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#Rstudio code - Dilipkumaar_dissertation_MSE
#loading libraries and dataset
library(readxl)
library(plm)
library(ggplot2)
library(car)
library(stargazer)
options(scipen = 999)
d <- read_xlsx("C:/Users/Dilip/Desktop/Dis data.xlsx", sheet = "Sheet1")
df <- pdata.frame(d)

#models
#MCCD ~ without dummy
fixedmodelMCCD <- plm(data=df, log(MCCDcity) ~ NO2 + SO2 + PM10 +
log(rainfall) + Tmin + Tmax + log(popdens))
randommodelMCCD <- plm(data=df, log(MCCDcity) ~ NO2 + SO2 + PM10 +
log(rainfall) + Tmin + Tmax + log(popdens), model = "random")
summary(fixedmodelMCCD)
summary(randommodelMCCD)
phtest(fixedmodelMCCD,randommodelMCCD)

#ARI ~ without dummy
fixedmodelARI <- plm(data=df, log(ARicity) ~ NO2 + SO2 + PM10 + log(rainfall)
+ Tmin + Tmax + log(popdens))
randommodelARI <- plm(data=df, log(ARicity) ~ NO2 + SO2 + PM10 + log(rainfall)
+ Tmin + Tmax + log(popdens), model = "random")
summary(fixedmodelARI)
summary(randommodelARI)
phtest(fixedmodelARI,randommodelARI)

#MCCD ~ all other vars
fixedMCCD <- plm(data=df, log(MCCDcity) ~ NO2 + SO2 + PM10 + log(rainfall) +
Tmin + Tmax + tier2city + log(popdens))
randomMCCD <- plm(data=df, log(MCCDcity) ~ NO2 + SO2 + PM10 + log(rainfall) +
Tmin + Tmax + tier2city + log(popdens), model = "random")
summary(fixedMCCD)
summary(randomMCCD)

phtest(fixedMCCD,randomMCCD)

#ARI ~ all other vars
fixedARI <- plm(data=df, log(ARicity) ~ NO2 + SO2 + PM10 + log(rainfall) +
Tmin + Tmax + tier2city + log(popdens))
randomARI <- plm(data=df, log(ARicity) ~ NO2 + SO2 + PM10 + log(rainfall) +
Tmin + Tmax + tier2city + log(popdens), model = "random")
summary(fixedARI)
summary(randomARI)

phtest(fixedARI,randomARI)

#pollution specific models
#NO2 - random
NO2MCCD <- plm(data=df, log(MCCDcity) ~ NO2 + log(rainfall) + Tmin + Tmax +
log(popdens), model = "random")

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NO2ARI <- plm(data=df, log(ARicity) ~ NO2 + log(rainfall) + Tmin + Tmax +
log(popdens), model = "random")
summary(NO2MCCD)
summary(NO2ARI)

#SO2 - random
SO2MCCD <- plm(data=df, log(MCCDcity) ~ SO2 + log(rainfall) + Tmin + Tmax +
log(popdens), model = "random")
SO2ARI <- plm(data=df, log(ARicity) ~ SO2 + log(rainfall) + Tmin + Tmax +
log(popdens), model = "random")
summary(SO2MCCD)
summary(SO2ARI)

#PM10 - random
PM10MCCD <- plm(data=df, log(MCCDcity) ~ PM10 + log(rainfall) + Tmin + Tmax +
log(popdens), model = "random")
PM10ARI <- plm(data=df, log(ARicity) ~ PM10 + log(rainfall) + Tmin + Tmax +
log(popdens), model = "random")
summary(PM10MCCD)
summary(PM10ARI)

#vif
vif(randommodelMCCD)
vif(randommodelARI)
vif(randomMCCD)
vif(randomARI)

#corr matrix
vars <- df[, c("MCCDcity", "ARicity", "PM10", "NO2", "SO2", "rainfall",
"Tmin", "Tmax", "popdens")]
cor_matrix <- cor(vars, use = "pairwise.complete.obs")
print(round(cor_matrix, 3))

#stargazer outputs
#1
stargazer(fixedmodelMCCD, randommodelMCCD, fixedmodelARI, randommodelARI,
type = "text", # use "latex" or "html" for export
title = "Panel Models: MCCD and ARI (Without Dummy)",
column.labels = c("MCCD FE", "MCCD RE", "ARI FE", "ARI RE"),
dep.var.labels = c("log(MCCDcity)", "log(ARicity)"),
model.numbers = FALSE,
digits = 3,
omit.stat = c("f", "ser"))

#2
stargazer(fixedMCCD, randomMCCD, fixedARI, randomARI,
type = "text",
title = "Panel Models: MCCD and ARI (With Tier2 Dummy)",
column.labels = c("MCCD FE", "MCCD RE", "ARI FE", "ARI RE"),
dep.var.labels = c("log(MCCDcity)", "log(ARicity)"),
model.numbers = FALSE,
digits = 3,

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omit.stat = c("f", "ser"))

#3
stargazer(NO2MCCD, NO2ARI, SO2MCCD, SO2ARI, PM10MCCD, PM10ARI,
  type = "text",
  title = "Random Effects Models by Pollutant: MCCD vs ARI",
  column.labels = c("NO2-MCCD", "NO2-ARI", "SO2-MCCD", "SO2-ARI",
"PM10-MCCD", "PM10-ARI"),
  dep.var.labels = c("log(MCCDcity)", "log(ARIdcity)"),
  model.numbers = FALSE,
  digits = 3,
  omit.stat = c("f", "ser"))

#heatmaps
ggplot(df, aes(x = factor(year), y = city, fill = log(MCCDcity))) +
  geom_tile(color = "white") +
  scale_fill_gradient(low = "white", high = "black") +
  labs(title="intensity of MCCD in city during the study period")
labs(x = "Year", y = "City", fill = "log(MCCDcity)") +
  theme_minimal()

ggplot(df, aes(x = factor(year), y = city, fill = log(ARIdcity))) +
  geom_tile(color = "white") +
  scale_fill_gradient(low = "white", high = "black") +
  labs(title="intensity of ARI in city during the study period")
labs(x = "Year", y = "City", fill = "log(MCCDcity)") +
  theme_minimal()

ggplot(df, aes(x = factor(year), y = city, fill = log(rainfall))) +
  geom_tile(color = "white") +
  scale_fill_gradient(low = "white", high = "black") +
  labs(title="intensity of rainfall in city during the study period")
labs(x = "Year", y = "City", fill = "log(MCCDcity)") +
  theme_minimal()

ggplot(df, aes(x = factor(year), y = city, fill = log(popdens))) +
  geom_tile(color = "white") +
  scale_fill_gradient(low = "white", high = "black") +
  labs(title="population density in city during the study period")
labs(x = "Year", y = "City", fill = "log(MCCDcity)") +
  theme_minimal()

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