

w12_async_ex

```
library(wooldridge)
str(jtrain)
```

```
## 'data.frame': 471 obs. of 30 variables:
## $ year : int 1987 1988 1989 1987 1988 1989 1987 1988 1989 1987 ...
## $ fcode : num 410032 410032 410032 410440 410440 ...
## $ employ : int 100 131 123 12 13 14 20 25 24 200 ...
## $ sales : num 47000000 43000000 49000000 1560000 1970000 ...
## $ avgsal : num 35000 37000 39000 10500 11000 ...
## $ scrap : num NA NA NA NA NA NA NA NA NA NA ...
## $ rework : num NA NA NA NA NA NA NA NA NA NA ...
## $ tothrs : int 12 8 8 12 12 10 50 50 50 0 ...
## $ union : int 0 0 0 0 0 0 0 0 0 0 ...
## $ grant : int 0 0 0 0 0 0 0 0 0 0 ...
## $ d89 : int 0 0 1 0 0 1 0 0 1 0 ...
## $ d88 : int 0 1 0 0 1 0 0 1 0 0 ...
## $ tottrain : int 100 50 50 12 13 14 15 10 20 0 ...
## $ hrsemp : num 12 3.05 3.25 12 12 ...
## $ lscrap : num NA NA NA NA NA NA NA NA NA NA ...
## $ lemploy : num 4.61 4.88 4.81 2.48 2.56 ...
## $ lsales : num 17.7 17.6 17.7 14.3 14.5 ...
## $ lrework : num NA NA NA NA NA NA NA NA NA NA ...
## $ lhrsemp : num 2.56 1.4 1.45 2.56 2.56 ...
## $ lscrap_1 : num NA NA NA NA NA NA NA NA NA NA ...
## $ grant_1 : int 0 0 0 0 0 0 0 0 0 0 ...
## $ clscrap : num NA NA NA NA NA NA NA NA NA NA ...
## $ cgrant : int 0 0 0 0 0 0 0 0 0 0 ...
## $ clempley : num NA 0.27 -0.063 NA 0.08 ...
## $ clsales : num NA -0.0889 0.1306 NA 0.2333 ...
## $ lavgsal : num 10.46 10.52 10.57 9.26 9.31 ...
## $ clavgsal : num NA 0.0556 0.0526 NA 0.0465 ...
## $ cgrant_1 : int NA 0 0 NA 0 0 NA 0 0 NA ...
## $ chrsemp : num NA -8.947 0.199 NA 0 ...
## $ clhrsemp : num NA -1.1654 0.0478 NA 0 ...
## - attr(*, "datalabel")= chr ""
## - attr(*, "time.stamp")= chr "25 Jun 2011 23:03"
## - attr(*, "formats")= chr "%9.0g" "%9.0g" "%9.0g" "%9.0g" ...
## - attr(*, "types")= int 252 254 252 254 254 254 252 251 251 ...
## - attr(*, "val.labels")= chr "" "" "" "" ...
## - attr(*, "var.labels")= chr "1987, 1988, or 1989" "firm code number" "# employees at plant" "annual"
## - attr(*, "version")= int 10
```

```
head(jtrain, 12)
```

```
##   year fcode employ  sales avgsal scrap rework tothrs union grant d89
## 1 1987 410032   100 47000000 35000    NA    NA    12     0     0  0
## 2 1988 410032   131 43000000 37000    NA    NA     8     0     0  0
## 3 1989 410032   123 49000000 39000    NA    NA     8     0     0  1
## 4 1987 410440    12 1560000 10500    NA    NA    12     0     0  0
## 5 1988 410440    13 1970000 11000    NA    NA    12     0     0  0
## 6 1989 410440    14 2350000 11500    NA    NA    10     0     0  1
```

```

## 7 1987 410495      20 750000 17680      NA      NA      50      0      0      0
## 8 1988 410495      25 110000 18720      NA      NA      50      0      0      0
## 9 1989 410495      24 950000 19760      NA      NA      50      0      0      1
## 10 1987 410500     200 23741000 13729      NA      NA      0      0      0      0
## 11 1988 410500     155 19659000 14287      NA      NA      0      0      0      0
## 12 1989 410500      80 25992000 15758      NA      NA      24      0      0      1
##      d88 tottrain      hrsemp lscrap      lemploy      lsales lrework      lhrsemp
## 1      0      100 12.000000      NA 4.605170 17.66566      NA 2.564949
## 2      1      50 3.053435      NA 4.875197 17.57671      NA 1.399565
## 3      0      50 3.252033      NA 4.812184 17.70733      NA 1.447397
## 4      0      12 12.000000      NA 2.484907 14.26020      NA 2.564949
## 5      1      13 12.000000      NA 2.564949 14.49354      NA 2.564949
## 6      0      14 10.000000      NA 2.639057 14.66993      NA 2.397895
## 7      0      15 37.500000      NA 2.995732 13.52783      NA 3.650658
## 8      1      10 20.000000      NA 3.218876 11.60824      NA 3.044523
## 9      0      20 41.666668      NA 3.178054 13.76422      NA 3.753418
## 10     0      0 0.000000      NA 5.298317 16.98271      NA 0.000000
## 11     1      0 0.000000      NA 5.043425 16.79405      NA 0.000000
## 12     0      20 6.000000      NA 4.382027 17.07330      NA 1.945910
##      lscrap_1 grant_1 clscrap cgrant      clemmploy      clsales      lavgsal
## 1      NA      0      NA      0      NA      NA 10.463103
## 2      NA      0      NA      0 0.27002716 -0.0889492 10.518673
## 3      NA      0      NA      0 -0.06301308 0.1306210 10.571317
## 4      NA      0      NA      0      NA      NA 9.259130
## 5      NA      0      NA      0 0.08004260 0.2333469 9.305651
## 6      NA      0      NA      0 0.07410812 0.1763821 9.350102
## 7      NA      0      NA      0      NA      NA 9.780190
## 8      NA      0      NA      0 0.22314358 -1.9195929 9.837348
## 9      NA      0      NA      0 -0.04082203 2.1559820 9.891415
## 10     NA      0      NA      0      NA      NA 9.527266
## 11     NA      0      NA      0 -0.25489235 -0.1886673 9.567105
## 12     NA      0      NA      0 -0.66139841 0.2792530 9.665104
##      clavgsal cgrant_1      chrsemp      clhrsemp
## 1      NA      NA      NA      NA
## 2 0.05556965      0 -8.9465647 -1.16538453
## 3 0.05264378      0 0.1985974 0.04783237
## 4      NA      NA      NA      NA
## 5 0.04652023      0 0.0000000 0.00000000
## 6 0.04445171      0 -2.0000000 -0.16705394
## 7      NA      NA      NA      NA
## 8 0.05715847      0 -17.5000000 -0.60613561
## 9 0.05406666      0 21.6666679 0.70889544
## 10     NA      NA      NA      NA
## 11 0.03983974      0 0.0000000 0.00000000
## 12 0.09799862      0 6.0000000 1.94591010

```

```

# split data set by year
x = split.data.frame(jtrain, as.factor(jtrain$year))
str(x)

```

```

## List of 3
## $ 1987:'data.frame': 157 obs. of 30 variables:
## ..$ year : int [1:157] 1987 1987 1987 1987 1987 1987 1987 1987 1987 1987 ...
## ..$ fcode : num [1:157] 410032 410440 410495 410500 410501 ...
## ..$ employ : int [1:157] 100 12 20 200 NA NA 15 24 48 17 ...

```

```

## ..$ sales : num [1:157] 47000000 1560000 750000 23741000 6000000 ...
## ..$ avgsal : num [1:157] 35000 10500 17680 13729 NA ...
## ..$ scrap : num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ rework : num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ tothrs : int [1:157] 12 12 50 0 0 0 0 0 14 150 ...
## ..$ union : int [1:157] 0 0 0 0 0 0 0 1 0 0 ...
## ..$ grant : int [1:157] 0 0 0 0 0 0 0 0 0 0 ...
## ..$ d89 : int [1:157] 0 0 0 0 0 0 0 0 0 0 ...
## ..$ d88 : int [1:157] 0 0 0 0 0 0 0 0 0 0 ...
## ..$ totrain : int [1:157] 100 12 15 0 10 0 0 0 3 5 ...
## ..$ hrsemp : num [1:157] 12 12 37.5 0 NA ...
## ..$ lscrap : num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ lemploy : num [1:157] 4.61 2.48 3 5.3 NA ...
## ..$ lsales : num [1:157] 17.7 14.3 13.5 17 15.6 ...
## ..$ lrework : num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ lhrsemp : num [1:157] 2.56 2.56 3.65 0 NA ...
## ..$ lscrap_1 : num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ grant_1 : int [1:157] 0 0 0 0 0 0 0 0 0 0 ...
## ..$ clscrap : num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ cgrant : int [1:157] 0 0 0 0 0 0 0 0 0 0 ...
## ..$ cemploy : num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ clsales : num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ lavgsal : num [1:157] 10.46 9.26 9.78 9.53 NA ...
## ..$ clavgsal : num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ cgrant_1 : int [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ chrsemp : num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ clhrsemp : num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..- attr(*, "datalabel")= chr ""
## ..- attr(*, "time.stamp")= chr "25 Jun 2011 23:03"
## ..- attr(*, "formats")= chr [1:30] "%9.0g" "%9.0g" "%9.0g" "%9.0g" ...
## ..- attr(*, "types")= int [1:30] 252 254 252 254 254 254 254 252 251 251 ...
## ..- attr(*, "val.labels")= chr [1:30] "" "" "" "" ...
## ..- attr(*, "var.labels")= chr [1:30] "1987, 1988, or 1989" "firm code number" "# employees at plant" ...
## ..- attr(*, "version")= int 10
## $ 1988:'data.frame': 157 obs. of 30 variables:
## ..$ year : int [1:157] 1988 1988 1988 1988 1988 1988 1988 1988 1988 1988 ...
## ..$ fcode : num [1:157] 410032 410440 410495 410500 410501 ...
## ..$ employ : int [1:157] 131 13 25 155 NA NA 16 20 47 16 ...
## ..$ sales : num [1:157] 43000000 1970000 110000 19659000 8000000 ...
## ..$ avgsal : num [1:157] 37000 11000 18720 14287 NA ...
## ..$ scrap : num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ rework : num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ tothrs : int [1:157] 8 12 50 0 0 0 0 0 14 100 ...
## ..$ union : int [1:157] 0 0 0 0 0 0 0 1 0 0 ...
## ..$ grant : int [1:157] 0 0 0 0 0 0 0 0 0 0 ...
## ..$ d89 : int [1:157] 0 0 0 0 0 0 0 0 0 0 ...
## ..$ d88 : int [1:157] 1 1 1 1 1 1 1 1 1 1 ...
## ..$ totrain : int [1:157] 50 13 10 0 20 0 0 0 3 3 ...
## ..$ hrsemp : num [1:157] 3.05 12 20 0 NA ...
## ..$ lscrap : num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ lemploy : num [1:157] 4.88 2.56 3.22 5.04 NA ...
## ..$ lsales : num [1:157] 17.6 14.5 11.6 16.8 15.9 ...
## ..$ lrework : num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ lhrsemp : num [1:157] 1.4 2.56 3.04 0 NA ...

```

```

## ..$ lscrap_1: num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ grant_1 : int [1:157] 0 0 0 0 0 0 0 0 0 0 ...
## ..$ clscrap : num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ cgrant : int [1:157] 0 0 0 0 0 0 0 0 0 0 ...
## ..$ cemploy: num [1:157] 0.27 0.08 0.223 -0.255 NA ...
## ..$ clsales : num [1:157] -0.0889 0.2333 -1.9196 -0.1887 0.2877 ...
## ..$ lavgsal : num [1:157] 10.52 9.31 9.84 9.57 NA ...
## ..$ clavgsal: num [1:157] 0.0556 0.0465 0.0572 0.0398 NA ...
## ..$ cgrant_1: int [1:157] 0 0 0 0 0 0 0 0 0 0 ...
## ..$ chrsemp : num [1:157] -8.95 0 -17.5 0 NA ...
## ..$ clhrsemp: num [1:157] -1.165 0 -0.606 0 NA ...
## ..- attr(*, "datalabel")= chr ""
## ..- attr(*, "time.stamp")= chr "25 Jun 2011 23:03"
## ..- attr(*, "formats")= chr [1:30] "%9.0g" "%9.0g" "%9.0g" "%9.0g" ...
## ..- attr(*, "types")= int [1:30] 252 254 252 254 254 254 254 252 251 251 ...
## ..- attr(*, "val.labels")= chr [1:30] "" "" "" "" ...
## ..- attr(*, "var.labels")= chr [1:30] "1987, 1988, or 1989" "firm code number" "# employees at plant" ...
## ..- attr(*, "version")= int 10
## $ 1989:'data.frame': 157 obs. of 30 variables:
## ..$ year : int [1:157] 1989 1989 1989 1989 1989 1989 1989 1989 1989 1989 ...
## ..$ fcode : num [1:157] 410032 410440 410495 410500 410501 ...
## ..$ employ : int [1:157] 123 14 24 80 NA 20 16 18 66 14 ...
## ..$ sales : num [1:157] 49000000 2350000 950000 25992000 10000000 ...
## ..$ avgsal : num [1:157] 39000 11500 19760 15758 NA ...
## ..$ scrap : num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ rework : num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ tothrs : int [1:157] 8 10 50 24 0 0 20 0 14 0 ...
## ..$ union : int [1:157] 0 0 0 0 0 0 0 1 0 0 ...
## ..$ grant : int [1:157] 0 0 0 0 0 0 0 0 0 0 ...
## ..$ d89 : int [1:157] 1 1 1 1 1 1 1 1 1 1 ...
## ..$ d88 : int [1:157] 0 0 0 0 0 0 0 0 0 0 ...
## ..$ totrain: int [1:157] 50 14 20 20 25 0 16 0 4 0 ...
## ..$ hrsemp : num [1:157] 3.25 10 41.67 6 NA ...
## ..$ lscrap : num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ lemploy: num [1:157] 4.81 2.64 3.18 4.38 NA ...
## ..$ lsales : num [1:157] 17.7 14.7 13.8 17.1 16.1 ...
## ..$ lrework: num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ lhrsemp: num [1:157] 1.45 2.4 3.75 1.95 NA ...
## ..$ lscrap_1: num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ grant_1 : int [1:157] 0 0 0 0 0 0 0 0 0 0 ...
## ..$ clscrap : num [1:157] NA NA NA NA NA NA NA NA NA NA ...
## ..$ cgrant : int [1:157] 0 0 0 0 0 0 0 0 0 0 ...
## ..$ cemploy: num [1:157] -0.063 0.0741 -0.0408 -0.6614 NA ...
## ..$ clsales : num [1:157] 0.131 0.176 2.156 0.279 0.223 ...
## ..$ lavgsal : num [1:157] 10.57 9.35 9.89 9.67 NA ...
## ..$ clavgsal: num [1:157] 0.0526 0.0445 0.0541 0.098 NA ...
## ..$ cgrant_1: int [1:157] 0 0 0 0 0 0 0 0 0 0 ...
## ..$ chrsemp : num [1:157] 0.199 -2 21.667 6 NA ...
## ..$ clhrsemp: num [1:157] 0.0478 -0.1671 0.7089 1.9459 NA ...
## ..- attr(*, "datalabel")= chr ""
## ..- attr(*, "time.stamp")= chr "25 Jun 2011 23:03"
## ..- attr(*, "formats")= chr [1:30] "%9.0g" "%9.0g" "%9.0g" "%9.0g" ...
## ..- attr(*, "types")= int [1:30] 252 254 252 254 254 254 254 252 251 251 ...
## ..- attr(*, "val.labels")= chr [1:30] "" "" "" "" ...

```

```
##   ..- attr(*, "var.labels")= chr [1:30] "1987, 1988, or 1989" "firm code number" "# employees at plant"
##   ..- attr(*, "version")= int 10
```

```
jtrain.87 = x$`1987`
jtrain.88 = x$`1988`
jtrain.89 = x$`1989`
str(jtrain.87)
```

```
## 'data.frame':   157 obs. of  30 variables:
##  $ year      : int  1987 1987 1987 1987 1987 1987 1987 1987 1987 1987 ...
##  $ fcode     : num  410032 410440 410495 410500 410501 ...
##  $ employ    : int  100 12 20 200 NA NA 15 24 48 17 ...
##  $ sales     : num  47000000 1560000 750000 23741000 6000000 ...
##  $ avgsal    : num  35000 10500 17680 13729 NA ...
##  $ scrap     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ rework    : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ tothrs    : int  12 12 50 0 0 0 0 0 14 150 ...
##  $ union     : int  0 0 0 0 0 0 0 1 0 0 ...
##  $ grant     : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ d89       : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ d88       : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ totrain   : int  100 12 15 0 10 0 0 0 3 5 ...
##  $ hrsemp    : num  12 12 37.5 0 NA ...
##  $ lscrap    : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ lemploy   : num  4.61 2.48 3 5.3 NA ...
##  $ lsales    : num  17.7 14.3 13.5 17 15.6 ...
##  $ lrework   : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ lhrsemp   : num  2.56 2.56 3.65 0 NA ...
##  $ lscrap_1  : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ grant_1   : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ clscrap   : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ cgrant    : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ clemploy  : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ clsales   : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ lavgsal   : num  10.46 9.26 9.78 9.53 NA ...
##  $ clavgsal  : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ cgrant_1  : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ chrsemp   : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ clhrsemp  : num  NA NA NA NA NA NA NA NA NA NA ...
##  - attr(*, "datalabel")= chr ""
##  - attr(*, "time.stamp")= chr "25 Jun 2011 23:03"
##  - attr(*, "formats")= chr  "%9.0g" "%9.0g" "%9.0g" "%9.0g" ...
##  - attr(*, "types")= int   252 254 252 254 254 254 254 252 251 251 ...
##  - attr(*, "val.labels")= chr  "" "" "" "" ...
##  - attr(*, "var.labels")= chr  "1987, 1988, or 1989" "firm code number" "# employees at plant" "annual sales"
##  - attr(*, "version")= int 10
```

```
jtrain.87.ols = lm(lscrap ~ hrsemp + lsales + lemploy, data = jtrain.87)
summary(jtrain.87.ols)
```

```
##
## Call:
## lm(formula = lscrap ~ hrsemp + lsales + lemploy, data = jtrain.87)
##
## Residuals:
```

```
##      Min      1Q   Median      3Q      Max
## -2.81878 -0.91530  0.03304  0.87052  2.68042
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 11.74426    4.57470   2.567  0.01420 *
## hrsemp      -0.04218    0.01868  -2.259  0.02957 *
## lsales      -0.95064    0.36984  -2.570  0.01409 *
## lemploy     0.99213    0.35692   2.780  0.00833 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.3 on 39 degrees of freedom
## (114 observations deleted due to missingness)
## Multiple R-squared:  0.3099, Adjusted R-squared:  0.2568
## F-statistic: 5.838 on 3 and 39 DF,  p-value: 0.002148
```

1. Given the summary statistics provided and the estimated model (in the last three slides), is there anything wrong with this estimated regression (in terms of understanding impact of training on scrap rate)?

The regression does not take advantage of panel data to infer the relationship between scrap rate and training, relative to firm size. A cross-sectional relationship is estimated, which may be biased due to omitted variables, including the year. A fixed effect analysis would provide estimators that remove the effects of time-invariant omitted variables and account for changes in relationship across time.

2. Interpret the coefficient associated with the variable `hrsemp`.

As total training hours per employee increases, log of scrap rate decreases by 4% More training leads to less errors.

3. Is the effect large? Is there any other information (perhaps not included in the regression) that you would need in order to answer this question?

We would need to know the standard deviation of the log scrap rate to see if this effect is large.

4. How would you estimate a cross-sectional model differently, if at all?

To estimate a cross-sectional model, I'd pool the data and add indicator variable for each year.

12.6. Random-Effect Models

```
library(plm)
```

```
## Loading required package: Formula
```

```
library(stargazer)
```

```
##
```

```
## Please cite as:
```

```
## Hlavac, Marek (2015). stargazer: Well-Formatted Regression and Summary Statistics Tables.
```

```
## R package version 5.2. http://CRAN.R-project.org/package=stargazer
```

```
str(wagepan)
```

```
## 'data.frame':  4360 obs. of  44 variables:
## $ nr      : int  13 13 13 13 13 13 13 13 17 17 ...
## $ year    : int  1980 1981 1982 1983 1984 1985 1986 1987 1980 1981 ...
## $ agric   : int  0 0 0 0 0 0 0 0 0 0 ...
```

```

## $ black : int 0 0 0 0 0 0 0 0 0 0 ...
## $ bus : int 1 0 1 1 0 1 1 1 0 0 ...
## $ construc: int 0 0 0 0 0 0 0 0 0 0 ...
## $ ent : int 0 0 0 0 0 0 0 0 0 0 ...
## $ exper : int 1 2 3 4 5 6 7 8 4 5 ...
## $ fin : int 0 0 0 0 0 0 0 0 0 0 ...
## $ hisp : int 0 0 0 0 0 0 0 0 0 0 ...
## $ poorhlth: int 0 0 0 0 0 0 0 0 0 0 ...
## $ hours : int 2672 2320 2940 2960 3071 2864 2994 2640 2484 2804 ...
## $ manuf : int 0 0 0 0 0 0 0 0 0 0 ...
## $ married : int 0 0 0 0 0 0 0 0 0 0 ...
## $ min : int 0 0 0 0 0 0 0 0 0 0 ...
## $ nrthcen : int 0 0 0 0 0 0 0 0 0 0 ...
## $ nrtheast: int 1 1 1 1 1 1 1 1 1 1 ...
## $ occ1 : int 0 0 0 0 0 0 0 0 0 0 ...
## $ occ2 : int 0 0 0 0 0 1 1 1 1 1 ...
## $ occ3 : int 0 0 0 0 0 0 0 0 0 0 ...
## $ occ4 : int 0 0 0 0 0 0 0 0 0 0 ...
## $ occ5 : int 0 0 0 0 1 0 0 0 0 0 ...
## $ occ6 : int 0 0 0 0 0 0 0 0 0 0 ...
## $ occ7 : int 0 0 0 0 0 0 0 0 0 0 ...
## $ occ8 : int 0 0 0 0 0 0 0 0 0 0 ...
## $ occ9 : int 1 1 1 1 0 0 0 0 0 0 ...
## $ per : int 0 1 0 0 1 0 0 0 0 0 ...
## $ pro : int 0 0 0 0 0 0 0 0 0 0 ...
## $ pub : int 0 0 0 0 0 0 0 0 0 0 ...
## $ rur : int 0 0 0 0 0 0 0 0 0 0 ...
## $ south : int 0 0 0 0 0 0 0 0 0 0 ...
## $ educ : int 14 14 14 14 14 14 14 14 13 13 ...
## $ tra : int 0 0 0 0 0 0 0 0 0 0 ...
## $ trad : int 0 0 0 0 0 0 0 0 1 1 ...
## $ union : int 0 1 0 0 0 0 0 0 0 0 ...
## $ lwage : num 1.2 1.85 1.34 1.43 1.57 ...
## $ d81 : int 0 1 0 0 0 0 0 0 0 1 ...
## $ d82 : int 0 0 1 0 0 0 0 0 0 0 ...
## $ d83 : int 0 0 0 1 0 0 0 0 0 0 ...
## $ d84 : int 0 0 0 0 1 0 0 0 0 0 ...
## $ d85 : int 0 0 0 0 0 1 0 0 0 0 ...
## $ d86 : int 0 0 0 0 0 0 1 0 0 0 ...
## $ d87 : int 0 0 0 0 0 0 0 1 0 0 ...
## $ expersq : int 1 4 9 16 25 36 49 64 16 25 ...
## - attr(*, "datalabel")= chr ""
## - attr(*, "time.stamp")= chr "25 Jun 2011 23:03"
## - attr(*, "formats")= chr "%9.0g" "%9.0g" "%9.0g" "%9.0g" ...
## - attr(*, "types")= int 252 252 251 251 251 251 251 251 251 251 ...
## - attr(*, "val.labels")= chr "" "" "" "" ...
## - attr(*, "var.labels")= chr "person identifier" "1980 to 1987" "=1 if in agriculture" "=1 if black"
## - attr(*, "version")= int 10

```

```

wagepan.panel = plm.data(wagepan, c('nr','year'))
summary(wagepan.panel)

```

```

##      nr      year      agric      black
## 13   :    8  1980   : 545   Min. :0.00000   Min. :0.0000
## 17   :    8  1981   : 545   1st Qu.:0.00000   1st Qu.:0.0000

```

```

## 18      :   8   1982      : 545   Median :0.00000   Median :0.0000
## 45      :   8   1983      : 545   Mean    :0.03211   Mean    :0.1156
## 110     :   8   1984      : 545   3rd Qu.:0.00000   3rd Qu.:0.0000
## 120     :   8   1985      : 545   Max.    :1.00000   Max.    :1.0000
## (Other):4312   (Other):1090
##      bus          construc          ent          exper
## Min.    :0.00000   Min.    :0.000   Min.    :0.00000   Min.    : 0.000
## 1st Qu.:0.00000   1st Qu.:0.000   1st Qu.:0.00000   1st Qu.: 4.000
## Median :0.00000   Median :0.000   Median :0.00000   Median : 6.000
## Mean    :0.07592   Mean    :0.075   Mean    :0.01514   Mean    : 6.515
## 3rd Qu.:0.00000   3rd Qu.:0.000   3rd Qu.:0.00000   3rd Qu.: 9.000
## Max.    :1.00000   Max.    :1.000   Max.    :1.00000   Max.    :18.000
##
##      fin          hisp          poorhlth          hours
## Min.    :0.00000   Min.    :0.000   Min.    :0.00000   Min.    : 120
## 1st Qu.:0.00000   1st Qu.:0.000   1st Qu.:0.00000   1st Qu.:2040
## Median :0.00000   Median :0.000   Median :0.00000   Median :2080
## Mean    :0.03693   Mean    :0.156   Mean    :0.01697   Mean    :2191
## 3rd Qu.:0.00000   3rd Qu.:0.000   3rd Qu.:0.00000   3rd Qu.:2414
## Max.    :1.00000   Max.    :1.000   Max.    :1.00000   Max.    :4992
##
##      manuf          married          min          nrthcen
## Min.    :0.0000   Min.    :0.000   Min.    :0.0000   Min.    :0.0000
## 1st Qu.:0.0000   1st Qu.:0.000   1st Qu.:0.0000   1st Qu.:0.0000
## Median :0.0000   Median :0.000   Median :0.0000   Median :0.0000
## Mean    :0.2823   Mean    :0.439   Mean    :0.0156   Mean    :0.2578
## 3rd Qu.:1.0000   3rd Qu.:1.000   3rd Qu.:0.0000   3rd Qu.:1.0000
## Max.    :1.0000   Max.    :1.000   Max.    :1.0000   Max.    :1.0000
##
##      nrtheast          occ1          occ2          occ3
## Min.    :0.0000   Min.    :0.0000   Min.    :0.00000   Min.    :0.00000
## 1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.00000   1st Qu.:0.00000
## Median :0.0000   Median :0.0000   Median :0.00000   Median :0.00000
## Mean    :0.1901   Mean    :0.1039   Mean    :0.09151   Mean    :0.05344
## 3rd Qu.:0.0000   3rd Qu.:0.0000   3rd Qu.:0.00000   3rd Qu.:0.00000
## Max.    :1.0000   Max.    :1.0000   Max.    :1.00000   Max.    :1.00000
##
##      occ4          occ5          occ6          occ7
## Min.    :0.0000   Min.    :0.0000   Min.    :0.0000   Min.    :0.00000
## 1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.00000
## Median :0.0000   Median :0.0000   Median :0.0000   Median :0.00000
## Mean    :0.1115   Mean    :0.2142   Mean    :0.2021   Mean    :0.09197
## 3rd Qu.:0.0000   3rd Qu.:0.0000   3rd Qu.:0.0000   3rd Qu.:0.00000
## Max.    :1.0000   Max.    :1.0000   Max.    :1.0000   Max.    :1.00000
##
##      occ8          occ9          per          pro
## Min.    :0.00000   Min.    :0.0000   Min.    :0.00000   Min.    :0.00000
## 1st Qu.:0.00000   1st Qu.:0.0000   1st Qu.:0.00000   1st Qu.:0.00000
## Median :0.00000   Median :0.0000   Median :0.00000   Median :0.00000
## Mean    :0.01468   Mean    :0.1167   Mean    :0.01674   Mean    :0.07638
## 3rd Qu.:0.00000   3rd Qu.:0.0000   3rd Qu.:0.00000   3rd Qu.:0.00000
## Max.    :1.00000   Max.    :1.0000   Max.    :1.00000   Max.    :1.00000
##
##      pub          rur          south          educ

```



```
## Min. :0.00000 Min. :0.0000 Min. :0.0000 Min. : 3.00
## 1st Qu.:0.00000 1st Qu.:0.0000 1st Qu.:0.0000 1st Qu.:11.00
## Median :0.00000 Median :0.0000 Median :0.0000 Median :12.00
## Mean :0.04014 Mean :0.2039 Mean :0.3507 Mean :11.77
## 3rd Qu.:0.00000 3rd Qu.:0.0000 3rd Qu.:1.0000 3rd Qu.:12.00
## Max. :1.00000 Max. :1.0000 Max. :1.0000 Max. :16.00
##
##      tra      trad      union      lwage
## Min. :0.0000 Min. :0.0000 Min. :0.000 Min. : -3.579
## 1st Qu.:0.0000 1st Qu.:0.0000 1st Qu.:0.000 1st Qu.: 1.351
## Median :0.0000 Median :0.0000 Median :0.000 Median : 1.671
## Mean :0.0656 Mean :0.2681 Mean :0.244 Mean : 1.649
## 3rd Qu.:0.0000 3rd Qu.:1.0000 3rd Qu.:0.000 3rd Qu.: 1.991
## Max. :1.0000 Max. :1.0000 Max. :1.000 Max. : 4.052
##
##      d81      d82      d83      d84
## Min. :0.000 Min. :0.000 Min. :0.000 Min. :0.000
## 1st Qu.:0.000 1st Qu.:0.000 1st Qu.:0.000 1st Qu.:0.000
## Median :0.000 Median :0.000 Median :0.000 Median :0.000
## Mean :0.125 Mean :0.125 Mean :0.125 Mean :0.125
## 3rd Qu.:0.000 3rd Qu.:0.000 3rd Qu.:0.000 3rd Qu.:0.000
## Max. :1.000 Max. :1.000 Max. :1.000 Max. :1.000
##
##      d85      d86      d87      expersq
## Min. :0.000 Min. :0.000 Min. :0.000 Min. : 0.00
## 1st Qu.:0.000 1st Qu.:0.000 1st Qu.:0.000 1st Qu.: 16.00
## Median :0.000 Median :0.000 Median :0.000 Median : 36.00
## Mean :0.125 Mean :0.125 Mean :0.125 Mean : 50.42
## 3rd Qu.:0.000 3rd Qu.:0.000 3rd Qu.:0.000 3rd Qu.: 81.00
## Max. :1.000 Max. :1.000 Max. :1.000 Max. :324.00
##
```

```
# pooled OLS
```

```
wagepan.ols = plm(lwage ~ educ + black + hisp + exper + exper^2 + married + union, data = wagepan.panel
```

```
# fixed effects
```

```
wagepan.fe = plm(lwage ~ educ + black + hisp + exper + exper^2 + married + union, data = wagepan.panel,
```

```
stargazer(wagepan.ols, wagepan.fe, summary=T, type='text')
```

```
##
## =====
##                               Dependent variable:
##                               -----
##                               lwage
##                               (1)         (2)
## -----
## exper                        0.060***    0.060***
##                               (0.003)    (0.003)
##
## married                     0.061***    0.061***
##                               (0.018)    (0.018)
##
## union                       0.084***    0.084***
##                               (0.019)    (0.019)
```

```
##
## -----
## Observations          4,360          4,360
## R2                    0.167          0.167
## Adjusted R2           0.048          0.048
## F Statistic (df = 3; 3812) 255.026*** 255.026***
## =====
## Note:                  *p<0.1; **p<0.05; ***p<0.01
```