

BSVI_intervention

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Loading Libraries and panel dataset

```
library(readxl)
```

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

```
library(plm)
```

```
options(scipen = 999)
```

```
df <- read_excel("C:\\Users\\Dilip\\Desktop\\data.xlsx", sheet = "Sheet1")
```

```
p.df <- pdata.frame(df)
```

```
## Warning in pdata.frame(df): duplicate couples (id-time) in resulting pdata.frame  
## to find out which, use, e.g., table(index(your_pdataframe), useNA = "ifany")
```

```
p.df$coastal <- as.factor(p.df$coastal)
```

```
p.df$d20 <- as.factor(p.df$d20)
```

```
d <- read_excel("C:\\Users\\Dilip\\Desktop\\data.xlsx", sheet = "Sheet2")
```

```
p.d <- pdata.frame(d)
```

```
## Warning in pdata.frame(d): duplicate couples (id-time) in resulting pdata.frame  
## to find out which, use, e.g., table(index(your_pdataframe), useNA = "ifany")
```

```
p.d$coastal <- as.factor(p.d$coastal)
```

Panel data regression models

Model 1

```
model1 <- plm(log(total_ARI) ~ log(pm25) + log(ghe) + log(trans) + log(ntrans) + log(rain) + log(popdens),  
summary(model1))
```

```
## Oneway (individual) effect Within Model
```

```
##
```

```
## Call:
```

```
## plm(formula = log(total_ARI) ~ log(pm25) + log(ghe) + log(trans) +  
##       log(ntrans) + log(rain) + log(popdens) + coastal, data = p.df,  
##       model = "within")  
##
```

```
## Unbalanced Panel: n = 35, T = 10-10, N = 350
```

```
##
```

```
## Residuals:
```

```
##      Min.    1st Qu.    Median    3rd Qu.    Max.  
## -2.380749 -0.262270  0.039981  0.298030  1.451545
```

```
##
```

```
## Coefficients:
```

```
##               Estimate Std. Error t-value          Pr(>|t|)
## log(pm25)      0.228993   0.119357  1.9186         0.055962 .
## log(ghe)     -0.547541   0.068719 -7.9679 0.00000000000003135 ***
## log(trans)    -0.309749   0.096369 -3.2142         0.001446 **
## log(ntrans)    0.167773   0.091633  1.8309         0.068074 .
## log(rain)     -0.280816   0.141703 -1.9817         0.048397 *
## log(popdens) -0.125085   0.338030 -0.3700         0.711606
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    119.06
## Residual Sum of Squares: 82.064
## R-Squared:              0.31074
## Adj. R-Squared: 0.22151
## F-statistic: 23.2178 on 6 and 309 DF, p-value: < 0.00000000000000222
```

Modella

```
modell1a <- plm(log(total_ARI) ~ log(pm25) + log(ghe) + log(trans) + log(ntrans) + log(rain) + log(popdens) + coastal, data = p.df,
summary(modell1a)
```

```
## Oneway (individual) effect Random Effect Model
##      (Swamy-Arora's transformation)
##
## Call:
## plm(formula = log(total_ARI) ~ log(pm25) + log(ghe) + log(trans) +
##      log(ntrans) + log(rain) + log(popdens) + coastal, data = p.df,
##      model = "random")
##
## Unbalanced Panel: n = 35, T = 10-10, N = 350
##
## Effects:
##               var std.dev share
## idiosyncratic 0.2656  0.5153 0.225
## individual    0.9130  0.9555 0.775
## theta:
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.8319  0.8319  0.8319  0.8319  0.8319  0.8319
##
## Residuals:
##      Min. 1st Qu.  Median    3rd Qu.    Max.
## -2.522672 -0.302970  0.056876  0.397551  1.615947
##
## Coefficients:
##               Estimate Std. Error z-value          Pr(>|z|)
## (Intercept)  15.089986   1.605049  9.4016 < 0.00000000000000022 ***
## log(pm25)     0.289758   0.132002  2.1951         0.02816 *
## log(ghe)     -0.527231   0.075065 -7.0236         0.000000000002162 ***
## log(trans)   -0.044648   0.100516 -0.4442         0.65691
## log(ntrans)   0.385880   0.096089  4.0159         0.000059226044513 ***
## log(rain)    -0.574084   0.145397 -3.9484         0.000078675396895 ***
## log(popdens) -0.104616   0.134408 -0.7784         0.43636
## coastal1      0.875832   0.394088  2.2224         0.02625 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## Total Sum of Squares:    145.54
## Residual Sum of Squares: 116.07
## R-Squared:    0.20251
## Adj. R-Squared: 0.18619
## Chisq: 86.8474 on 7 DF, p-value: 0.0000000000000054854
```

Model2

```
model2 <- plm(log(pm25) ~ log(trans) + log(ntrans) + log(rain) + log(popdens) + coastal, model = "within", data = p.df)
summary(model2)
```

```
## Oneway (individual) effect Within Model
##
## Call:
## plm(formula = log(pm25) ~ log(trans) + log(ntrans) + log(rain) +
##      log(popdens) + coastal, data = p.df, model = "within")
##
## Unbalanced Panel: n = 35, T = 10-10, N = 350
##
## Residuals:
##      Min.    1st Qu.    Median    3rd Qu.    Max.
## -0.761732 -0.084110  0.010690  0.086997  0.874201
##
## Coefficients:
##              Estimate Std. Error t-value Pr(>|t|)
## log(trans)    0.042057   0.045366  0.9270  0.35462
## log(ntrans)  -0.034655   0.041728 -0.8305  0.40689
## log(rain)     0.115249   0.066952  1.7214  0.08618
## log(popdens)  0.182958   0.157274  1.1633  0.24560
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    19.306
## Residual Sum of Squares: 18.92
## R-Squared:    0.019969
## Adj. R-Squared: -0.099778
## F-statistic: 1.5842 on 4 and 311 DF, p-value: 0.1783
```

Model2a

```
model2a <- plm(log(pm25) ~ log(trans) + log(ntrans) + log(rain) + log(popdens) + coastal, model = "random", data = p.df)
summary(model2a)
```

```
## Oneway (individual) effect Random Effect Model
##      (Swamy-Arora's transformation)
##
## Call:
## plm(formula = log(pm25) ~ log(trans) + log(ntrans) + log(rain) +
##      log(popdens) + coastal, data = p.df, model = "random")
##
## Unbalanced Panel: n = 35, T = 10-10, N = 350
##
## Effects:
##              var std.dev share
## idiosyncratic 0.06084 0.24665 0.475
```

```
## individual      0.06726 0.25935 0.525
## theta:
##      Min. 1st Qu.  Median      Mean 3rd Qu.      Max.
##      0.712  0.712   0.712   0.712   0.712   0.712
##
## Residuals:
##      Min.      1st Qu.      Median      3rd Qu.      Max.
## -0.8792719 -0.1065828  0.0051999  0.1173082  0.9581146
##
## Coefficients:
##              Estimate Std. Error z-value Pr(>|z|)
## (Intercept)  2.0478529  0.5561174   3.6824  0.000231 ***
## log(trans)    0.0647045  0.0381324   1.6968  0.089727 .
## log(ntrans)  -0.0068080  0.0351814  -0.1935  0.846559
## log(rain)     0.0087676  0.0544441   0.1610  0.872063
## log(popdens)  0.1539558  0.0352051   4.3731  0.00001225 ***
## coastal1     -0.3119887  0.0978565  -3.1882  0.001431 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    23.302
## Residual Sum of Squares: 21.142
## R-Squared:    0.092674
## Adj. R-Squared: 0.079486
## Chisq: 35.1361 on 5 DF, p-value: 0.0000014134
```

Model3

```
model3 <- plm(log(total_ARI) ~ log(pm25) + log(ghe) + log(public) + coastal + log(rain), model = "within", data = p.d)
summary(model3)
```

```
## Oneway (individual) effect Within Model
##
## Call:
## plm(formula = log(total_ARI) ~ log(pm25) + log(ghe) + log(public) +
##      coastal + log(rain), data = p.d, model = "within")
##
## Unbalanced Panel: n = 35, T = 8-8, N = 280
##
## Residuals:
##      Min.      1st Qu.      Median      3rd Qu.      Max.
## -2.327095 -0.171426  0.052484  0.214247  1.317759
##
## Coefficients:
##              Estimate Std. Error t-value Pr(>|t|)
## log(pm25)    -0.012736  0.101442  -0.1255  0.9001949
## log(ghe)     -0.207267  0.060515  -3.4251  0.0007223 ***
## log(public)  -0.081294  0.069175  -1.1752  0.2410772
## log(rain)    -0.414599  0.123514  -3.3567  0.0009164 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    42.524
## Residual Sum of Squares: 37.909
## R-Squared:    0.10852
```

```
## Adj. R-Squared: -0.032045
## F-statistic: 7.33428 on 4 and 241 DF, p-value: 0.000013706
```

Model3a

```
model3a <- plm(log(total_ARI) ~ log(pm25) + log(ghe) + log(public) + coastal + log(rain), model = "random", data = p.d, fixed = 0)
summary(model3a)
```

```
## Oneway (individual) effect Random Effect Model
## (Swamy-Arora's transformation)
##
## Call:
## plm(formula = log(total_ARI) ~ log(pm25) + log(ghe) + log(public) +
## coastal + log(rain), data = p.d, model = "random")
##
## Unbalanced Panel: n = 35, T = 8-8, N = 280
##
## Effects:
##               var std.dev share
## idiosyncratic 0.1573  0.3966 0.145
## individual    0.9240  0.9612 0.855
## theta:
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.8557 0.8557  0.8557  0.8557  0.8557  0.8557
##
## Residuals:
##   Min. 1st Qu.  Median    3rd Qu.    Max.
## -2.36588 -0.17294  0.04220  0.27573  1.21987
##
## Coefficients:
##               Estimate Std. Error z-value      Pr(>|z|)
## (Intercept) 15.292670   1.146559 13.3379 < 0.00000000000000022 ***
## log(pm25)    0.024545   0.107393  0.2286      0.819216
## log(ghe)     -0.068959   0.061772 -1.1163      0.264278
## log(public)  0.200713   0.059702  3.3619      0.000774 ***
## coastal1     0.862381   0.368492  2.3403      0.019268 *
## log(rain)    -0.595363   0.122804 -4.8481      0.000001247 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    57.963
## Residual Sum of Squares: 50.416
## R-Squared:    0.13021
## Adj. R-Squared: 0.11434
## Chisq: 41.0178 on 5 DF, p-value: 0.000000093055
```

Difference-in-Differences Model

```
p.df_did <- subset(p.df, year %in% c(2017, 2020))
p.df_did$policy <- ifelse(p.df_did$year == 2020, 1, 0)
threshold <- quantile(p.df_did$pm25, 0.75)
p.df_did$policy_group <- ifelse(p.df_did$pm25 > threshold, 1, 0)

did_model <- plm(log(total_ARI) ~ policy * policy_group + coastal + rain + ttrans, data = p.df_did, fixed = 0)
summary(did_model)
```

```

## Oneway (individual) effect Within Model
##
## Call:
## plm(formula = log(total_ARI) ~ policy * policy_group + coastal +
##      rain + ttrans, data = p.df_did, model = "within", index = c("state",
##      "year"))
##
## Unbalanced Panel: n = 35, T = 2-2, N = 70
##
## Residuals:
##              Min.              1st Qu.              Median
## -0.82439442508069926685 -0.14902378310809299977  0.00000000000000088818
##              3rd Qu.              Max.
##  0.14902378310809094586  0.82439442508069926685
##
## Coefficients:
##              Estimate      Std. Error t-value Pr(>|t|)
## policy          -0.526144655256   0.130061659667 -4.0453 0.0003371 ***
## policy_group     -0.308262293248   0.407841006485 -0.7558 0.4556398
## rain             -0.000022637370   0.000158946635 -0.1424 0.8876995
## ttrans           -0.000000090845   0.000000038862 -2.3376 0.0262689 *
## policy:policy_group 0.064435812428  0.219267648341  0.2939 0.7708821
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Total Sum of Squares:    13.916
## Residual Sum of Squares: 4.3809
## R-Squared:    0.6852
## Adj. R-Squared: 0.27595
## F-statistic: 13.0595 on 5 and 30 DF, p-value: 0.00000086178

```