working paper

DB

June 17, 2016

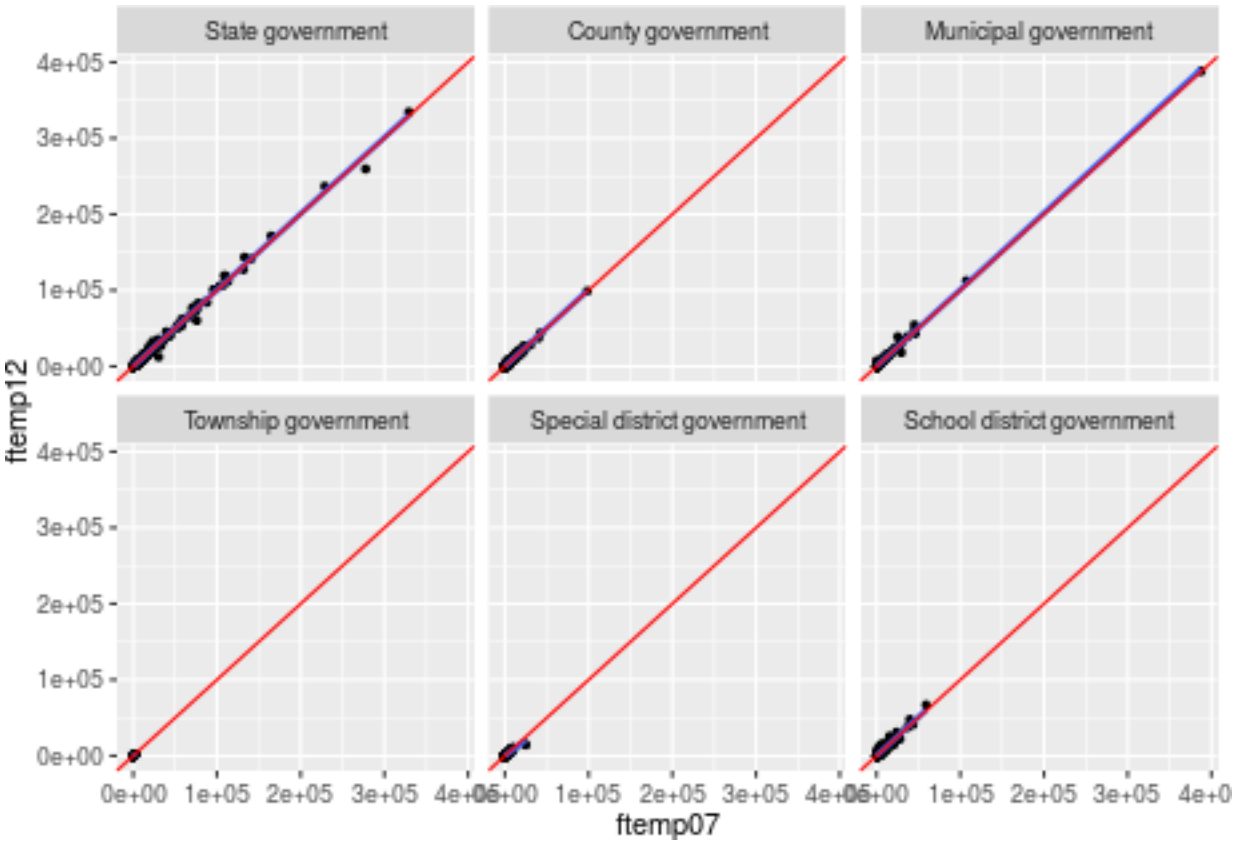
Pre-requisite

Execute :

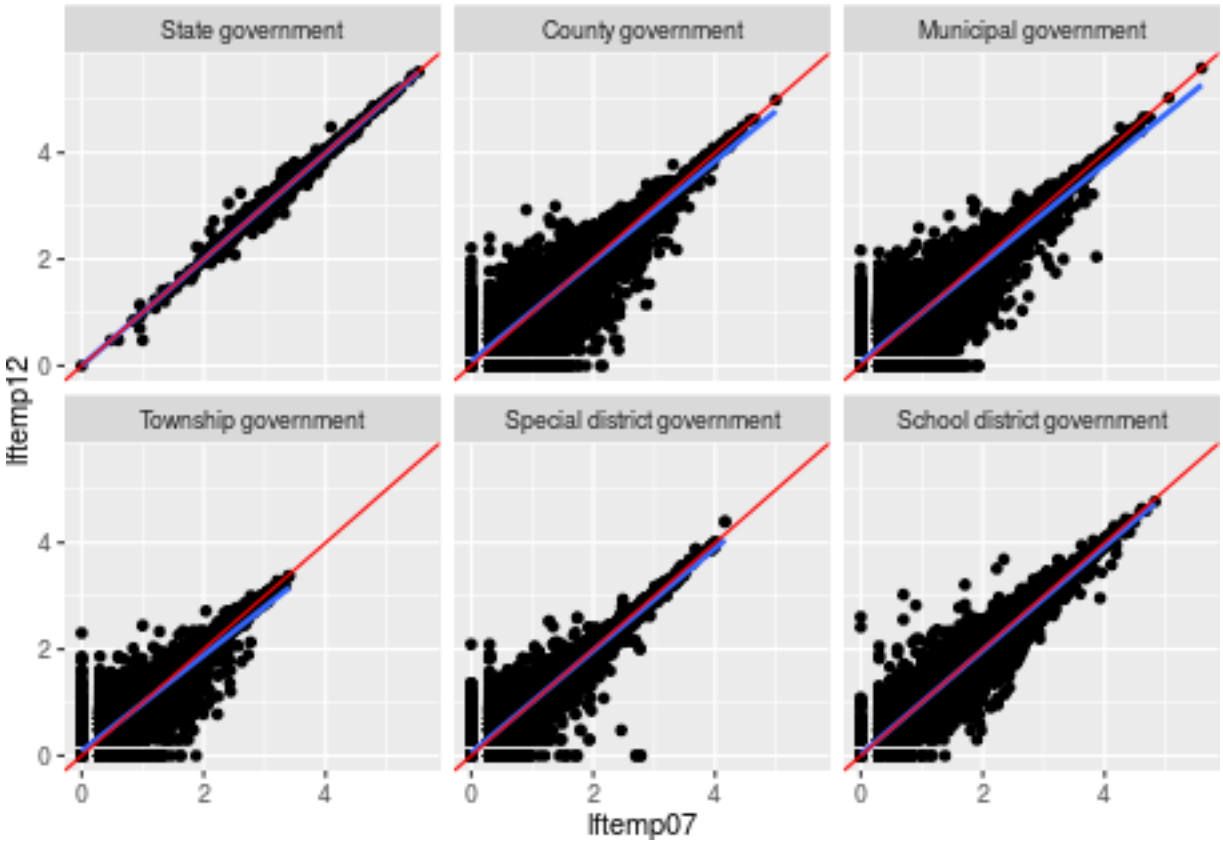
```
devtools::install_github(
  "DanielBonnery/pubBonneryLahiriTran2016")
library(pubBonneryLahiriTran2016)
```

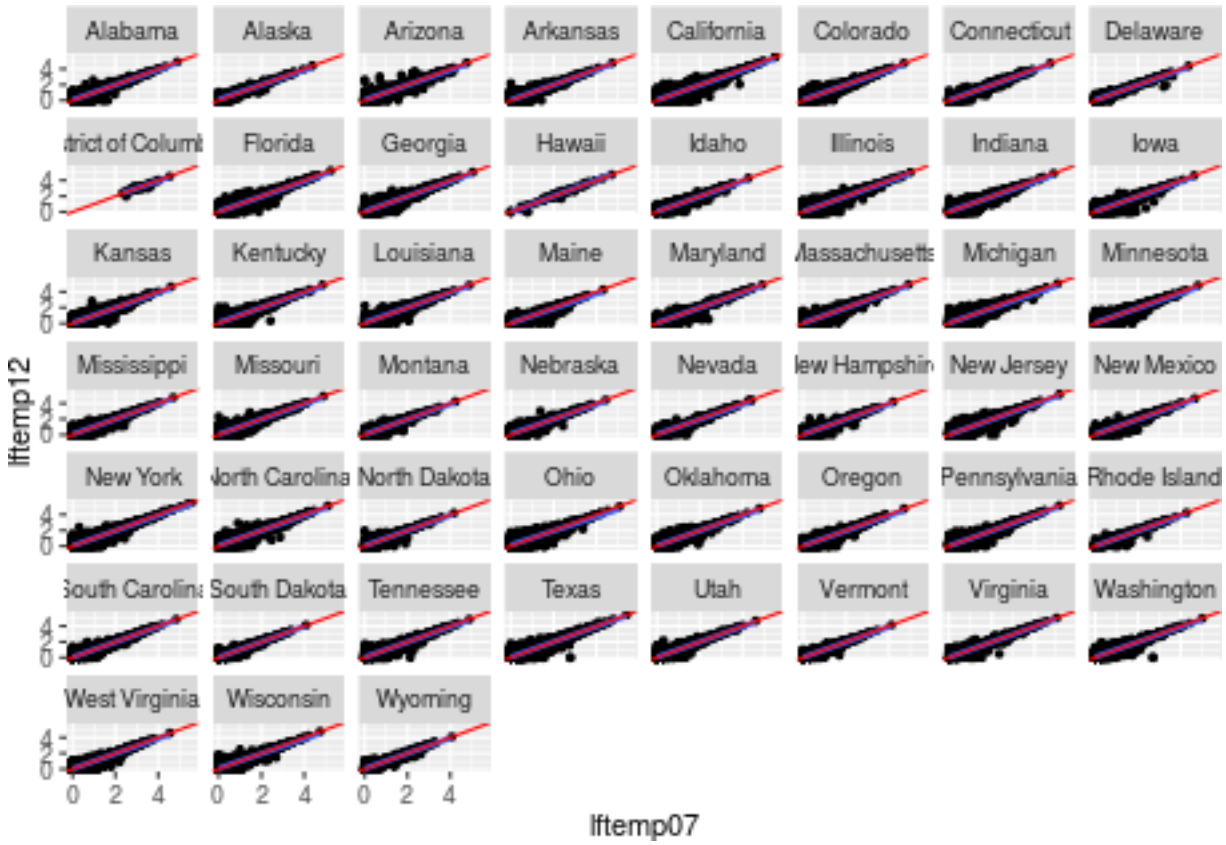
Descriptive statistics and graphs

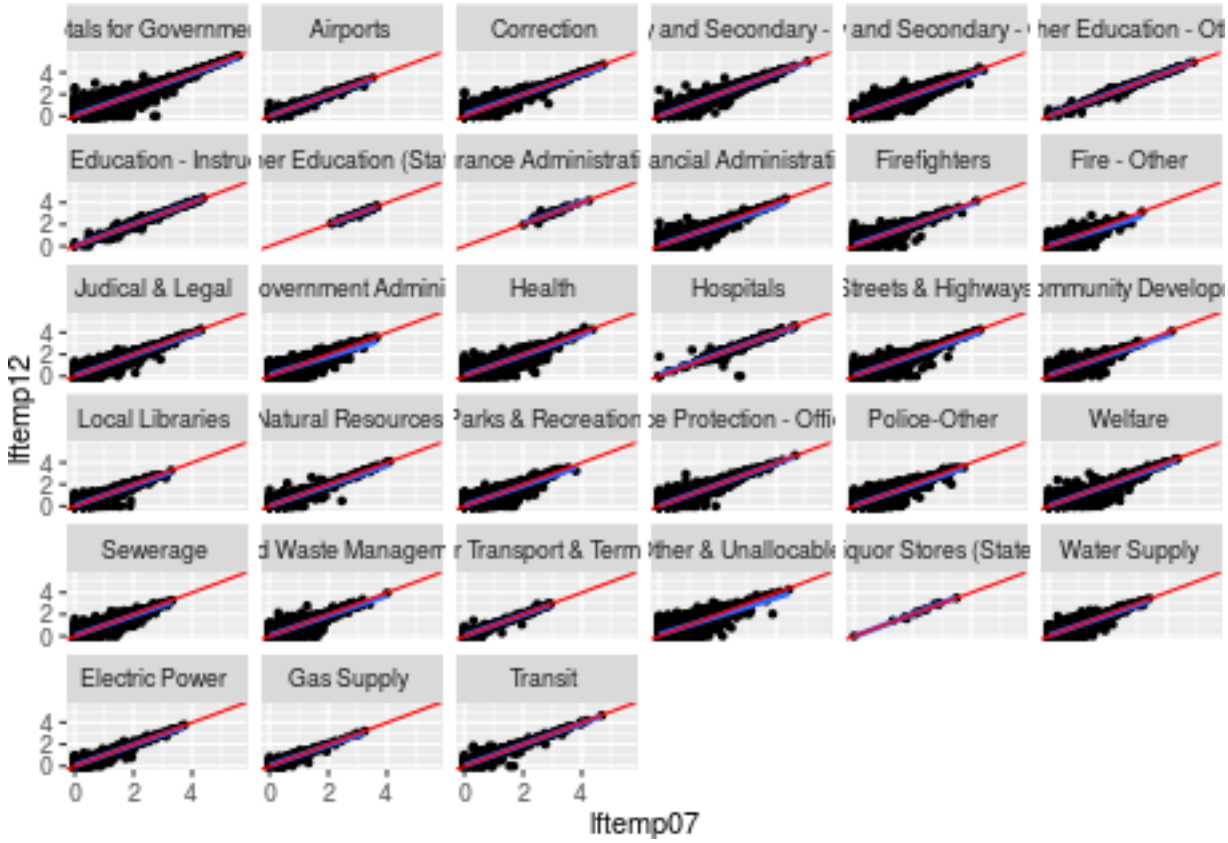
```
demo(descriptive)
```



log scale:


State government
County government
Municipal government
Township government
Special district government
School district government
lftemp12
lftemp07
0
2
4


Alabama
Alaska
Arizona
Arkansas
California
Colorado
Connecticut
Delaware
Florida
Georgia
Hawaii
Idaho
Illinois
Indiana
Iowa
Kansas
Kentucky
Louisiana
Maine
Maryland
Michigan
Minnesota
Mississippi
Missouri
Montana
Nebraska
Nevada
New Jersey
New Mexico
New York
North Dakota
Ohio
Oklahoma
Oregon
Pennsylvania
Rhode Island
South Dakota
Tennessee
Texas
Utah
Vermont
Virginia
Washington
West Virginia
Wisconsin
Wyoming
lftemp12
lftemp07
0
2
4



Frequentist analysis

```
demo(freq1)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: lftemp12 ~ lftemp07 + (lftemp07 | state/type_of_gov/itemcode)
##    Data: xy
## REML criterion at convergence: -87890.13
## Random effects:
##  Groups                       Name        Std.Dev. Corr
##  itemcode:(type_of_gov:state) (Intercept) 0.055627
##                               lftemp07    0.051588 -0.74
##  type_of_gov:state            (Intercept) 0.041186
##                               lftemp07    0.042147 -0.75
##  state                        (Intercept) 0.000000
##                               lftemp07    0.006799  NaN
##  Residual                                 0.196323
## Number of obs: 224982, groups:
## itemcode:(type_of_gov:state), 4371; type_of_gov:state, 267; state, 51
## Fixed Effects:
## (Intercept)     lftemp07
##     0.06548      0.93682
## convergence code 0; 2 optimizer warnings; 0 lme4 warnings
```

Simple model

$$\begin{aligned}\ln(\text{ftemp}_{2012,k}) &= \beta_{0,\text{state}_k,\text{code}_k,\text{type}_k} \\ &\quad +\beta_{1,\text{state}_k,\text{code}_k,\text{type}_k} \times \ln(\text{ftemp}_{2007,k}) + \varepsilon_k\end{aligned}$$

with all fixed parameters, normal prior on all the β. inverse gamma prior on variance parameter.

The model used in jags is:

```
"model {
    for (i in 1:N) {
    lftemp12[i]~
      dnorm(beta0[state[i],itemcode[i],type_of_gov[i]]+
            beta1[state[i],itemcode[i],type_of_gov[i]]*
            lftemp07[i],tau)}
  for (i1 in 1:dime[1]) {
    for (i2 in 1:dime[2]) {
    for (i3 in 1:dime[3]) {
    beta0[i1,i2,i3]~ dnorm (0 ,1.0E-4);
    beta1[i1,i2,i3]~ dnorm (1 ,1.0E-4);}}}
    tau~ dgamma (1.0E-4 ,1.0E-4);
    sigma <- 1/tau
    }"
```

To execute:

```
library(pubBonneryLahiriTran2016)
demo(mcmc1)
```

Model discussed

The jags model is:

```
"model {
    for (i in 1:N) {
    lftemp12[i]~dnorm(beta0[state[i],itemcode[i],type_of_gov[i]]+beta1[state[i],itemcode[i],type_of_gov
    for (i1 in 1:dime[1]) {
    for (i2 in 1:dime[2]) {
    for (i3 in 1:dime[3]) {
    beta0[i1,i2,i3]~ dnorm (a1[i1]+a2[i2]+a3[i3]+b1[i2,i3]+b2[i1,i3]+b3[i1,i2] ,1.0E-4);
    beta1[i1,i2,i3]~ dnorm (c1[i1]+c2[i2]+c3[i3]+d1[i2,i3]+d2[i1,i3]+d3[i1,i2] ,1.0E-4);}}}
    for (i1 in 1:dime[1]) {a1[i1]~dnorm(0,1.0E-4);c1[i1]~dnorm(0,1.0E-4)}
    for (i2 in 1:dime[2]) {a2[i2]~dnorm(0,1.0E-4);c2[i2]~dnorm(0,1.0E-4)}
    for (i3 in 1:dime[3]) {a3[i3]~dnorm(0,1.0E-4);c3[i3]~dnorm(0,1.0E-4)}
```

```
    for (i1 in 1:dime[1]) {
    for (i2 in 1:dime[2]) {b3[i1,i2]~dnorm(0,tau_1[1,1]);d3[i1,i2]~dnorm(0,tau_1[2,1])}}
    for (i1 in 1:dime[1]) {
    for (i3 in 1:dime[3]) {b2[i1,i3]~dnorm(0,tau_1[1,2]);d2[i1,i3]~dnorm(0,tau_1[2,2])}}
    for (i2 in 1:dime[2]) {
    for (i3 in 1:dime[3]) {b1[i2,i3]~dnorm(0,tau_1[1,3]);d1[i2,i3]~dnorm(0,tau_1[2,3])}}
    for (i in 1:2) {for (j in 1:3){tau_1[i,j]~dgamma (1.0E-4 ,1.0E-4)}}
    sigma_1~ dgamma (1.0E-4 ,1.0E-4);
    sigma <- 1/sigma_1
    tau<-1/tau_1
    }"
```

To run:

```
demo(mcmc3)
```