# globaldebt.R

Alexandros

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```
library(readxl)
```

```
## Warning: package 'readxl' was built under R version 4.1.2
```

```
library(ggplot2)
```

```
## Warning: package 'ggplot2' was built under R version 4.1.3
```

```
library(tidyverse)
```

```
## Warning: package 'tidyverse' was built under R version 4.1.2
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.1 --
```

```
## v tibble  3.1.2     v dplyr   1.0.7
## v tidyr   1.1.3     v stringr 1.4.0
## v readr   1.4.0     v forcats 0.5.1
## v purrr   0.3.4
```

```
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
data=read_excel("C:\\Users\\Alexandros\\Downloads\\globaldebt.xlsx")
data2=read_excel("C:\\Users\\Alexandros\\Downloads\\globaldebt.xlsx",sheet="processed")
data2
```

```
## Warning in fansi::strwrap_ctl(x, width = max(width, 0), indent = indent, :
## Encountered a C0 control character, see `?unhandled_ctl`; you can use
## `warn=FALSE` to turn off these warnings.
```

```
## # A tibble: 1,349 x 13
##    Country  Year Tp_all Tp_ld H_all  H_ld Nf_all Nf_ld pub_sector NF_pubsector
##    <chr>   <dbl>  <dbl> <dbl> <dbl> <dbl>  <dbl> <dbl> <lgl>      <lgl>
##  1 Greece   1950     NA    NA    NA    NA     NA    NA NA         NA
##  2 Greece   1951     NA    NA    NA    NA     NA    NA NA         NA
##  3 Greece   1952     NA    NA    NA    NA     NA    NA NA         NA
##  4 Greece   1953     NA    NA    NA    NA     NA    NA NA         NA
##  5 Greece   1954     NA    NA    NA    NA     NA    NA NA         NA
##  6 Greece   1955     NA    NA    NA    NA     NA    NA NA         NA
##  7 Greece   1956     NA    NA    NA    NA     NA    NA NA         NA
##  8 Greece   1957     NA    NA    NA    NA     NA    NA NA         NA
##  9 Greece   1958     NA    NA    NA    NA     NA    NA NA         NA
## 10 Greece   1959     NA    NA    NA    NA     NA    NA NA         NA
## # ... with 1,339 more rows, and 3 more variables: Gen_gov_debt <dbl>,
## #   central_gov_debt <dbl>, Y_nom
 (billions) <dbl>
```

```
colnames(data)=colnames(data2)

data
```

```
## Warning in fansi::strwrap_ctl(x, width = max(width, 0), indent = indent, :
## Encountered a C0 control character, see `?unhandled_ctl`; you can use
## `warn=FALSE` to turn off these warnings.
```

```
## # A tibble: 1,349 x 13
##    Country  Year Tp_all Tp_ld H_all  H_ld Nf_all Nf_ld pub_sector NF_pubsector
##    <chr>   <dbl>  <dbl> <dbl> <dbl> <dbl>  <dbl> <dbl> <lgl>      <lgl>
##  1 Greece   1950     NA    NA    NA    NA     NA    NA NA         NA
##  2 Greece   1951     NA    NA    NA    NA     NA    NA NA         NA
##  3 Greece   1952     NA    NA    NA    NA     NA    NA NA         NA
##  4 Greece   1953     NA    NA    NA    NA     NA    NA NA         NA
##  5 Greece   1954     NA    NA    NA    NA     NA    NA NA         NA
##  6 Greece   1955     NA    NA    NA    NA     NA    NA NA         NA
##  7 Greece   1956     NA    NA    NA    NA     NA    NA NA         NA
##  8 Greece   1957     NA    NA    NA    NA     NA    NA NA         NA
##  9 Greece   1958     NA    NA    NA    NA     NA    NA NA         NA
## 10 Greece   1959     NA    NA    NA    NA     NA    NA NA         NA
## # ... with 1,339 more rows, and 3 more variables: Gen_gov_debt <dbl>,
## #   central_gov_debt <dbl>, Y_nom
 (billions) <dbl>
```

```
datadec=data %>% mutate_at(vars(Tp_all:central_gov_debt), function(x) x/100)
datadec %>% tail
```

```
## Warning in fansi::strwrap_ctl(x, width = max(width, 0), indent = indent, :
## Encountered a C0 control character, see `?unhandled_ctl`; you can use
## `warn=FALSE` to turn off these warnings.
```

```
## # A tibble: 6 x 13
##   Country  Year Tp_all Tp_ld H_all  H_ld Nf_all Nf_ld pub_sector NF_pubsector
##   <chr>   <dbl>  <dbl> <dbl> <dbl> <dbl>  <dbl> <dbl>      <dbl>        <dbl>
## 1 Spain    2015   2.21  1.78 0.722 0.680   1.49 1.10          NA           NA
## 2 Spain    2016   2.12  1.69 0.689 0.645   1.43 1.05          NA           NA
## 3 Spain    2017   2.03  1.60 0.657 0.612   1.37 0.993         NA           NA
## 4 Spain    2018   1.96  1.54 0.636 0.590   1.32 0.952         NA           NA
## 5 Spain    2019   1.90  1.50 0.618 0.569   1.28 0.930         NA           NA
## 6 Spain    2020   2.10  1.70 0.674 0.625   1.43 1.08          NA           NA
## # ... with 3 more variables: Gen_gov_debt <dbl>, central_gov_debt <dbl>, Y_nom
## #   (billions) <dbl>
```

```
summary(datadec)
```

```
##    Country               Year          Tp_all           Tp_ld
##  Length:1349        Min.   :1950   Min.   :0.4849   Min.   :0.1210
##  Class :character   1st Qu.:1967   1st Qu.:1.3572   1st Qu.:0.6862
##  Mode  :character   Median :1985   Median :1.7485   Median :1.0637
##                     Mean   :1985   Mean   :1.9994   Mean   :1.1949
##                     3rd Qu.:2003   3rd Qu.:2.5730   3rd Qu.:1.4504
##                     Max.   :2020   Max.   :4.7255   Max.   :4.1257
##                                    NA's   :865      NA's   :402
##      H_all             H_ld           Nf_all           Nf_ld
##  Min.   :0.0179   Min.   :0.0130   Min.   :0.3611   Min.   :0.1075
##  1st Qu.:0.3419   1st Qu.:0.2347   1st Qu.:0.9669   1st Qu.:0.5767
##  Median :0.5286   Median :0.4107   Median :1.2681   Median :0.7849
##  Mean   :0.5544   Mean   :0.4332   Mean   :1.4450   Mean   :0.9409
##  3rd Qu.:0.6969   3rd Qu.:0.5883   3rd Qu.:1.7358   3rd Qu.:1.1649
##  Max.   :1.5133   Max.   :1.3139   Max.   :4.0387   Max.   :3.4178
##  NA's   :865      NA's   :697      NA's   :865      NA's   :697
##    pub_sector    NF_pubsector   Gen_gov_debt    central_gov_debt
##  Min.   : NA    Min.   :0.01   Min.   :0.0376   Min.   :0.0083
##  1st Qu.: NA    1st Qu.:0.01   1st Qu.:0.2530   1st Qu.:0.1672
##  Median : NA    Median :0.01   Median :0.5111   Median :0.3746
##  Mean   :NaN    Mean   :0.01   Mean   :0.5471   Mean   :0.4585
##  3rd Qu.: NA    3rd Qu.:0.01   3rd Qu.:0.7128   3rd Qu.:0.6290
##  Max.   : NA    Max.   :0.01   Max.   :2.1121   Max.   :2.2554
##  NA's   :1349   NA's   :1335   NA's   :484      NA's   :408
##  Y_nom\r\n(billions)
##  Min.   :   0.041
##  1st Qu.:   6.414
##  Median :  35.788
##  Mean   : 264.021
##  3rd Qu.: 203.968
##  Max.   :3473.350
##  NA's   :205
```

```
countries=data %>% select(Country) %>% unique %>% unlist

split(countries,5)
```

```
## $`5`
##          Country1          Country2          Country3          Country4
##          "Greece"         "Austria"         "Belgium"         "Cyprus"
##          Country5          Country6          Country7          Country8
##         "Estonia"         "Finland"          "France"         "Germany"
##          Country9         Country10         Country11         Country12
##         "Ireland"           "Italy"          "Latvia"       "Lithuania"
##         Country13         Country14         Country15         Country16
##      "Luxembourg"           "Malta"     "Netherlands"        "Portugal"
##         Country17         Country18         Country19
## "Slovak Republic"        "Slovenia"           "Spain"
```

```
ceiling(seq_along(countries)/5)
```

```
##  [1] 1 1 1 1 1 2 2 2 2 2 3 3 3 3 3 4 4 4 4
```

```
countries %>% unlist %>% length
```

```
## [1] 19
```

```
countries[1:5]
```

```
##  Country1  Country2  Country3  Country4  Country5
##  "Greece" "Austria" "Belgium"  "Cyprus" "Estonia"
```

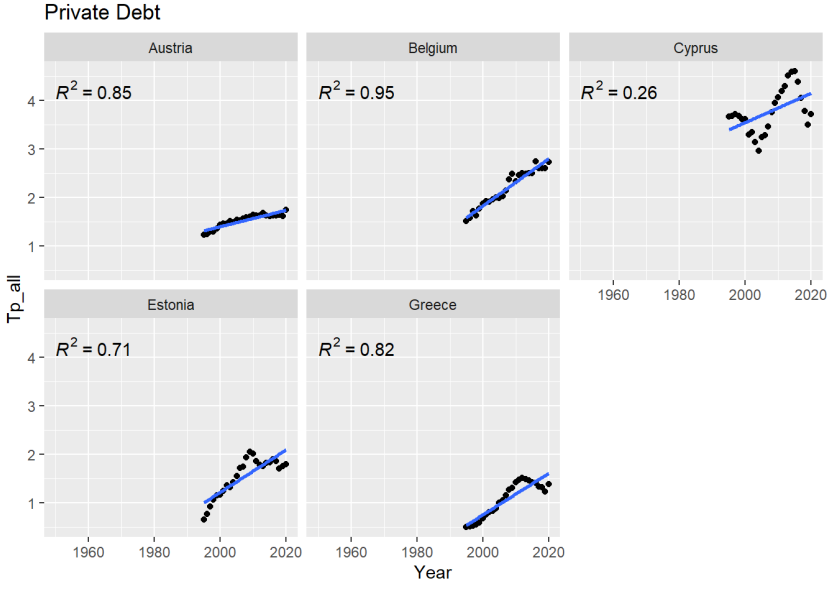
```
datadec %>% filter(Country %in% countries[1:5]) %>%
  ggplot(aes(x=Year,y=Tp_all))+
  geom_point()+
  geom_smooth(method=lm,se=FALSE)+
  #ggpubr::stat_regline_equation( aes(label = ..eq.label..))
  ggpubr::stat_regline_equation( aes(label = ..rr.label..)) +
  facet_wrap(~Country)+
  ggtitle("Private Debt")
```

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

```
## Warning: Removed 225 rows containing non-finite values (stat_smooth).
```

```
## Warning: Removed 225 rows containing non-finite values (stat_regline_equation).
```

```
## Warning: Removed 225 rows containing missing values (geom_point).
```



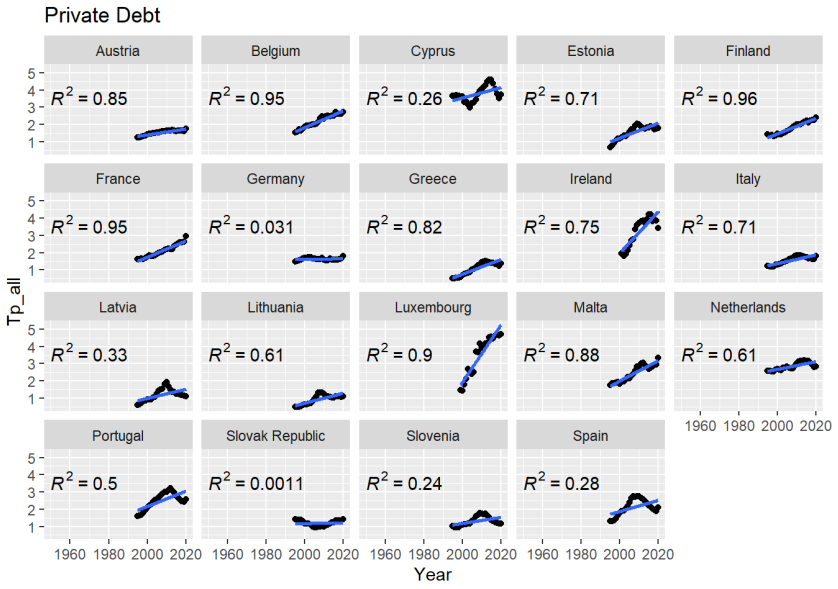
```
datadec  %>%
  ggplot(aes(x=Year,y=Tp_all))+
  geom_point()+
  geom_smooth(method=lm,se=FALSE)+
  #ggpubr::stat_regline_equation( aes(label = ..eq.label..))
  ggpubr::stat_regline_equation( aes(label = ..rr.label..)) +
  facet_wrap(~Country)+
  ggtitle("Private Debt")
```

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

```
## Warning: Removed 865 rows containing non-finite values (stat_smooth).
```

```
## Warning: Removed 865 rows containing non-finite values (stat_regline_equation).
```

```
## Warning: Removed 865 rows containing missing values (geom_point).
```



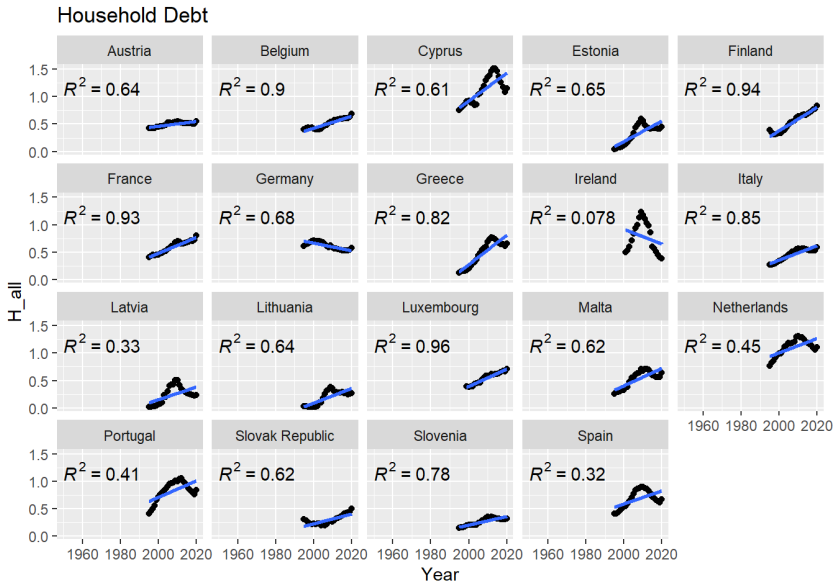

```
datadec  %>%
  ggplot(aes(x=Year,y=H_all))+
  geom_point()+
  geom_smooth(method=lm,se=FALSE)+
  #ggpubr::stat_regline_equation( aes(label = ..eq.label..))
  ggpubr::stat_regline_equation( aes(label = ..rr.label..)) +
  facet_wrap(~Country)+
  ggtitle("Household Debt")
```

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

```
## Warning: Removed 865 rows containing non-finite values (stat_smooth).
```

```
## Warning: Removed 865 rows containing non-finite values (stat_regline_equation).
```

```
## Warning: Removed 865 rows containing missing values (geom_point).
```



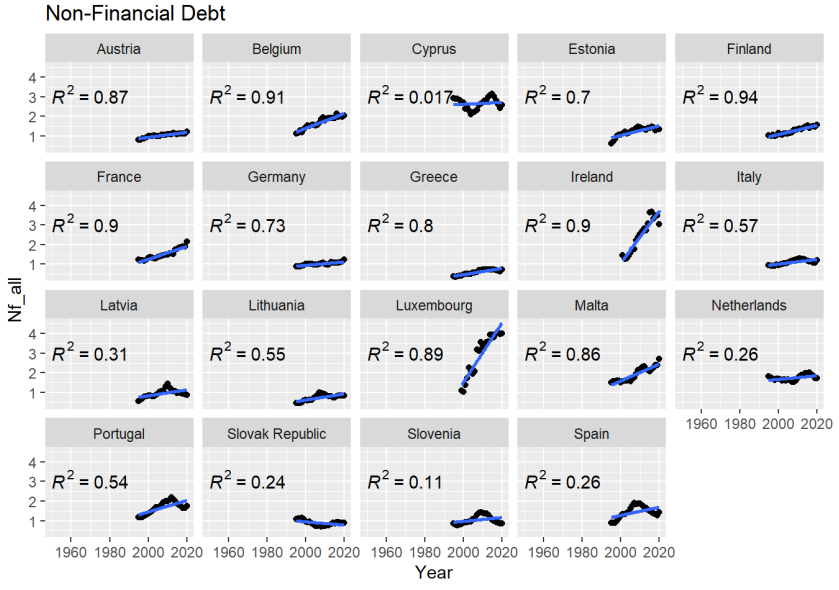

```
datadec  %>%
  ggplot(aes(x=Year,y=Nf_all))+
  geom_point()+
  geom_smooth(method=lm,se=FALSE)+
  #ggpubr::stat_regline_equation( aes(label = ..eq.label..))
  ggpubr::stat_regline_equation( aes(label = ..rr.label..)) +
  facet_wrap(~Country)+
  ggtitle("Non-Financial Debt")
```

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

```
## Warning: Removed 865 rows containing non-finite values (stat_smooth).
```

```
## Warning: Removed 865 rows containing non-finite values (stat_regline_equation).
```

```
## Warning: Removed 865 rows containing missing values (geom_point).
```



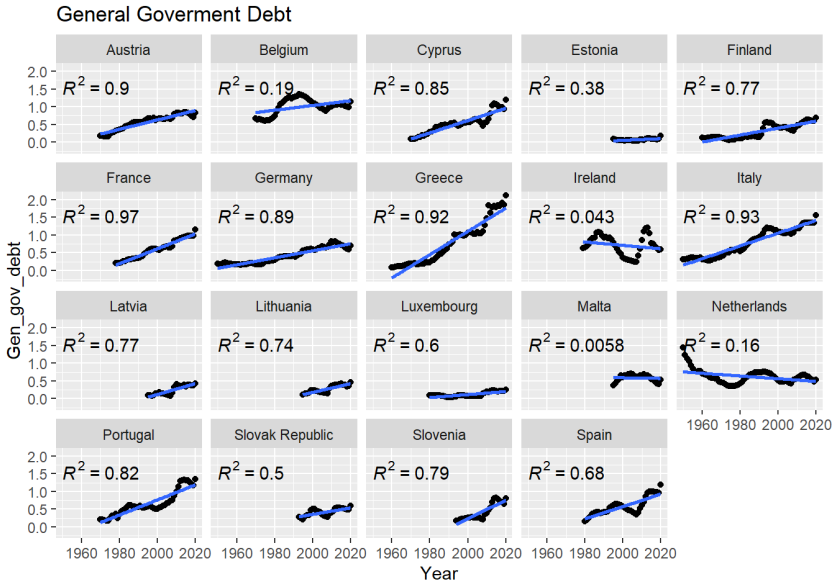

```
datadec  %>%
  ggplot(aes(x=Year,y=Gen_gov_debt))+
  geom_point()+
  geom_smooth(method=lm,se=FALSE)+
  #ggpubr::stat_regline_equation( aes(label = ..eq.label..))
  ggpubr::stat_regline_equation( aes(label = ..rr.label..)) +
  facet_wrap(~Country)+
  ggtitle("General Goverment Debt")
```

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

```
## Warning: Removed 484 rows containing non-finite values (stat_smooth).
```

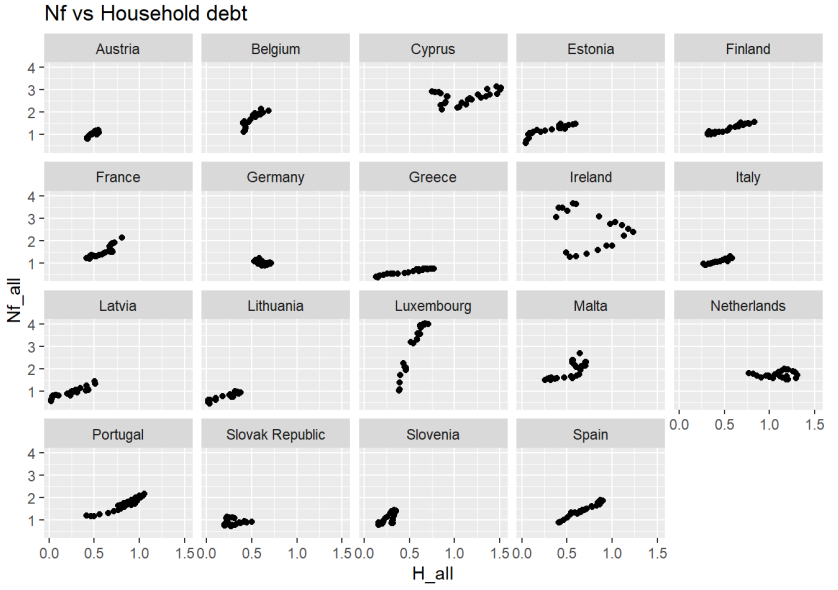
```
## Warning: Removed 484 rows containing non-finite values (stat_regline_equation).
```

```
## Warning: Removed 484 rows containing missing values (geom_point).
```




```
datadec  %>%
  ggplot(aes(x=H_all,y=Nf_all))+
  geom_point()+
  facet_wrap(~Country)+
  ggtitle("Nf vs Household debt")
```

```
## Warning: Removed 865 rows containing missing values (geom_point).
```

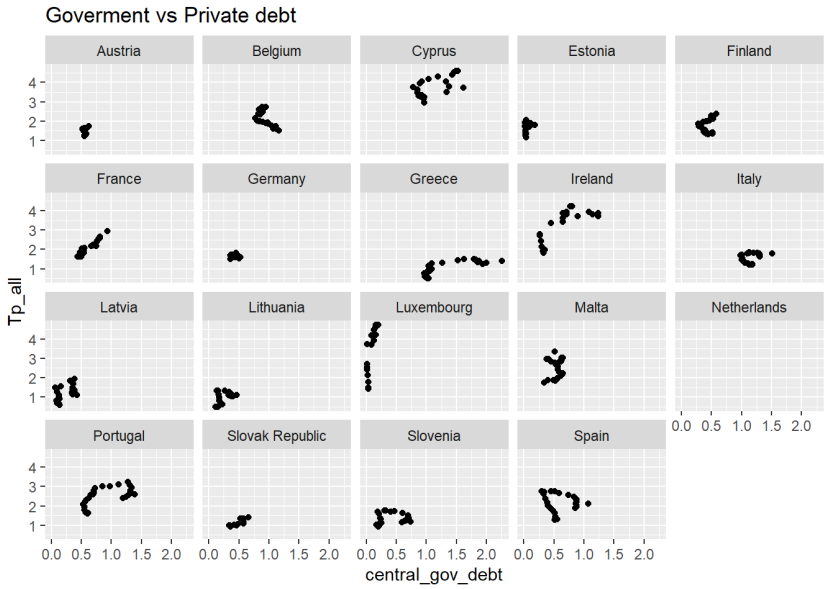



```
datadec %>% split(.$Country) %>%
  map(~cor(.x$Nf_all,.x$H_all,use="pairwise.complete.obs"))
```

```
## $Austria
## [1] 0.8431528
##
## $Belgium
## [1] 0.8886508
##
## $Cyprus
## [1] 0.4391422
##
## $Estonia
## [1] 0.8889172
##
## $Finland
## [1] 0.9637853
##
## $France
## [1] 0.8943275
##
## $Germany
## [1] -0.518721
##
## $Greece
## [1] 0.976764
##
## $Ireland
## [1] -0.2120301
##
## $Italy
## [1] 0.9401194
##
## $Latvia
## [1] 0.9150648
##
## $Lithuania
## [1] 0.9214189
##
## $Luxembourg
## [1] 0.9688264
##
## $Malta
## [1] 0.7464923
##
## $Netherlands
## [1] 0.1307664
##
## $Portugal
## [1] 0.9472113
##
## $`Slovak Republic`
## [1] 0.07160217
##
## $Slovenia
## [1] 0.7196991
##
## $Spain
## [1] 0.984294
```

```
datadec  %>%
  ggplot(aes(x=central_gov_debt,y=Tp_all))+
  geom_point()+
  facet_wrap(~Country)+
  ggtitle("Goverment vs Private debt")
```

```
## Warning: Removed 912 rows containing missing values (geom_point).
```




```
datadec %>% split(.$Country) %>%
  map(~cor(.x$central_gov_debt,.x$Tp_all,use="pairwise.complete.obs"))
```

```
## $Austria
## [1] 0.3773722
##
## $Belgium
## [1] -0.6767664
##
## $Cyprus
## [1] 0.6181939
##
## $Estonia
## [1] 0.3333259
##
## $Finland
## [1] 0.4023774
##
## $France
## [1] 0.9645735
##
## $Germany
## [1] -0.1319242
##
## $Greece
## [1] 0.7967556
##
## $Ireland
## [1] 0.7726925
##
## $Italy
## [1] 0.3528727
##
## $Latvia
## [1] 0.5099847
##
## $Lithuania
## [1] 0.5057299
##
## $Luxembourg
## [1] 0.8696955
##
## $Malta
## [1] 0.1825996
##
## $Netherlands
## [1] NA
##
## $Portugal
## [1] 0.6300003
##
## $`Slovak Republic`
## [1] 0.8302395
##
## $Slovenia
## [1] 0.2219466
##
## $Spain
## [1] -0.09300926
```

```
library(plm)
```

```
## Warning: package 'plm' was built under R version 4.1.3
```

```
##
## Attaching package: 'plm'
```

```
## The following objects are masked from 'package:dplyr':
##
##     between, lag, lead
```

```
model=plm(data=datadec,formula=H_all~Nf_all+as.factor(Country),model="pooling",index=c("Country","Year"))

model %>% summary
```

```
## Pooling Model
##
## Call:
## plm(formula = H_all ~ Nf_all + as.factor(Country), data = datadec,
##     model = "pooling", index = c("Country", "Year"))
##
## Unbalanced Panel: n = 19, T = 20-26, N = 484
##
## Residuals:
##       Min.    1st Qu.     Median    3rd Qu.       Max.
## -0.5614968 -0.0770291  0.0097676  0.0833966  0.4745082
##
## Coefficients:
##                                   Estimate Std. Error t-value  Pr(>|t|)
## (Intercept)                        0.2926231  0.0328294  8.9134 < 2.2e-16 ***
## Nf_all                             0.1953804  0.0181458 10.7672 < 2.2e-16 ***
## as.factor(Country)Belgium         -0.1136432  0.0398975 -2.8484 0.0045894 **
## as.factor(Country)Cyprus           0.3022317  0.0481822  6.2727 8.139e-10 ***
## as.factor(Country)Estonia         -0.2055055  0.0382687 -5.3701 1.247e-07 ***
## as.factor(Country)Finland          0.0023214  0.0383303  0.0606 0.9517340
## as.factor(Country)France           0.0057479  0.0390669  0.1471 0.8830928
## as.factor(Country)Germany          0.1254691  0.0381163  3.2917 0.0010717 **
## as.factor(Country)Greece           0.0713404  0.0389324  1.8324 0.0675299 .
## as.factor(Country)Ireland          0.0016019  0.0485892  0.0330 0.9737141
## as.factor(Country)Italy           -0.0496247  0.0381371 -1.3012 0.1938295
## as.factor(Country)Latvia          -0.2386258  0.0381436 -6.2560 8.984e-10 ***
## as.factor(Country)Lithuania       -0.2456638  0.0384808 -6.3841 4.189e-10 ***
## as.factor(Country)Luxembourg      -0.3252696  0.0529684 -6.1408 1.765e-09 ***
## as.factor(Country)Malta           -0.1417862  0.0414072 -3.4242 0.0006713 ***
## as.factor(Country)Netherlands      0.4713125  0.0402386 11.7129 < 2.2e-16 ***
## as.factor(Country)Portugal         0.2036350  0.0398624  5.1084 4.753e-07 ***
## as.factor(Country)Slovak Republic -0.1707366  0.0382049 -4.4690 9.889e-06 ***
## as.factor(Country)Slovenia        -0.2329563  0.0381163 -6.1117 2.091e-09 ***
## as.factor(Country)Spain            0.1083372  0.0388189  2.7908 0.0054739 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    42.257
## Residual Sum of Squares: 8.7631
## R-Squared:      0.79262
## Adj. R-Squared: 0.78413
## F-statistic: 93.3402 on 19 and 464 DF, p-value: < 2.22e-16
```

```
model2=plm(data=datadec,formula=Nf_all~central_gov_debt+as.factor(Country),model="pooling",index=c("Country","Year"))

model2 %>% summary
```

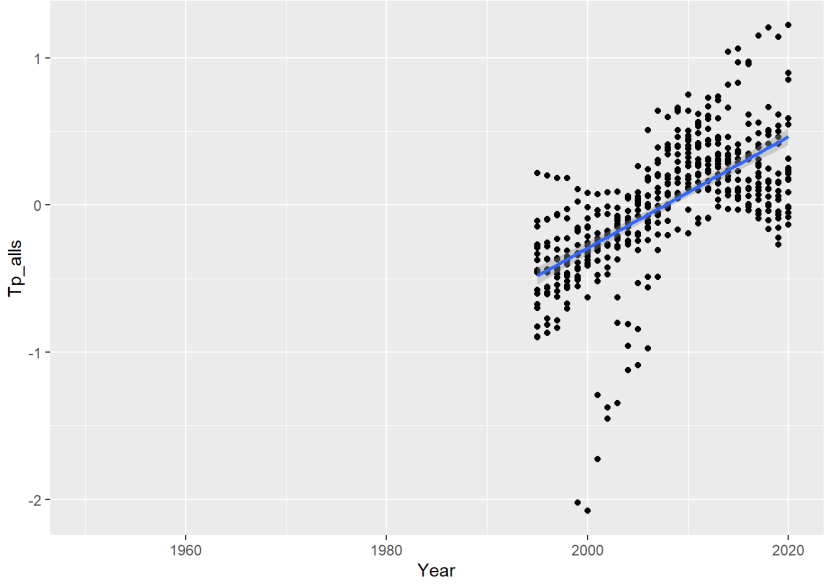
```
## Pooling Model
##
## Call:
## plm(formula = Nf_all ~ central_gov_debt + as.factor(Country),
##     data = datadec, model = "pooling", index = c("Country", "Year"))
##
## Unbalanced Panel: n = 18, T = 15-26, N = 437
##
## Residuals:
##       Min.    1st Qu.     Median    3rd Qu.       Max.
## -1.8819405 -0.1425885 -0.0083676  0.1629007  1.1102938
##
## Coefficients:
##                                   Estimate Std. Error t-value  Pr(>|t|)
## (Intercept)                       0.678805   0.083204  8.1583 4.023e-15 ***
## central_gov_debt                  0.624324   0.086377  7.2279 2.349e-12 ***
## as.factor(Country)Belgium         0.427238   0.099953  4.2744 2.376e-05 ***
## as.factor(Country)Cyprus          1.230159   0.111608 11.0221 < 2.2e-16 ***
## as.factor(Country)Estonia         0.591212   0.109560  5.3962 1.142e-07 ***
## as.factor(Country)Finland         0.304874   0.095757  3.1838  0.001562 **
## as.factor(Country)France          0.436201   0.095223  4.5809 6.121e-06 ***
## as.factor(Country)Germany         0.077603   0.095964  0.8087  0.419165
## as.factor(Country)Greece         -0.945298   0.118249 -7.9941 1.288e-14 ***
## as.factor(Country)Ireland         1.393270   0.102253 13.6257 < 2.2e-16 ***
## as.factor(Country)Italy          -0.295811   0.107795 -2.7442  0.006327 **
## as.factor(Country)Latvia          0.129629   0.099455  1.3034  0.193157
## as.factor(Country)Lithuania      -0.099328   0.098742 -1.0059  0.315027
## as.factor(Country)Luxembourg      2.222464   0.107481 20.6777 < 2.2e-16 ***
## as.factor(Country)Malta           0.907863   0.095118  9.5446 < 2.2e-16 ***
## as.factor(Country)Portugal        0.437298   0.099268  4.4052 1.345e-05 ***
## as.factor(Country)Slovak Republic -0.167495   0.111299 -1.5049  0.133104
## as.factor(Country)Slovenia        0.132294   0.096465  1.3714  0.170979
## as.factor(Country)Spain           0.387316   0.095125  4.0717 5.584e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    225.88
## Residual Sum of Squares: 49.136
## R-Squared:      0.78247
## Adj. R-Squared: 0.7731
## F-statistic: 83.5295 on 18 and 418 DF, p-value: < 2.22e-16
```

```
datadec %>%group_by(Country) %>%
  mutate(Tp_alls=scale(Tp_all,scale=F)) %>%
  ggplot(aes(x=Year,y=Tp_alls))+
  geom_point()+
  geom_smooth(method=lm)
```

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

```
## Warning: Removed 865 rows containing non-finite values (stat_smooth).
```

```
## Warning: Removed 865 rows containing missing values (geom_point).
```



```
datadec %>%group_by(Country) %>%
  mutate(H_alls=scale(H_all,scale=F)) %>%
  ggplot(aes(x=Year,y=H_alls))+
  geom_point()+
  geom_smooth(method=lm)
```

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

```
## Warning: Removed 865 rows containing non-finite values (stat_smooth).

## Warning: Removed 865 rows containing missing values (geom_point).
```