2.1  0.5605  23826.1316  2.8148     0.1
## 570 swe 1967   74.09    12.6  0.8994  23321.3335  1.2000    10.7
## 571 swe 1975   75.14     8.7  1.1645  29732.5739  1.7000     0.7
## 572 swe 1981   76.26     6.9  1.4738  31425.0641  2.3000     0.7
## 573 swe 1987   77.20     6.2  1.2120  36304.4518  2.8000     0.5
## 574 swe 1992   78.16     5.1  1.3417  36454.8296  2.7000     0.7
## 575 swe 1995   78.92     4.0  0.9970  37870.9188  2.8470     1.0
## 576 swe 2000   79.76     3.4  1.0065  44941.6704  3.0731     0.2
## 577 swe 2003   80.26     3.2  0.8929  47212.7085  3.3509     0.8
## 578 swe 2004   80.24     3.1  1.0819  49066.8962  3.4378     0.9
## 579 swe 2005   80.64     3.0  0.8965  50268.1757  3.5107     1.6
## 580 swe 2006   80.77     2.8  0.8371  52316.9632  3.5960     0.9
## 581 swe 2007   80.88     2.7  1.1477  53716.4434  3.6760     0.8
## 582 swe 2008   81.02     2.6  0.7808  53059.4539  3.7353     1.0
## 583 swe 2009   81.16     2.5  0.9067  50326.2220  3.8065     1.0
## 584 swe 2010   81.52     2.5  0.9774  52869.0443  3.8779     1.2
## 585 swe 2011   81.62     2.4  0.7361  54147.9404  3.9569     1.1
## 586 swe 2012   81.80     2.4  0.6570  53432.6448  4.0368     1.0
## 587 swe 2013   81.92     2.4  0.8099  53611.1018  4.1259     1.1
## 588 swe 2014   82.11     2.4  0.8234  54492.5991  4.2037     1.0
## 589 swe 2015   82.23     2.4  1.0814  56339.9943  4.2856     1.1
## 590 tha 1994   70.43    24.8  7.3581   3299.3849  0.2380    50.9
```

```
## 591 tha 2002   72.95    17.5  5.0703   3731.2731  0.2964    40.1
## 592 tha 2007   75.86    14.0  5.1155   4745.3037  0.2959    24.8
## 593 tha 2008   76.31    13.4  4.6154   4801.8775  0.3164    23.0
## 594 tha 2009   76.82    12.9  4.2014   4744.7628  0.3387    20.3
## 595 tha 2010   77.00    12.5  4.7913   5076.3402  0.3906    17.8
## 596 tha 2015   78.23    10.5  3.1488   5741.3539  0.4651     7.1
## 597 tjk 1999   67.47    78.8  8.0662    389.5969  2.1186    98.1
## 598 tjk 2003   68.93    61.0  3.8053    531.9299  1.9396    90.7
## 599 tjk 2004   69.23    57.3  3.0616    576.4443  1.9512    80.6
## 600 tur 2009   77.51    17.6  1.1028   9976.1505  1.6635    16.7
## 601 tur 2010   77.58    16.4  1.4472  10672.3893  1.7068    15.9
## 602 tur 2011   77.81    15.3  1.1908  11678.1308  1.7160    13.6
## 603 tur 2012   77.98    14.2  1.2251  12039.2957  1.7384    13.0
## 604 tur 2013   78.02    13.2  1.6670  12842.1638  1.7619    11.4
## 605 tur 2014   78.07    12.3  1.5113  13277.7608  1.7560    10.5
## 606 tur 2015   78.35    11.6  1.3458  13853.0971  1.7988    11.5
## 607 ukr 1992   69.06    16.8 10.8717   3263.3632  4.2970    41.3
## 608 ukr 1993   68.49    17.0 11.2673   2797.5687  4.3420    42.6
## 609 ukr 1995   66.67    17.5 14.1332   1917.4326  4.4070    48.7
## 610 ukr 1996   67.02    17.5 14.0456   1741.0677  2.9920    57.5
## 611 ukr 2002   68.21    14.3 10.6640   2131.7312  3.0188    47.3
## 612 ukr 2003   68.31    13.6  9.9063   2353.6044  3.0096    37.8
## 613 ukr 2004   68.04    13.0  9.2478   2658.6886  3.0161    29.5
## 614 usa 1979   73.92    13.2  9.7560  28939.6399  1.4000     1.2
## 615 usa 1986   75.00    10.4  8.5632  32925.2267  1.7000     1.2
## 616 usa 1991   75.70     9.1 10.3987  35542.1411  1.9000     1.5
## 617 usa 1997   76.58     7.5  7.5739  40614.4056  2.1000     1.5
## 618 usa 2000   76.87     7.1  6.1939  44726.9654  2.5942     1.5
## 619 usa 2004   77.53     6.9  6.1447  47287.5938  2.7147     1.7
## 620 usa 2007   78.05     6.6  6.4158  49856.2815  2.4358     1.7
## 621 uzb 1998   67.31    55.1  4.2599    926.5114  3.0747    87.3
## 622 uzb 2000   67.30    52.7  3.9283    979.0120  2.9628    96.5
## 623 uzb 2002   67.14    50.0  3.6272   1034.2238  2.8456    96.1
## 624 uzb 2003   67.01    48.6  2.5269   1065.5270  2.7816    96.4
## 625 ven 1981   69.80    33.9 11.0104  13839.0924  0.9960    33.7
## 626 ven 1987   71.62    27.6  8.4604  12511.1901  1.4010    36.5
## 627 ven 1989   71.90    25.6 12.4228  11515.1824  1.6950    28.9
## 628 zaf 2008   53.38    46.6 11.0365   7432.1168  0.6968    57.9
```

```
g1 <- ggplot(ddf_gap, aes(x=log10(infmort), y=lifeexp)) +
        geom_point() + geom_smooth() + geom_smooth(method="lm", color="red") +
          labs(x="Infant mortality rate per 1000 births", y="Life exp (years)") +
            theme_minimal()


g2 <- ggplot(ddf_gap, aes(x=log10(murder), y=lifeexp)) +
        geom_point() + geom_smooth() + geom_smooth(method="lm", color="red") +
          labs(x="Murders per 100,000 people", y="Life exp (years)") +
            theme_minimal()


g3 <- ggplot(ddf_gap, aes(x=log10(gdp), y=lifeexp)) +
        geom_point() + geom_smooth() + geom_smooth(method="lm", color="red") +
          labs(x="GDP per capita (US$)", y="Life exp (years)") +
```

```
            theme_minimal()

g4 <- ggplot(ddf_gap, aes(x=log10(doctors), y=lifeexp)) +
        geom_point() + geom_smooth() + geom_smooth(method="lm", color="red") +
          labs(x="Medical Doctors per 1000 people", y="Life exp (years)") +
            theme_minimal()

g5 <- ggplot(ddf_gap, aes(x=log10(poverty), y=lifeexp)) +
        geom_point() + geom_smooth() + geom_smooth(method="lm", color="red") +
          labs(x="Poverty (% of pop. below 5.50 US$)", y= "Life exp (years)") +
             theme_minimal()

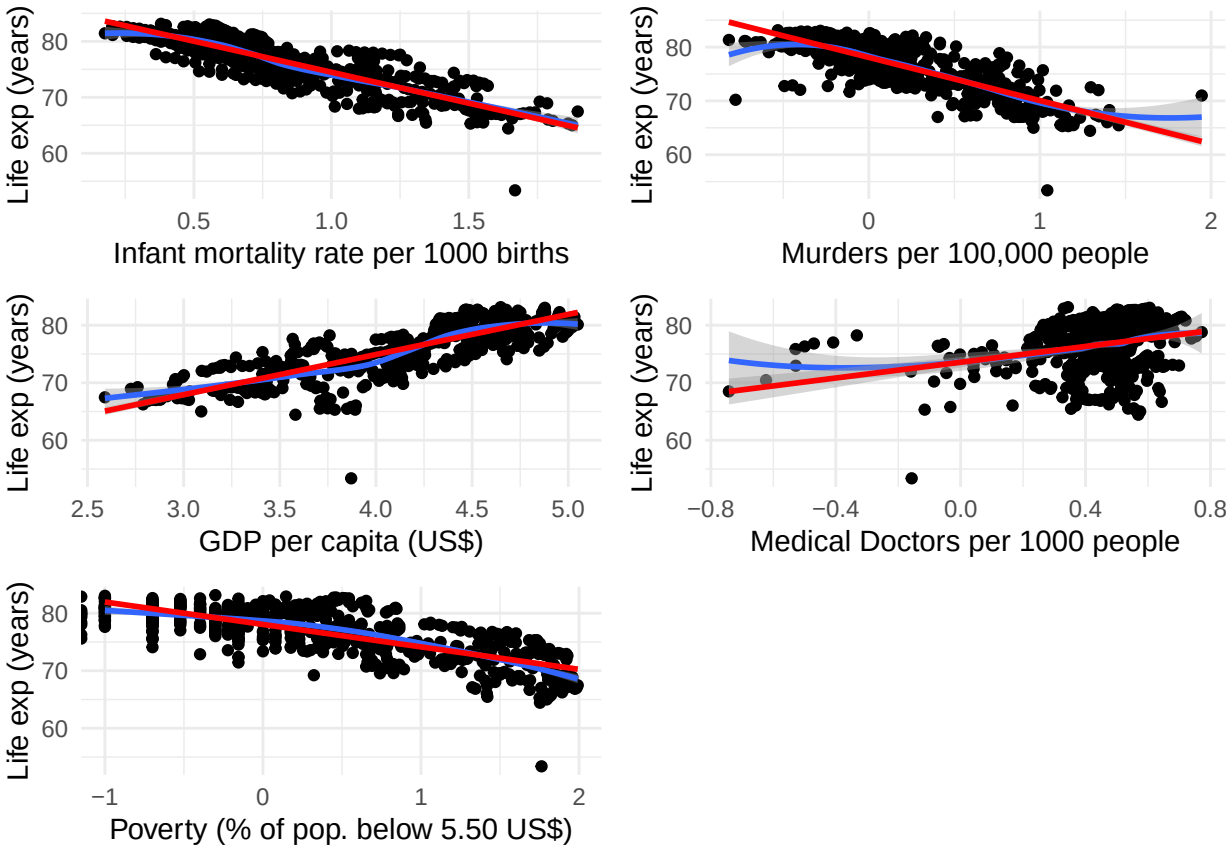
gridExtra::grid.arrange(g1, g2, g3, g4, g5, ncol = 2, nrow = 3)
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
## `geom_smooth()` using formula 'y ~ x'
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
## `geom_smooth()` using formula 'y ~ x'
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
## `geom_smooth()` using formula 'y ~ x'
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
## `geom_smooth()` using formula 'y ~ x'
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## Warning: Removed 10 rows containing non-finite values (stat_smooth).
```

```
## `geom_smooth()` using formula 'y ~ x'
```

```
## Warning: Removed 10 rows containing non-finite values (stat_smooth).
```




```
ddf_gap_cor <- cor(ddf_gap[c(3:8)])
ddf_gap_cor
```

```
##            lifeexp    infmort     murder        gdp    doctors    poverty
## lifeexp  1.0000000 -0.7674301 -0.5581566  0.6863967  0.2846597 -0.7293084
## infmort -0.7674301  1.0000000  0.4719312 -0.5305251 -0.2927723  0.8292905
## murder  -0.5581566  0.4719312  1.0000000 -0.3412597 -0.2063548  0.4199768
## gdp      0.6863967 -0.5305251 -0.3412597  1.0000000  0.1813927 -0.5780013
## doctors  0.2846597 -0.2927723 -0.2063548  0.1813927  1.0000000 -0.2031502
## poverty -0.7293084  0.8292905  0.4199768 -0.5780013 -0.2031502  1.0000000
```

Explanation for Problem 1:

Visualize life expectancy versus the five candidate predictors it appears that infant mortality rate, murder rate, poverty rate had negative linear relationship while GDP per capita and number of doctors show positive linear relationship with target variable.

Problem 2->

Explanation based on the visualizations from Problem 1:

We will utilize the log of infant mortality rate as our sole predictor since, according to a visual inspection and correlation matrix, it appears to have the strongest linear association with life expectancy.

```
fit <- lm(lifeexp ~ log10(infmort), data = ddf_gap)

summary(fit)
```

```
##
## Call:
## lm(formula = lifeexp ~ log10(infmort), data = ddf_gap)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -13.7098  -1.2938   0.1379   1.3695   5.9011
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)     85.5675     0.2184  391.71   <2e-16 ***
## log10(infmort) -11.0752     0.2477  -44.71   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.178 on 626 degrees of freedom
## Multiple R-squared:  0.7615, Adjusted R-squared:  0.7611
## F-statistic:  1999 on 1 and 626 DF,  p-value: < 2.2e-16
```

Model diagnostics

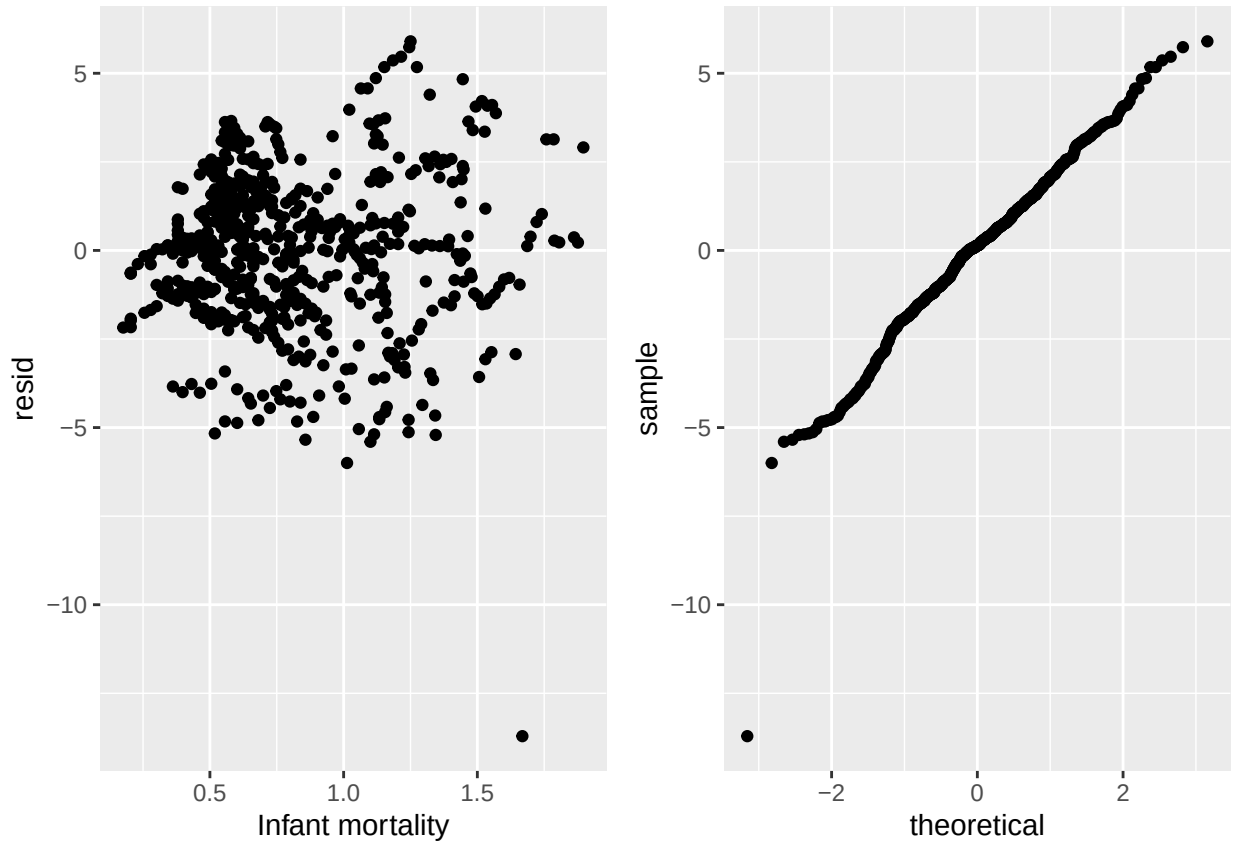
A effective technique to evaluate a model visually and look for model assumption breaches is to plot the residuals (errors).

Plotting the residuals

```
g1 <- ddf_gap %>%
  add_residuals(fit, "resid") %>%
    ggplot(aes(x=log10(infmort),y=resid)) +
      geom_point() + labs(x="Infant mortality")

g2 <- ddf_gap %>%
  add_residuals(fit, "resid") %>%
    ggplot(aes(sample=resid)) + geom_qq()

gridExtra::grid.arrange(g1, g2, ncol=2)
```



Simple random scatter is shown in the residual plot against the predictor, and no model assumptions are broken. The residuals are roughly normal, as seen by the QQ-plot.

But we find a significant outlier that needs to be eliminated:

```
outlier <- ddf_gap %>%
  add_residuals(fit, "resid") %>%
  filter(resid < -10)

outlier
```

```
##   geo time lifeexp infmort  murder      gdp doctors poverty     resid
## 1 zaf 2008   53.38    46.6 11.0365 7432.117  0.6968    57.9 -13.70982
```

```
ddf_gap1 <- anti_join(ddf_gap, outlier, by=c("geo", "time"))
fit1 <- lm(lifeexp ~ log10(infmort), data = ddf_gap1)
summary(fit1)
```

```
##
## Call:
## lm(formula = lifeexp ~ log10(infmort), data = ddf_gap1)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -6.054 -1.317  0.105  1.385  5.811
##
```

```
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)     85.4648     0.2121  402.97   <2e-16 ***
## log10(infmort) -10.9210     0.2410  -45.31   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.108 on 625 degrees of freedom
## Multiple R-squared:  0.7667, Adjusted R-squared:  0.7663
## F-statistic:  2053 on 1 and 625 DF,  p-value: < 2.2e-16
```

We plot residuals once more after deleting the outlier and re-fitting the model:

```
g1 <- ggplot(ddf_gap1, aes(x=log10(infmort), y=lifeexp)) +
        geom_point() + geom_smooth() + geom_smooth(method="lm", color="red") +
          labs(x="Infant mortality rate per 1000 births", y="Life expectancy (years)") +
            theme_minimal()

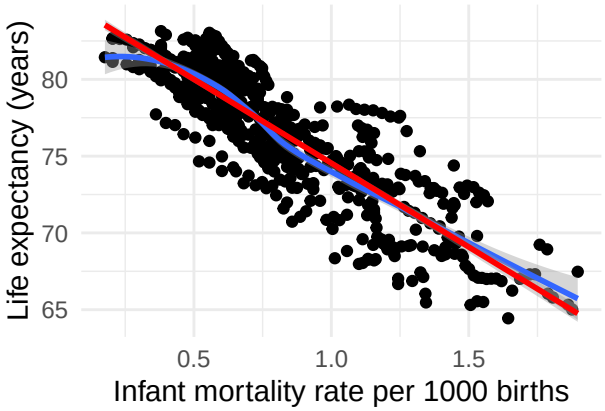
g2 <- ddf_gap1 %>%
  add_residuals(fit1, "resid") %>%
    ggplot(aes(x=log10(infmort),y=resid)) +
      geom_point() + labs(x="Infant mortality")

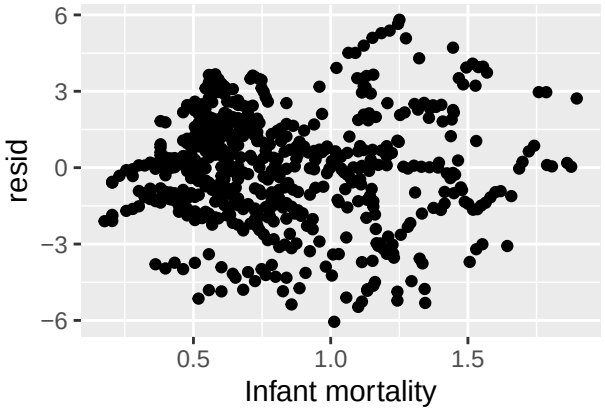
g3 <- ddf_gap1 %>%
  add_residuals(fit1, "resid") %>%
    ggplot(aes(sample=resid)) + geom_qq()

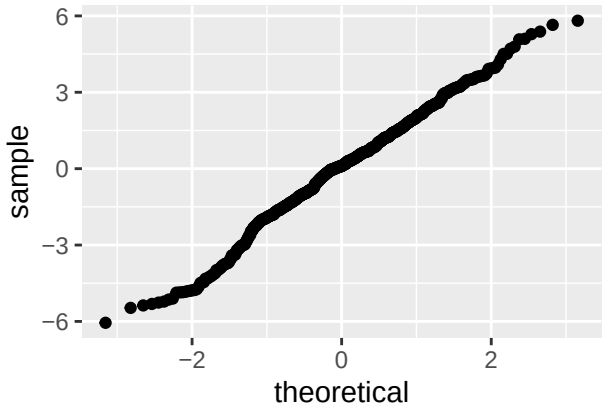
gridExtra::grid.arrange(g1, g2, g3, ncol=2)
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'

## `geom_smooth()` using formula 'y ~ x'
```







Explanation for Problem 2:

Like before, there are no violations of the model assumptions and just simple random scatter is visible in the residual plot against the predictor. The residuals appear to be approximately normal, according to the QQ-plot. There aren't any outliers.

Problem 3->

```
g1 <- ddf_gap1 %>%
  add_residuals(fit1, "resid") %>%
    ggplot(aes(x=log10(murder),y=resid)) +
      geom_point() + geom_smooth() +
        geom_smooth(method="lm", color="red") + labs(x="Murder rate")

g2 <- ddf_gap1 %>%
  add_residuals(fit1, "resid") %>%
    ggplot(aes(x=log10(gdp),y=resid)) +
      geom_point() + geom_smooth() +
        geom_smooth(method="lm", color="red") + labs(x="GDP per capita")

g3 <- ddf_gap1 %>%
  add_residuals(fit1, "resid") %>%
    ggplot(aes(x=log10(doctors),y=resid)) +
      geom_point() + geom_smooth() +
        geom_smooth(method="lm", color="red") + labs(x="Medical doctors")

g4 <- ddf_gap1 %>%
```

```
  add_residuals(fit1, "resid") %>%
    ggplot(aes(x=log10(poverty),y=resid)) +
      geom_point() + geom_smooth() +
        geom_smooth(method="lm", color="red") + labs(x="Poverty rate")


gridExtra::grid.arrange(g1, g2, g3, g4)
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## `geom_smooth()` using formula 'y ~ x'
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## `geom_smooth()` using formula 'y ~ x'
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

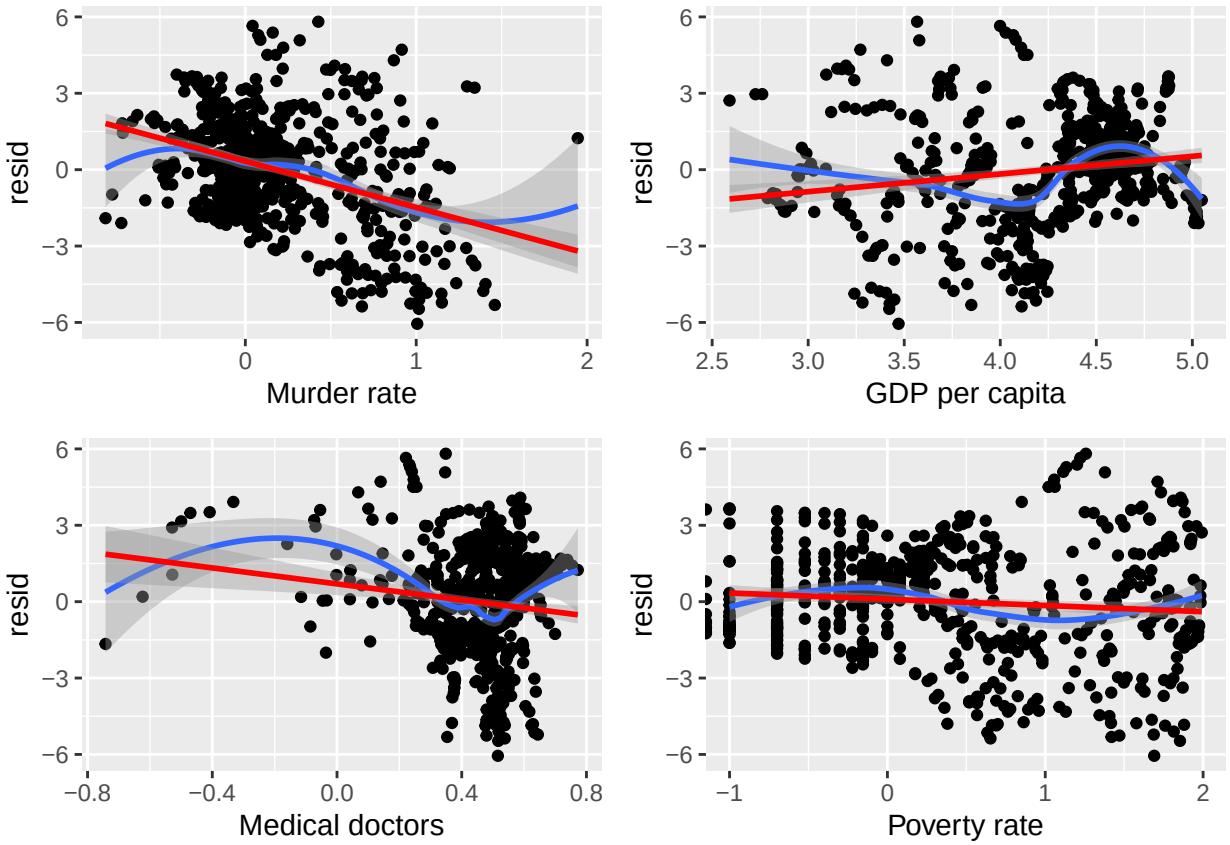
```
## `geom_smooth()` using formula 'y ~ x'
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## Warning: Removed 10 rows containing non-finite values (stat_smooth).
```

```
## `geom_smooth()` using formula 'y ~ x'
```

```
## Warning: Removed 10 rows containing non-finite values (stat_smooth).
```



The residuals and the log of the murder rate show a minor negative linear relationship that suggests we should include it in the model. All other residual plots seem random and lack significant visual cues to support their inclusion.

As a result, we incorporate the murder rate's log into the model.

```
fit2 <- lm(lifeexp ~ log10(infmort) + log2(murder), data=ddf_gap1)

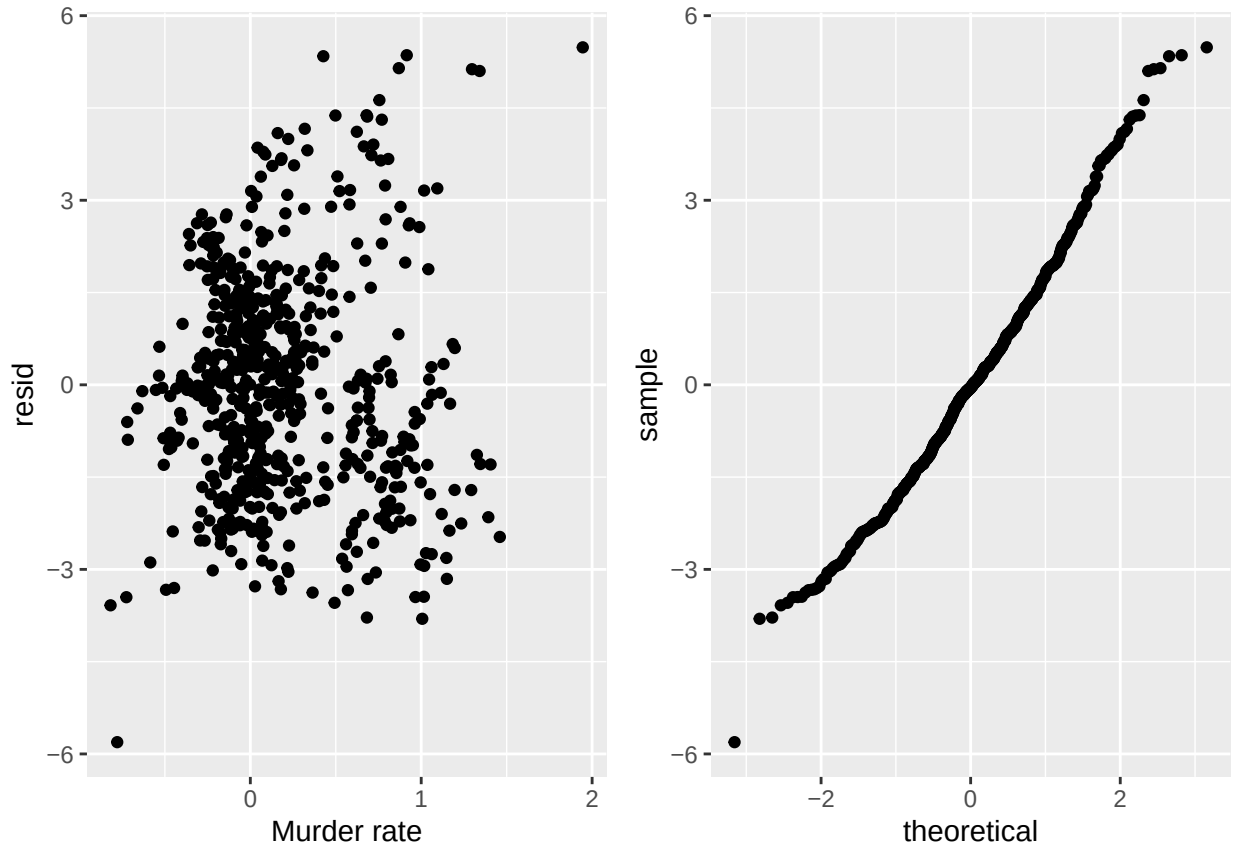
summary(fit2)
```

```
##
## Call:
## lm(formula = lifeexp ~ log10(infmort) + log2(murder), data = ddf_gap1)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5.8085 -1.3207 -0.0484  1.1241  5.4854
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)     83.6914     0.2165  386.62   <2e-16 ***
## log10(infmort)  -7.9391     0.2859  -27.77   <2e-16 ***
## log2(murder)    -1.0464     0.0694  -15.08   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.806 on 624 degrees of freedom
## Multiple R-squared:  0.829,  Adjusted R-squared:  0.8284
## F-statistic:  1512 on 2 and 624 DF,  p-value: < 2.2e-16
```

```
g1 <- ddf_gap1 %>%
  add_residuals(fit2, "resid") %>%
    ggplot(aes(x=log10(murder),y=resid)) +
      geom_point() + labs(x="Murder rate")

g2 <- ddf_gap1 %>%
  add_residuals(fit2, "resid") %>%
    ggplot(aes(sample=resid)) + geom_qq()

gridExtra::grid.arrange(g1, g2, ncol=2)
```



Simple random scatter is shown in the residual plot against the predictor, and no model assumptions are broken. The residuals are roughly normal, as seen by the QQ-plot.

But we find a significant outlier that needs to be eliminated:

```
outlier <- ddf_gap1 %>%
  add_residuals(fit2, "resid") %>%
  filter(resid < -4.5)

outlier
```

```
##   geo time lifeexp infmort murder      gdp doctors poverty     resid
## 1 egy 2015   70.21    20.3 0.1664 2703.742  0.8217    61.9 -5.808489
```

```
ddf_gap2 <- anti_join(ddf_gap1, outlier, by=c("geo", "time"))
fit3 <- lm(lifeexp ~ log10(infmort) + log10(murder), data = ddf_gap2)
summary(fit3)
```

```
##
## Call:
## lm(formula = lifeexp ~ log10(infmort) + log10(murder), data = ddf_gap2)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.7322 -1.3284 -0.0636  1.1114  5.6178
##
```

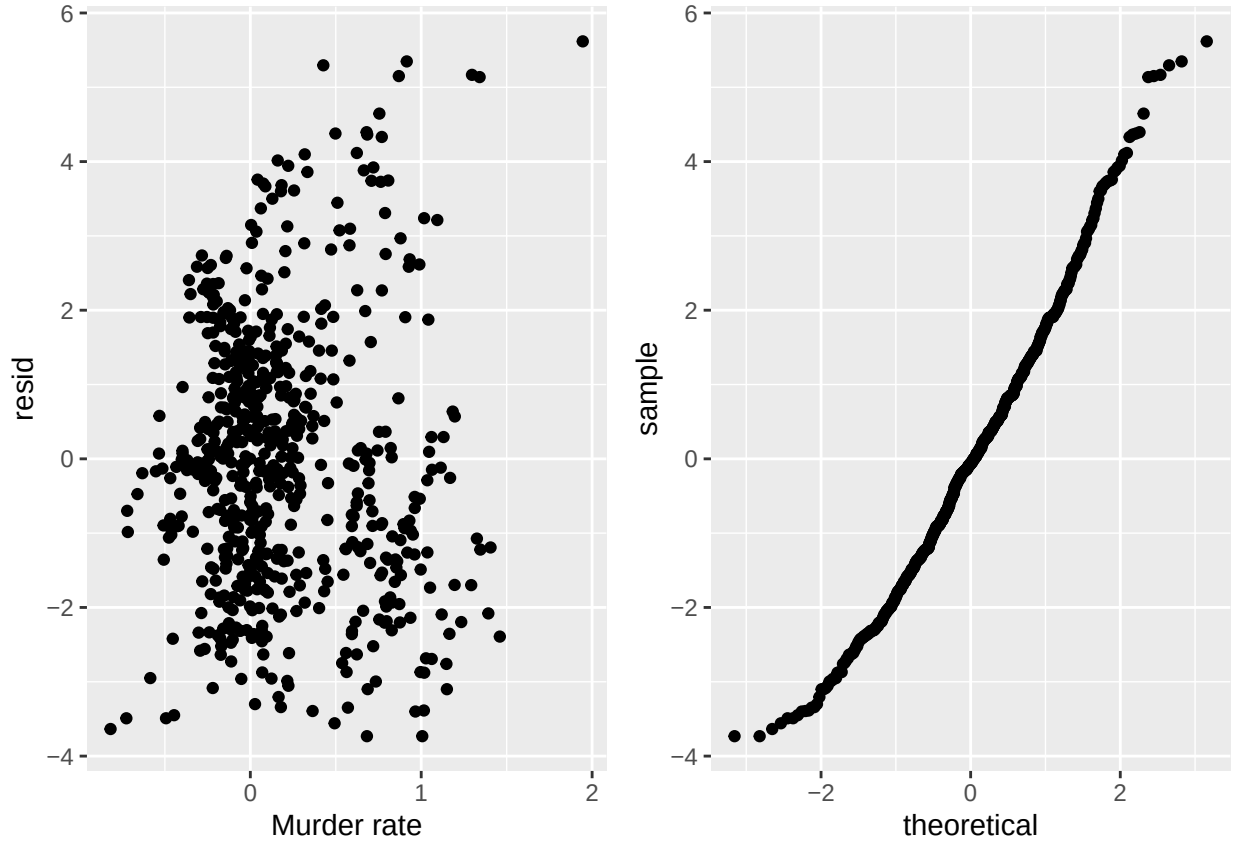
```
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)     83.5996     0.2166  386.03   <2e-16 ***
## log10(infmort)  -7.7827     0.2876  -27.06   <2e-16 ***
## log10(murder)   -3.6127     0.2325  -15.54   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.792 on 623 degrees of freedom
## Multiple R-squared:  0.8313, Adjusted R-squared:  0.8308
## F-statistic:  1535 on 2 and 623 DF,  p-value: < 2.2e-16
```

We plot residuals once more after deleting the outlier and re-fitting the model:

```
g1 <- ddf_gap2 %>%
  add_residuals(fit3, "resid") %>%
    ggplot(aes(x=log10(murder),y=resid)) +
      geom_point() + labs(x="Murder rate")

g2 <- ddf_gap2 %>%
  add_residuals(fit3, "resid") %>%
    ggplot(aes(sample=resid)) + geom_qq()

gridExtra::grid.arrange(g1, g2, ncol=2)
```



Explanation for Problem 3:

Like before, there are no violations of the model assumptions and just simple random scatter is visible in the residual plot against the predictor. The residuals appear to be approximately normal, according to the QQ-plot. There aren't any outliers.

Problem 4->

```
set.seed(1234)

df_cv <- crossv_kfold(ddf_gap2, k=10)
df_cv <- mutate(df_cv, fit = map(train, ~ lm(lifeexp ~ log10(infmort) + log10(murder), data = .)),
rmse = map2_dbl(fit, test, ~ rmse(.x, .y)))

mean(df_cv$rmse)
```

```
## [1] 1.790321
```

We also provide the RMSE on training data for the original model

```
rmse(fit3, ddf_gap2)
```

```
## [1] 1.788023
```

Explanation for Problem 4:

Not surprisingly, the CV RMSE is greater. In contrast to the more realistic RMSE determined using test data, as is done in CV, we would anticipate that the RMSE of a model using the same data used to train it would be less.

Problem 5->

Partitioning the dataset

```
set.seed(1234)

df_part <- resample_partition(ddf_gap2, p=c(train=0.5, valid=0.25, test=0.25))
```

Step 1:

```
f1 <- lm(lifeexp ~ log10(infmort), data=df_part$train)
f2 <- lm(lifeexp ~ log10(murder), data=df_part$train)
f3 <- lm(lifeexp ~ log10(gdp), data=df_part$train)
f4 <- lm(lifeexp ~ log10(doctors), data=df_part$train)
f5 <- lm(lifeexp ~ log10(1 + poverty), data=df_part$train)
```

```
rmse(f1, df_part$valid)
```

```
## [1] 2.289694
```

```
rmse(f2, df_part$valid)
```

```
## [1] 2.698456
```

```
rmse(f3, df_part$valid)
```

```
## [1] 2.343242
```

```
rmse(f4, df_part$valid)
```

```
## [1] 4.157883
```

```
rmse(f5, df_part$valid)
```

```
## [1] 2.529225
```

Adding log10(infmort)

Step 2:

```
f12 <- lm(lifeexp ~ log2(infmort) + log10(murder), data=df_part$train)
f13 <- lm(lifeexp ~ log2(infmort) + log10(gdp), data=df_part$train)
f14 <- lm(lifeexp ~ log2(infmort) + log(doctors), data=df_part$train)
f15 <- lm(lifeexp ~ log2(infmort) + log2(1 + poverty), data=df_part$train)

rmse(f12, df_part$valid)
```

```
## [1] 1.935183
```

```
rmse(f13, df_part$valid)
```

```
## [1] 2.126156
```

```
rmse(f14, df_part$valid)
```

```
## [1] 2.263225
```

```
rmse(f15, df_part$valid)
```

```
## [1] 2.225588
```

Adding log10(murder)

Step 3:

```
f123 <- lm(lifeexp ~ log10(infmort) + log10(murder) + log10(gdp), data=df_part$train)
f124 <- lm(lifeexp ~ log10(infmort) + log10(murder) + log10(doctors), data=df_part$train)
f125 <- lm(lifeexp ~ log10(infmort) + log10(murder) + log10(1 + poverty), data=df_part$train)

rmse(f123, df_part$valid)
```

```
## [1] 1.823806
```

```
rmse(f124, df_part$valid)
```

```
## [1] 1.858871
```

```
rmse(f125, df_part$valid)
```

```
## [1] 1.926612
```

Adding log10(gdp)

Step 4:

```
f1234 <- lm(lifeexp ~ log10(infmort) + log10(murder) + log10(gdp) + log10(doctors), data=df_part$train)
f1235 <- lm(lifeexp ~ log10(infmort) + log10(murder) + log10(gdp) + log10(1 + poverty), data=df_part$tra

rmse(f1234, df_part$valid)
```

```
## [1] 1.766089
```

```
rmse(f1235, df_part$valid)
```

```
## [1] 1.805457
```

Adding log10(doctors)

```
f12345 <- lm(lifeexp ~ log10(infmort) + log10(murder) + log10(gdp) + log10(doctors), log10(1+ poverty),

rmse(f12345, df_part$valid)
```

```
## Warning in predict.lm(model, data): prediction from a rank-deficient fit may be
## misleading
```

```
## [1] 4.740098
```

The RMSE increases, so we would not add poverty

```
rmse(f1234, df_part$test)
```

```
## [1] 1.62575
```

Explanation for Problem 5:

The RMSE of the final model lifeexp ~ log10(infmort) + log10(murder) + log10(gdp) + log10(doctors) is: 1.62575