**AAEC 6311**

**LAB #5**

Objectives:

1. Learn to estimate panel data models

Cornell and Rupert (1988) analyzed the returns to schooling in a balanced panel of 595 observations on heads of households. The sample data are drawn from years 1976-1982 from the Panel Study of Income Dynamics.

The estimating equation is:

+

= Years of full time work experience

= Weeks worked

= 1 if blue-collar occupation, 0 if not.

= 1 if the individual works in a manufacturing industry, 0 if not.

= 1 if the individual lives in the South, 0 if not.

= 1 if the individual resides in an SMS, 0 if not.

= 1 if the individual is married, 0 if not.

= 1 if the individual wage is set by a union contract, 0 if not.

= years of education

= 1 if the individual is female, 0 if not.

= 1 if the individual is black, 0 if not.

Note that and are time invariant. The main interest of the study was . Since Ed is time invariant, fixed effects model cannot estimate this.

**Part 1. Basic Operations Using SAS**

* 1. I**mport and manipulate the data**
  2. **Calculate basic summary statistics and report results for all variables included in the model:**

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| 1. The SAS System |

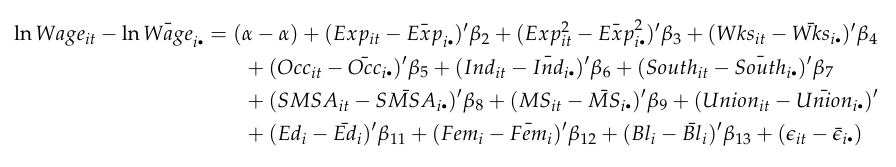
The MEANS Procedure

| **Variable** | **Label** | **N** | **Mean** | **Std Dev** | **Minimum** | **Maximum** |
| --- | --- | --- | --- | --- | --- | --- |
| |  | | --- | | **T** | | **ID** | | **EXP** | | **WKS** | | **OCC** | | **IND** | | **SOUTH** | | **SMSA** | | **MS** | | **FEM** | | **UNION** | | **ED** | | **BLK** | | **LWAGE** | | |  | | --- | | **T** | | **ID** | | **EXP** | | **WKS** | | **OCC** | | **IND** | | **SOUTH** | | **SMSA** | | **MS** | | **FEM** | | **UNION** | | **ED** | | **BLK** | | **LWAGE** | | |  | | --- | | 4165 | | 4165 | | 4165 | | 4165 | | 4165 | | 4165 | | 4165 | | 4165 | | 4165 | | 4165 | | 4165 | | 4165 | | 4165 | | 4165 | | |  | | --- | | 4.0000000 | | 298.0000000 | | 19.8537815 | | 46.8115246 | | 0.5111645 | | 0.3954382 | | 0.2902761 | | 0.6537815 | | 0.8144058 | | 0.1126050 | | 0.3639856 | | 12.8453782 | | 0.0722689 | | 6.6763464 | | |  | | --- | | 2.0002401 | | 171.7820858 | | 10.9663702 | | 5.1290982 | | 0.4999354 | | 0.4890033 | | 0.4539442 | | 0.4758210 | | 0.3888256 | | 0.3161473 | | 0.4812023 | | 2.7879950 | | 0.2589637 | | 0.4615122 | | |  | | --- | | 1.0000000 | | 1.0000000 | | 1.0000000 | | 5.0000000 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 4.0000000 | | 0 | | 4.6051700 | | |  | | --- | | 7.0000000 | | 595.0000000 | | 51.0000000 | | 52.0000000 | | 1.0000000 | | 1.0000000 | | 1.0000000 | | 1.0000000 | | 1.0000000 | | 1.0000000 | | 1.0000000 | | 17.0000000 | | 1.0000000 | | 8.5370000 | |

**Part 2. Write the three panel data models discussed in class using mathematical notation:**

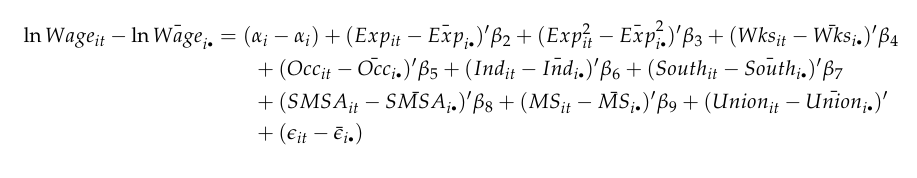
**Pooled Model**

OLS on the following:

****

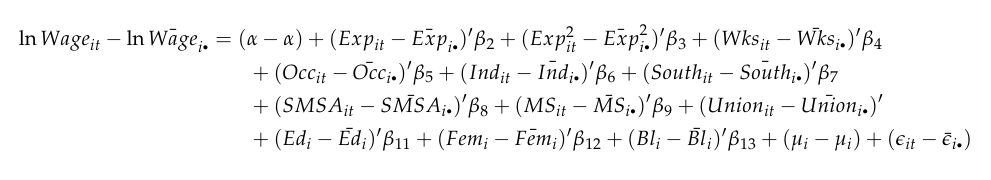
**FE Model**

OLS on the following:

****

**RE Model**

OLS on the following:

****

**Part 3. Estimation of Panel data Models using Pooled OLS.**

**3.1. Of the three panel data models discussed in class (Pooled Model, FE model and RE model), which ones can be consistently estimated using pooled OLS?**

Using pooled OLS, only the pooled model and random effects model can be consistently used to estimate . Pooled OLS is inconsistent if the model is a fixed effects model.

**3.2. Use the proc reg procedure to estimate the model using pooled OLS. Report estimation results.**

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| The SAS System |

The REG Procedure

Model: MODEL1

Dependent Variable: LWAGE LWAGE

|  |  |
| --- | --- |
| **Number of Observations Read** | 4165 |
| **Number of Observations Used** | 4165 |

| **Analysis of Variance** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **Model** | 12 | 380.13925 | 31.67827 | 259.54 | <.0001 |
| **Error** | 4152 | 506.76569 | 0.12205 |  |  |
| **Corrected Total** | 4164 | 886.90494 |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Root MSE** | 0.34936 | **R-Square** | 0.4286 |
| **Dependent Mean** | 6.67635 | **Adj R-Sq** | 0.4270 |
| **Coeff Var** | 5.23282 |  |  |

| **Parameter Estimates** | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **Label** | **DF** | **Parameter Estimate** | **Standard Error** | **t Value** | **Pr > |t|** | **Heteroscedasticity Consistent** | | |
| **Standard Error** | **t Value** | **Pr > |t|** |
| **Intercept** | Intercept | **1** | 5.25112 | 0.07129 | 73.66 | <.0001 | 0.07435 | 70.63 | <.0001 |
| **EXP** | EXP | **1** | 0.04010 | 0.00216 | 18.57 | <.0001 | 0.00216 | 18.59 | <.0001 |
| **EXP2** |  | **1** | -0.00067338 | 0.00004744 | -14.19 | <.0001 | 0.00004789 | -14.06 | <.0001 |
| **WKS** | WKS | **1** | 0.00422 | 0.00108 | 3.90 | <.0001 | 0.00114 | 3.69 | 0.0002 |
| **OCC** | OCC | **1** | -0.14001 | 0.01466 | -9.55 | <.0001 | 0.01494 | -9.37 | <.0001 |
| **IND** | IND | **1** | 0.04679 | 0.01179 | 3.97 | <.0001 | 0.01199 | 3.90 | <.0001 |
| **SOUTH** | SOUTH | **1** | -0.05564 | 0.01253 | -4.44 | <.0001 | 0.01274 | -4.37 | <.0001 |
| **SMSA** | SMSA | **1** | 0.15167 | 0.01207 | 12.57 | <.0001 | 0.01208 | 12.56 | <.0001 |
| **MS** | MS | **1** | 0.04845 | 0.02057 | 2.36 | 0.0185 | 0.02049 | 2.36 | 0.0181 |
| **FEM** | FEM | **1** | -0.36779 | 0.02510 | -14.65 | <.0001 | 0.02310 | -15.92 | <.0001 |
| **UNION** | UNION | **1** | 0.09263 | 0.01280 | 7.24 | <.0001 | 0.01233 | 7.51 | <.0001 |
| **ED** | ED | **1** | 0.05670 | 0.00261 | 21.70 | <.0001 | 0.00273 | 20.80 | <.0001 |
| **BLK** | BLK | **1** | -0.16694 | 0.02204 | -7.57 | <.0001 | 0.02075 | -8.05 | <.0001 |

**3.3. Use the proc panel procedure to estimate the model using pooled OLS. Report estimation results and compare them with the model estimated using proc reg?**

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| The SAS System |

The PANEL Procedure

Pooled (OLS) Estimates

Model: POOLED1

Dependent Variable: LWAGE (LWAGE)

| **Model Description** | |
| --- | --- |
| **Model Statement Label** | POOLED1 |
| **Estimation Method** | Pooled |
| **Number of Cross Sections** | 595 |
| **Time Series Length** | 7 |

| **Fit Statistics** | | | |
| --- | --- | --- | --- |
| **SSE** | 506.7657 | **DFE** | 4152 |
| **MSE** | 0.1221 | **Root MSE** | 0.3494 |
| **R-Square** | 0.4286 |  |  |

| **Parameter Estimates** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **DF** | **Estimate** | **Standard Error** | **t Value** | **Pr > |t|** | **Label** |
| **Intercept** | 1 | 5.251124 | 0.0713 | 73.66 | <.0001 | Intercept |
| **EXP** | 1 | 0.040105 | 0.00216 | 18.57 | <.0001 | EXP |
| **EXP2** | 1 | -0.00067 | 0.000047 | -14.19 | <.0001 |  |
| **WKS** | 1 | 0.004216 | 0.00108 | 3.90 | <.0001 | WKS |
| **OCC** | 1 | -0.14001 | 0.0147 | -9.55 | <.0001 | OCC |
| **IND** | 1 | 0.046789 | 0.0118 | 3.97 | <.0001 | IND |
| **SOUTH** | 1 | -0.05564 | 0.0125 | -4.44 | <.0001 | SOUTH |
| **SMSA** | 1 | 0.151667 | 0.0121 | 12.57 | <.0001 | SMSA |
| **MS** | 1 | 0.048449 | 0.0206 | 2.36 | 0.0185 | MS |
| **FEM** | 1 | -0.36779 | 0.0251 | -14.65 | <.0001 | FEM |
| **UNION** | 1 | 0.092627 | 0.0128 | 7.24 | <.0001 | UNION |
| **ED** | 1 | 0.056704 | 0.00261 | 21.70 | <.0001 | ED |
| **BLK** | 1 | -0.16694 | 0.0220 | -7.57 | <.0001 | BLK |

Using proc model and proc model gives us the same estimates and standard errors, save for small rounding errors.

**3.4. Using proc panel and the pooled estimator, estimate, report results and COMPARE parameter and standard errors estimated using: a) the standard var-cov matrix obtained using OLS, b) White’s HCCCM, and c) Panel Robust HCCME.**

**More information about HCCMEs for panel data model can be found here:**

[**http://documentation.sas.com/doc/en/pgmsascdc/9.4\_3.3/etsug/etsug\_panel\_details38.htm**](http://documentation.sas.com/doc/en/pgmsascdc/9.4_3.3/etsug/etsug_panel_details38.htm)

**Proc panel pooled estimator**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | OLS | | White's HCCM | | Panel Robust HCCME | |
|  | Estimate | SE | Estimate | SE | Estimate | SE |
| **Intercept** | 5.25112 | 0.0713 | 5.25112 | 0.0744 | 5.25112 | 0.1233 |
| **EXP** | 0.04011 | 0.00216 | 0.04011 | 0.00216 | 0.04011 | 0.00407 |
| **EXP2** | -0.0007 | 4.7E-05 | -0.0007 | 4.8E-05 | -0.0007 | 9.1E-05 |
| **WKS** | 0.00422 | 0.00108 | 0.00422 | 0.00114 | 0.00422 | 0.00154 |
| **OCC** | -0.14 | 0.0147 | -0.14 | 0.0149 | -0.14 | 0.0272 |
| **IND** | 0.04679 | 0.0118 | 0.04679 | 0.012 | 0.04679 | 0.0236 |
| **SOUTH** | -0.0556 | 0.0125 | -0.0556 | 0.0127 | -0.0556 | 0.0261 |
| **SMSA** | 0.15167 | 0.0121 | 0.15167 | 0.0121 | 0.15167 | 0.024 |
| **MS** | 0.04845 | 0.0206 | 0.04845 | 0.0205 | 0.04845 | 0.0409 |
| **FEM** | -0.3678 | 0.0251 | -0.3678 | 0.0231 | -0.3678 | 0.0455 |
| **UNION** | 0.09263 | 0.0128 | 0.09263 | 0.0123 | 0.09263 | 0.0236 |
| **ED** | 0.0567 | 0.00261 | 0.0567 | 0.00273 | 0.0567 | 0.00555 |
| **BLK** | -0.1669 | 0.022 | -0.1669 | 0.0207 | -0.1669 | 0.0442 |

As we can see, the estimates obtained from OLS, White’s HCCM, and panel robust HCCME results in the same coefficients. The standard errors, however, differ based on whether or not we assume homoskedasticity.

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| 1. The SAS System |

The PANEL Procedure

Pooled (OLS) Estimates

Model: POOLED1

Dependent Variable: LWAGE (LWAGE)

| **Model Description** | |
| --- | --- |
| **Model Statement Label** | POOLED1 |
| **Estimation Method** | Pooled |
| **Number of Cross Sections** | 595 |
| **Time Series Length** | 7 |

| **Fit Statistics** | | | |
| --- | --- | --- | --- |
| **SSE** | 506.7657 | **DFE** | 4152 |
| **MSE** | 0.1221 | **Root MSE** | 0.3494 |
| **R-Square** | 0.4286 |  |  |

| **Parameter Estimates** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **DF** | **Estimate** | **Standard Error** | **t Value** | **Pr > |t|** | **Label** |
| **Intercept** | 1 | 5.251124 | 0.0713 | 73.66 | <.0001 | Intercept |
| **EXP** | 1 | 0.040105 | 0.00216 | 18.57 | <.0001 | EXP |
| **EXP2** | 1 | -0.00067 | 0.000047 | -14.19 | <.0001 |  |
| **WKS** | 1 | 0.004216 | 0.00108 | 3.90 | <.0001 | WKS |
| **OCC** | 1 | -0.14001 | 0.0147 | -9.55 | <.0001 | OCC |
| **IND** | 1 | 0.046789 | 0.0118 | 3.97 | <.0001 | IND |
| **SOUTH** | 1 | -0.05564 | 0.0125 | -4.44 | <.0001 | SOUTH |
| **SMSA** | 1 | 0.151667 | 0.0121 | 12.57 | <.0001 | SMSA |
| **MS** | 1 | 0.048449 | 0.0206 | 2.36 | 0.0185 | MS |
| **FEM** | 1 | -0.36779 | 0.0251 | -14.65 | <.0001 | FEM |
| **UNION** | 1 | 0.092627 | 0.0128 | 7.24 | <.0001 | UNION |
| **ED** | 1 | 0.056704 | 0.00261 | 21.70 | <.0001 | ED |
| **BLK** | 1 | -0.16694 | 0.0220 | -7.57 | <.0001 | BLK |
| 1. The SAS System | | | | | | |

The PANEL Procedure

Pooled (OLS) Estimates

Model: POOLED2

Dependent Variable: LWAGE (LWAGE)

| **Model Description** | |
| --- | --- |
| **Model Statement Label** | POOLED2 |
| **Estimation Method** | Pooled |
| **Number of Cross Sections** | 595 |
| **Time Series Length** | 7 |
| **Hetero. Corr. Cov. Matrix Estimator** | 0 |

| **Fit Statistics** | | | |
| --- | --- | --- | --- |
| **SSE** | 506.7657 | **DFE** | 4152 |
| **MSE** | 0.1221 | **Root MSE** | 0.3494 |
| **R-Square** | 0.4286 |  |  |

| **Parameter Estimates** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **DF** | **Estimate** | **Standard Error** | **t Value** | **Pr > |t|** | **Label** |
| **Intercept** | 1 | 5.251124 | 0.0744 | 70.63 | <.0001 | Intercept |
| **EXP** | 1 | 0.040105 | 0.00216 | 18.59 | <.0001 | EXP |
| **EXP2** | 1 | -0.00067 | 0.000048 | -14.06 | <.0001 |  |
| **WKS** | 1 | 0.004216 | 0.00114 | 3.69 | 0.0002 | WKS |
| **OCC** | 1 | -0.14001 | 0.0149 | -9.37 | <.0001 | OCC |
| **IND** | 1 | 0.046789 | 0.0120 | 3.90 | <.0001 | IND |
| **SOUTH** | 1 | -0.05564 | 0.0127 | -4.37 | <.0001 | SOUTH |
| **SMSA** | 1 | 0.151667 | 0.0121 | 12.56 | <.0001 | SMSA |
| **MS** | 1 | 0.048449 | 0.0205 | 2.36 | 0.0181 | MS |
| **FEM** | 1 | -0.36779 | 0.0231 | -15.92 | <.0001 | FEM |
| **UNION** | 1 | 0.092627 | 0.0123 | 7.51 | <.0001 | UNION |
| **ED** | 1 | 0.056704 | 0.00273 | 20.80 | <.0001 | ED |
| **BLK** | 1 | -0.16694 | 0.0207 | -8.05 | <.0001 | BLK |
| 1. The SAS System | | | | | | |

The PANEL Procedure

Pooled (OLS) Estimates

Model: POOLED3

Dependent Variable: LWAGE (LWAGE)

| **Model Description** | |
| --- | --- |
| **Model Statement Label** | POOLED3 |
| **Estimation Method** | Pooled |
| **Number of Cross Sections** | 595 |
| **Time Series Length** | 7 |
| **Hetero. Corr. Cov. Matrix Estimator** | 4 |

| **Fit Statistics** | | | |
| --- | --- | --- | --- |
| **SSE** | 506.7657 | **DFE** | 4152 |
| **MSE** | 0.1221 | **Root MSE** | 0.3494 |
| **R-Square** | 0.4286 |  |  |

| **Parameter Estimates** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **DF** | **Estimate** | **Standard Error** | **t Value** | **Pr > |t|** | **Label** |
| **Intercept** | 1 | 5.251124 | 0.1233 | 42.60 | <.0001 | Intercept |
| **EXP** | 1 | 0.040105 | 0.00407 | 9.86 | <.0001 | EXP |
| **EXP2** | 1 | -0.00067 | 0.000091 | -7.39 | <.0001 |  |
| **WKS** | 1 | 0.004216 | 0.00154 | 2.74 | 0.0062 | WKS |
| **OCC** | 1 | -0.14001 | 0.0272 | -5.15 | <.0001 | OCC |
| **IND** | 1 | 0.046789 | 0.0236 | 1.98 | 0.0476 | IND |
| **SOUTH** | 1 | -0.05564 | 0.0261 | -2.13 | 0.0331 | SOUTH |
| **SMSA** | 1 | 0.151667 | 0.0240 | 6.31 | <.0001 | SMSA |
| **MS** | 1 | 0.048449 | 0.0409 | 1.19 | 0.2357 | MS |
| **FEM** | 1 | -0.36779 | 0.0455 | -8.09 | <.0001 | FEM |
| **UNION** | 1 | 0.092627 | 0.0236 | 3.92 | <.0001 | UNION |
| **ED** | 1 | 0.056704 | 0.00555 | 10.21 | <.0001 | ED |
| **BLK** | 1 | -0.16694 | 0.0442 | -3.77 | 0.0002 | BLK |

**Part 4. Estimation of the Panel data Models using the Between Estimator.**

**4.1. Of the three panel data models discussed in class (Pooled Model, FE model and RE model), which ones can be consistently estimated using the Between Estimator?**

The between estimator can only be used to consistently estimate the pooled model and random effects model. The between estimator is inconsistent in estimating the fixed effects model.

4.2. Using proc panel and the Between estimator, estimate, report and **COMPARE** parameter and standard errors using: a) the standard var-cov matrix obtained using OLS, b) White’s HCCCM, and c) Panel Robust HCCME.

**Proc panel between estimator**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | OLS | | White's HCCM | | Panel Robust HCCME | |
|  | Estimate | SE | Estimate | SE | Estimate | SE |
| **Intercept** | 5.12143 | 0.2042 | 5.12143 | 0.2078 | 5.12143 | 0.2078 |
| **EXP** | 0.0319 | 0.00478 | 0.0319 | 0.0046 | 0.0319 | 0.0046 |
| **EXP2** | -0.0006 | 0.00011 | -0.0006 | 0.0001 | -0.0006 | 0.0001 |
| **WKS** | 0.00919 | 0.0036 | 0.00919 | 0.00358 | 0.00919 | 0.00358 |
| **OCC** | -0.1676 | 0.0338 | -0.1676 | 0.0334 | -0.1676 | 0.0334 |
| **IND** | 0.05792 | 0.0255 | 0.05792 | 0.0264 | 0.05792 | 0.0264 |
| **SOUTH** | -0.0571 | 0.026 | -0.0571 | 0.0266 | -0.0571 | 0.0266 |
| **SMSA** | 0.17578 | 0.0258 | 0.17578 | 0.0254 | 0.17578 | 0.0254 |
| **MS** | 0.11478 | 0.0477 | 0.11478 | 0.0499 | 0.11478 | 0.0499 |
| **FEM** | -0.3171 | 0.0547 | -0.3171 | 0.051 | -0.3171 | 0.051 |
| **UNION** | 0.10907 | 0.0292 | 0.10907 | 0.0283 | 0.10907 | 0.0283 |
| **ED** | 0.05144 | 0.00555 | 0.05144 | 0.00586 | 0.05144 | 0.00586 |
| **BLK** | -0.1578 | 0.045 | -0.1578 | 0.0435 | -0.1578 | 0.0435 |

Again, like in the proc panel pooled estimator, the estimates for our coefficients between OLS, White’s HCCM, and the panel robust HCCME remains the same. However, the standard errors differ depending on whether or not we assume homoskedasticity.

a.)

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| The SAS System |

The PANEL Procedure

Between-Groups Estimates

Model: BTWNG1

Dependent Variable: LWAGE (LWAGE)

| **Model Description** | |
| --- | --- |
| **Model Statement Label** | BTWNG1 |
| **Estimation Method** | BtwGrps |
| **Number of Cross Sections** | 595 |
| **Time Series Length** | 7 |

| **Fit Statistics** | | | |
| --- | --- | --- | --- |
| **SSE** | 42.0726 | **DFE** | 582 |
| **MSE** | 0.0723 | **Root MSE** | 0.2689 |
| **R-Square** | 0.5443 |  |  |

| **Parameter Estimates** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **DF** | **Estimate** | **Standard Error** | **t Value** | **Pr > |t|** | **Label** |
| **Intercept** | 1 | 5.121431 | 0.2042 | 25.07 | <.0001 | Intercept |
| **EXP** | 1 | 0.031901 | 0.00478 | 6.68 | <.0001 | EXP |
| **EXP2** | 1 | -0.00057 | 0.000105 | -5.39 | <.0001 |  |
| **WKS** | 1 | 0.009189 | 0.00360 | 2.55 | 0.0110 | WKS |
| **OCC** | 1 | -0.16762 | 0.0338 | -4.96 | <.0001 | OCC |
| **IND** | 1 | 0.057918 | 0.0255 | 2.27 | 0.0237 | IND |
| **SOUTH** | 1 | -0.05705 | 0.0260 | -2.20 | 0.0284 | SOUTH |
| **SMSA** | 1 | 0.175775 | 0.0258 | 6.82 | <.0001 | SMSA |
| **MS** | 1 | 0.114782 | 0.0477 | 2.41 | 0.0164 | MS |
| **FEM** | 1 | -0.31706 | 0.0547 | -5.79 | <.0001 | FEM |
| **UNION** | 1 | 0.109069 | 0.0292 | 3.73 | 0.0002 | UNION |
| **ED** | 1 | 0.051436 | 0.00555 | 9.26 | <.0001 | ED |
| **BLK** | 1 | -0.1578 | 0.0450 | -3.51 | 0.0005 | BLK |

b.)

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| --- |
| The SAS System |

The PANEL Procedure

Between-Groups Estimates

Model: BTWNG2

Dependent Variable: LWAGE (LWAGE)

| **Model Description** | |
| --- | --- |
| **Model Statement Label** | BTWNG2 |
| **Estimation Method** | BtwGrps |
| **Number of Cross Sections** | 595 |
| **Time Series Length** | 7 |
| **Hetero. Corr. Cov. Matrix Estimator** | 0 |

| **Fit Statistics** | | | |
| --- | --- | --- | --- |
| **SSE** | 42.0726 | **DFE** | 582 |
| **MSE** | 0.0723 | **Root MSE** | 0.2689 |
| **R-Square** | 0.5443 |  |  |

| **Parameter Estimates** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **DF** | **Estimate** | **Standard Error** | **t Value** | **Pr > |t|** | **Label** |
| **Intercept** | 1 | 5.121431 | 0.2078 | 24.65 | <.0001 | Intercept |
| **EXP** | 1 | 0.031901 | 0.00460 | 6.94 | <.0001 | EXP |
| **EXP2** | 1 | -0.00057 | 0.000102 | -5.55 | <.0001 |  |
| **WKS** | 1 | 0.009189 | 0.00358 | 2.57 | 0.0105 | WKS |
| **OCC** | 1 | -0.16762 | 0.0334 | -5.02 | <.0001 | OCC |
| **IND** | 1 | 0.057918 | 0.0264 | 2.20 | 0.0284 | IND |
| **SOUTH** | 1 | -0.05705 | 0.0266 | -2.14 | 0.0324 | SOUTH |
| **SMSA** | 1 | 0.175775 | 0.0254 | 6.92 | <.0001 | SMSA |
| **MS** | 1 | 0.114782 | 0.0499 | 2.30 | 0.0218 | MS |
| **FEM** | 1 | -0.31706 | 0.0510 | -6.21 | <.0001 | FEM |
| **UNION** | 1 | 0.109069 | 0.0283 | 3.85 | 0.0001 | UNION |
| **ED** | 1 | 0.051436 | 0.00586 | 8.77 | <.0001 | ED |
| **BLK** | 1 | -0.1578 | 0.0435 | -3.63 | 0.0003 | BLK |

c.)

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| The SAS System |

The PANEL Procedure

Between-Groups Estimates

Model: BTWNG3

Dependent Variable: LWAGE (LWAGE)

| **Model Description** | |
| --- | --- |
| **Model Statement Label** | BTWNG3 |
| **Estimation Method** | BtwGrps |
| **Number of Cross Sections** | 595 |
| **Time Series Length** | 7 |
| **Hetero. Corr. Cov. Matrix Estimator** | 0 |

| **Fit Statistics** | | | |
| --- | --- | --- | --- |
| **SSE** | 42.0726 | **DFE** | 582 |
| **MSE** | 0.0723 | **Root MSE** | 0.2689 |
| **R-Square** | 0.5443 |  |  |

| **Parameter Estimates** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **DF** | **Estimate** | **Standard Error** | **t Value** | **Pr > |t|** | **Label** |
| **Intercept** | 1 | 5.121431 | 0.2078 | 24.65 | <.0001 | Intercept |
| **EXP** | 1 | 0.031901 | 0.00460 | 6.94 | <.0001 | EXP |
| **EXP2** | 1 | -0.00057 | 0.000102 | -5.55 | <.0001 |  |
| **WKS** | 1 | 0.009189 | 0.00358 | 2.57 | 0.0105 | WKS |
| **OCC** | 1 | -0.16762 | 0.0334 | -5.02 | <.0001 | OCC |
| **IND** | 1 | 0.057918 | 0.0264 | 2.20 | 0.0284 | IND |
| **SOUTH** | 1 | -0.05705 | 0.0266 | -2.14 | 0.0324 | SOUTH |
| **SMSA** | 1 | 0.175775 | 0.0254 | 6.92 | <.0001 | SMSA |
| **MS** | 1 | 0.114782 | 0.0499 | 2.30 | 0.0218 | MS |
| **FEM** | 1 | -0.31706 | 0.0510 | -6.21 | <.0001 | FEM |
| **UNION** | 1 | 0.109069 | 0.0283 | 3.85 | 0.0001 | UNION |
| **ED** | 1 | 0.051436 | 0.00586 | 8.77 | <.0001 | ED |
| **BLK** | 1 | -0.1578 | 0.0435 | -3.63 | 0.0003 | BLK |

**Part 5. Estimation of the Panel data Models using the FE (or Within) Estimator.**

**5.1. Of the three panel data models discussed in class (Pooled Model, FE model and RE model), which ones can be consistently estimated using the FE Estimator?**

The fixed effects estimator can consistently estimate for all three models: pooled model, fixed effects model, and random effects model.

**5.2. Is it possible to estimate all the model parameters using the FE estimator?**

No, the fixed effect estimator cannot estimate the parameters of time invariant variables.

5.2. Using proc panel and the FE estimator, estimate, report results and **COMPARE** parameters and standard errors using: a) the standard var-cov matrix obtained using OLS, b) White’s HCCCM, and c) Panel Robust HCCME.

**Proc panel fixed effects estimator**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | OLS | | White's HCCM | | Panel Robust HCCME | |
|  | Estimate | SE | Estimate | SE | Estimate | SE |
| **Intercept** | 5.61891 | 0.0681 | 5.61891 | 0.0468 | 5.61891 | 0.0551 |
| **EXP** | 0.11321 | 0.00247 | 0.11321 | 0.0026 | 0.11321 | 0.00404 |
| **EXP2** | -0.0004 | 5.5E-05 | -0.0004 | 5.4E-05 | -0.0004 | 8.2E-05 |
| **WKS** | 0.00084 | 0.0006 | 0.00084 | 0.00075 | 0.00084 | 0.00086 |
| **OCC** | -0.0215 | 0.0138 | -0.0215 | 0.0128 | -0.0215 | 0.019 |
| **IND** | 0.01921 | 0.0154 | 0.01921 | 0.0159 | 0.01921 | 0.0226 |
| **SOUTH** | -0.0019 | 0.0343 | -0.0019 | 0.058 | -0.0019 | 0.0891 |
| **SMSA** | -0.0425 | 0.0194 | -0.0425 | 0.024 | -0.0425 | 0.0294 |
| **MS** | -0.0297 | 0.019 | -0.0297 | 0.0164 | -0.0297 | 0.0268 |
| **UNION** | 0.03279 | 0.0149 | 0.03279 | 0.0158 | 0.03279 | 0.025 |

Like in our previous two estimators, the fixed effects estimator results in the same coefficients using OLS, White’s HCCM, and the panel robust HCCME. The standard errors, again, differ depending on whether or not we assume homoskedasticity.

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| The SAS System |

The PANEL Procedure

Fixed One-Way Estimates

Model: FE1

Dependent Variable: LWAGE (LWAGE)

| **Model Description** | |
| --- | --- |
| **Model Statement Label** | FE1 |
| **Estimation Method** | FixOne |
| **Number of Cross Sections** | 595 |
| **Time Series Length** | 7 |

| **Fit Statistics** | | | |
| --- | --- | --- | --- |
| **SSE** | 82.2673 | **DFE** | 3561 |
| **MSE** | 0.0231 | **Root MSE** | 0.1520 |
| **R-Square** | 0.9072 |  |  |

| **F Test for No Fixed Effects** | | | |
| --- | --- | --- | --- |
| **Num DF** | **Den DF** | **F Value** | **Pr > F** |
| 594 | 3561 | 38.25 | <.0001 |

| **Parameter Estimates** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **DF** | **Estimate** | **Standard Error** | **t Value** | **Pr > |t|** | **Label** |
| **Intercept** | 1 | 5.618905 | 0.0681 | 82.49 | <.0001 | Intercept |
| **EXP** | 1 | 0.113208 | 0.00247 | 45.81 | <.0001 | EXP |
| **EXP2** | 1 | -0.00042 | 0.000055 | -7.66 | <.0001 |  |
| **WKS** | 1 | 0.000836 | 0.000600 | 1.39 | 0.1634 | WKS |
| **OCC** | 1 | -0.02148 | 0.0138 | -1.56 | 0.1193 | OCC |
| **IND** | 1 | 0.01921 | 0.0154 | 1.24 | 0.2137 | IND |
| **SOUTH** | 1 | -0.00186 | 0.0343 | -0.05 | 0.9567 | SOUTH |
| **SMSA** | 1 | -0.04247 | 0.0194 | -2.19 | 0.0289 | SMSA |
| **MS** | 1 | -0.02973 | 0.0190 | -1.57 | 0.1175 | MS |
| **UNION** | 1 | 0.032785 | 0.0149 | 2.20 | 0.0281 | UNION |

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| The SAS System |

The PANEL Procedure

Fixed One-Way Estimates

Model: FE2

Dependent Variable: LWAGE (LWAGE)

| **Model Description** | |
| --- | --- |
| **Model Statement Label** | FE2 |
| **Estimation Method** | FixOne |
| **Number of Cross Sections** | 595 |
| **Time Series Length** | 7 |
| **Hetero. Corr. Cov. Matrix Estimator** | 0 |

| **Fit Statistics** | | | |
| --- | --- | --- | --- |
| **SSE** | 82.2673 | **DFE** | 3561 |
| **MSE** | 0.0231 | **Root MSE** | 0.1520 |
| **R-Square** | 0.9072 |  |  |

| **F Test for No Fixed Effects** | | | |
| --- | --- | --- | --- |
| **Num DF** | **Den DF** | **F Value** | **Pr > F** |
| 594 | 3561 | 38.25 | <.0001 |

| **Parameter Estimates** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **DF** | **Estimate** | **Standard Error** | **t Value** | **Pr > |t|** | **Label** |
| **Intercept** | 1 | 5.618905 | 0.0468 | 120.15 | <.0001 | Intercept |
| **EXP** | 1 | 0.113208 | 0.00260 | 43.54 | <.0001 | EXP |
| **EXP2** | 1 | -0.00042 | 0.000054 | -7.74 | <.0001 |  |
| **WKS** | 1 | 0.000836 | 0.000752 | 1.11 | 0.2662 | WKS |
| **OCC** | 1 | -0.02148 | 0.0128 | -1.67 | 0.0945 | OCC |
| **IND** | 1 | 0.01921 | 0.0159 | 1.21 | 0.2273 | IND |
| **SOUTH** | 1 | -0.00186 | 0.0580 | -0.03 | 0.9744 | SOUTH |
| **SMSA** | 1 | -0.04247 | 0.0240 | -1.77 | 0.0770 | SMSA |
| **MS** | 1 | -0.02973 | 0.0164 | -1.81 | 0.0701 | MS |
| **UNION** | 1 | 0.032785 | 0.0158 | 2.07 | 0.0384 | UNION |

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| The SAS System |

The PANEL Procedure

Fixed One-Way Estimates

Model: FE3

Dependent Variable: LWAGE (LWAGE)

| **Model Description** | |
| --- | --- |
| **Model Statement Label** | FE3 |
| **Estimation Method** | FixOne |
| **Number of Cross Sections** | 595 |
| **Time Series Length** | 7 |
| **Hetero. Corr. Cov. Matrix Estimator** | 4 |

| **Fit Statistics** | | | |
| --- | --- | --- | --- |
| **SSE** | 82.2673 | **DFE** | 3561 |
| **MSE** | 0.0231 | **Root MSE** | 0.1520 |
| **R-Square** | 0.9072 |  |  |

| **F Test for No Fixed Effects** | | | |
| --- | --- | --- | --- |
| **Num DF** | **Den DF** | **F Value** | **Pr > F** |
| 594 | 3561 | 38.25 | <.0001 |

| **Parameter Estimates** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **DF** | **Estimate** | **Standard Error** | **t Value** | **Pr > |t|** | **Label** |
| **Intercept** | 1 | 5.618905 | 0.0551 | 101.89 | <.0001 | Intercept |
| **EXP** | 1 | 0.113208 | 0.00404 | 28.01 | <.0001 | EXP |
| **EXP2** | 1 | -0.00042 | 0.000082 | -5.08 | <.0001 |  |
| **WKS** | 1 | 0.000836 | 0.000864 | 0.97 | 0.3334 | WKS |
| **OCC** | 1 | -0.02148 | 0.0190 | -1.13 | 0.2574 | OCC |
| **IND** | 1 | 0.01921 | 0.0226 | 0.85 | 0.3962 | IND |
| **SOUTH** | 1 | -0.00186 | 0.0891 | -0.02 | 0.9833 | SOUTH |
| **SMSA** | 1 | -0.04247 | 0.0294 | -1.44 | 0.1490 | SMSA |
| **MS** | 1 | -0.02973 | 0.0268 | -1.11 | 0.2678 | MS |
| **UNION** | 1 | 0.032785 | 0.0250 | 1.31 | 0.1901 | UNION |

**5.3. Interpret the results of the F-test testing the significance of individual (or group effects).**

H0: All fixed effects are jointly zero

Ha: All fixed effects are not jointly zero

Since the f-statistic is 38.25, which is a p-value of less than 0.0001, we have evidence to rejected our null hypothesis and conclude that all fixed effects are not jointly zero, and that there is evidence to use the fixed effects model.

**Part 6. Estimation of the Panel data Models using the RE Estimator.**

**6.1. Of the three panel data models discussed in class (Pooled Model, FE model and RE model), which ones can be consistently estimated using the RE Estimator?**

Only the pooled and random effects model can be consistently estimated using the random effects estimator. The fixed effects model cannot be estimated using the random effects estimator.

6.2. Using proc panel and the RE estimator, estimate, report results and **COMPARE** parameter estimates and standard errors using: a) the standard var-cov matrix obtained using OLS, b) White’s HCCCM, and c) Panel Robust HCCME.

**Proc panel random effects estimator**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | OLS | | White's HCCM | | Panel Robust HCCME | |
|  | Estimate | SE | Estimate | SE | Estimate | SE |
| **Intercept** | 3.03059 | 0.2089 | 3.03059 | 0.2193 | 3.03059 | 0.202 |
| **EXP** | 0.10915 | 0.00241 | 0.10915 | 0.00263 | 0.10915 | 0.00397 |
| **EXP2** | -0.0005 | 5.3E-05 | -0.0005 | 5.6E-05 | -0.0005 | 8.2E-05 |
| **WKS** | 0.00084 | 0.00059 | 0.00084 | 0.0008 | 0.00084 | 0.00086 |
| **OCC** | -0.0239 | 0.0135 | -0.0239 | 0.0131 | -0.0239 | 0.0187 |
| **IND** | 0.01545 | 0.015 | 0.01545 | 0.0161 | 0.01545 | 0.0222 |
| **SOUTH** | 0.0042 | 0.0317 | 0.0042 | 0.053 | 0.0042 | 0.0802 |
| **SMSA** | -0.0464 | 0.0187 | -0.0464 | 0.0234 | -0.0464 | 0.0291 |
| **MS** | -0.0377 | 0.0186 | -0.0377 | 0.0172 | -0.0377 | 0.026 |
| **FEM** | -0.1611 | 0.136 | -0.1611 | 0.1269 | -0.1611 | 0.109 |
| **UNION** | 0.03678 | 0.0145 | 0.03678 | 0.0162 | 0.03678 | 0.0248 |
| **ED** | 0.13846 | 0.0152 | 0.13846 | 0.0161 | 0.13846 | 0.0132 |
| **BLK** | -0.2657 | 0.166 | -0.2657 | 0.1533 | -0.2657 | 0.1575 |

The coefficients obtained for the random effects estimator is consistent throughout using OLS, White’s HCCM, and the panel robust HCCME. The standard errors differ depending on whether or not we assume homoskedasticity.

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| The SAS System |

The PANEL Procedure

Wansbeek and Kapteyn Variance Components (RanOne)

Model: RE1

Dependent Variable: LWAGE (LWAGE)

| **Model Description** | |
| --- | --- |
| **Model Statement Label** | RE1 |
| **Estimation Method** | RanOne |
| **Number of Cross Sections** | 595 |
| **Time Series Length** | 7 |

| **Fit Statistics** | | | |
| --- | --- | --- | --- |
| **SSE** | 92.8739 | **DFE** | 4152 |
| **MSE** | 0.0224 | **Root MSE** | 0.1496 |
| **R-Square** | 0.6172 |  |  |

| **Variance Component Estimates** | |
| --- | --- |
| **Variance Component for Cross Sections** | 1.064748 |
| **Variance Component for Error** | 0.023102 |

| **Hausman Test for Random Effects** | | | |
| --- | --- | --- | --- |
| **Coefficients** | **DF** | **m Value** | **Pr > m** |
| 9 | 9 | 303.40 | <.0001 |

| **Breusch Pagan Test for Random Effects (One Way)** | | |
| --- | --- | --- |
| **DF** | **m Value** | **Pr > m** |
| 1 | 3497.02 | <.0001 |

| **Parameter Estimates** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **DF** | **Estimate** | **Standard Error** | **t Value** | **Pr > |t|** | **Label** |
| **Intercept** | 1 | 3.03059 | 0.2089 | 14.50 | <.0001 | Intercept |
| **EXP** | 1 | 0.109147 | 0.00241 | 45.37 | <.0001 | EXP |
| **EXP2** | 1 | -0.00048 | 0.000053 | -9.11 | <.0001 |  |
| **WKS** | 1 | 0.000838 | 0.000589 | 1.42 | 0.1553 | WKS |
| **OCC** | 1 | -0.02385 | 0.0135 | -1.77 | 0.0769 | OCC |
| **IND** | 1 | 0.015445 | 0.0150 | 1.03 | 0.3034 | IND |
| **SOUTH** | 1 | 0.004196 | 0.0317 | 0.13 | 0.8948 | SOUTH |
| **SMSA** | 1 | -0.0464 | 0.0187 | -2.48 | 0.0131 | SMSA |
| **MS** | 1 | -0.03769 | 0.0186 | -2.03 | 0.0424 | MS |
| **FEM** | 1 | -0.16106 | 0.1360 | -1.18 | 0.2365 | FEM |
| **UNION** | 1 | 0.036783 | 0.0145 | 2.53 | 0.0114 | UNION |
| **ED** | 1 | 0.138457 | 0.0152 | 9.09 | <.0001 | ED |
| **BLK** | 1 | -0.26569 | 0.1660 | -1.60 | 0.1096 | BLK |

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| The SAS System |

The PANEL Procedure

Wansbeek and Kapteyn Variance Components (RanOne)

Model: RE2

Dependent Variable: LWAGE (LWAGE)

| **Model Description** | |
| --- | --- |
| **Model Statement Label** | RE2 |
| **Estimation Method** | RanOne |
| **Number of Cross Sections** | 595 |
| **Time Series Length** | 7 |
| **Hetero. Corr. Cov. Matrix Estimator** | 0 |

| **Fit Statistics** | | | |
| --- | --- | --- | --- |
| **SSE** | 92.8739 | **DFE** | 4152 |
| **MSE** | 0.0224 | **Root MSE** | 0.1496 |
| **R-Square** | 0.6172 |  |  |

| **Variance Component Estimates** | |
| --- | --- |
| **Variance Component for Cross Sections** | 1.064748 |
| **Variance Component for Error** | 0.023102 |

| **Hausman Test for Random Effects** | | | |
| --- | --- | --- | --- |
| **Coefficients** | **DF** | **m Value** | **Pr > m** |
| 9 | 9 | 25.76 | 0.0022 |

| **Parameter Estimates** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **DF** | **Estimate** | **Standard Error** | **t Value** | **Pr > |t|** | **Label** |
| **Intercept** | 1 | 3.03059 | 0.2193 | 13.82 | <.0001 | Intercept |
| **EXP** | 1 | 0.109147 | 0.00263 | 41.44 | <.0001 | EXP |
| **EXP2** | 1 | -0.00048 | 0.000056 | -8.66 | <.0001 |  |
| **WKS** | 1 | 0.000838 | 0.000795 | 1.05 | 0.2922 | WKS |
| **OCC** | 1 | -0.02385 | 0.0131 | -1.82 | 0.0692 | OCC |
| **IND** | 1 | 0.015445 | 0.0161 | 0.96 | 0.3367 | IND |
| **SOUTH** | 1 | 0.004196 | 0.0530 | 0.08 | 0.9369 | SOUTH |
| **SMSA** | 1 | -0.0464 | 0.0234 | -1.98 | 0.0479 | SMSA |
| **MS** | 1 | -0.03769 | 0.0172 | -2.20 | 0.0281 | MS |
| **FEM** | 1 | -0.16106 | 0.1269 | -1.27 | 0.2045 | FEM |
| **UNION** | 1 | 0.036783 | 0.0162 | 2.27 | 0.0231 | UNION |
| **ED** | 1 | 0.138457 | 0.0161 | 8.62 | <.0001 | ED |
| **BLK** | 1 | -0.26569 | 0.1533 | -1.73 | 0.0832 | BLK |

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| The SAS System |

The PANEL Procedure

Wansbeek and Kapteyn Variance Components (RanOne)

Model: RE3

Dependent Variable: LWAGE (LWAGE)

| **Model Description** | |
| --- | --- |
| **Model Statement Label** | RE3 |
| **Estimation Method** | RanOne |
| **Number of Cross Sections** | 595 |
| **Time Series Length** | 7 |
| **Hetero. Corr. Cov. Matrix Estimator** | 4 |

| **Fit Statistics** | | | |
| --- | --- | --- | --- |
| **SSE** | 92.8739 | **DFE** | 4152 |
| **MSE** | 0.0224 | **Root MSE** | 0.1496 |
| **R-Square** | 0.6172 |  |  |

| **Variance Component Estimates** | |
| --- | --- |
| **Variance Component for Cross Sections** | 1.064748 |
| **Variance Component for Error** | 0.023102 |

| **Hausman Test for Random Effects** | | | |
| --- | --- | --- | --- |
| **Coefficients** | **DF** | **m Value** | **Pr > m** |
| 9 | 9 | . | . |

| **Parameter Estimates** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **DF** | **Estimate** | **Standard Error** | **t Value** | **Pr > |t|** | **Label** |
| **Intercept** | 1 | 3.03059 | 0.2020 | 15.00 | <.0001 | Intercept |
| **EXP** | 1 | 0.109147 | 0.00397 | 27.52 | <.0001 | EXP |
| **EXP2** | 1 | -0.00048 | 0.000082 | -5.94 | <.0001 |  |
| **WKS** | 1 | 0.000838 | 0.000861 | 0.97 | 0.3307 | WKS |
| **OCC** | 1 | -0.02385 | 0.0187 | -1.28 | 0.2023 | OCC |
| **IND** | 1 | 0.015445 | 0.0222 | 0.70 | 0.4861 | IND |
| **SOUTH** | 1 | 0.004196 | 0.0802 | 0.05 | 0.9583 | SOUTH |
| **SMSA** | 1 | -0.0464 | 0.0291 | -1.59 | 0.1108 | SMSA |
| **MS** | 1 | -0.03769 | 0.0260 | -1.45 | 0.1469 | MS |
| **FEM** | 1 | -0.16106 | 0.1090 | -1.48 | 0.1395 | FEM |
| **UNION** | 1 | 0.036783 | 0.0248 | 1.48 | 0.1386 | UNION |
| **ED** | 1 | 0.138457 | 0.0132 | 10.49 | <.0001 | ED |
| **BLK** | 1 | -0.26569 | 0.1575 | -1.69 | 0.0917 | BLK |

**6.3. Interpret the results of the Breusch Pagan test for Random Effects and the Hausman test for the RE model.**

BP test:

H0:

Since our m-value is 3479 and is significant, we have evidence to reject our null hypothesis and to conclude there is evidence to suggest that there is heterogeneity and that we should use the random effects model.

Hausman Test

Since our m-value is 303.40 and is significant, we have evidence to reject our null hypothesis and to conclude there is evidence that the estimates for our random effects and fixed effects estimators are different. We have evidence to suggest that we should use the fixed effects model.

**Part 7. Overall Comparison of Models and Conclusions**

7.1. Construct a Table that includes the parameter estimates and panel robust standard errors of models estimated using Pooled, FE and RE estimators. Evaluate the overall robustness of the results (i.e., evaluate changes in parameter estimates and standard error values).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Pooled | | FE | | RE | |
|  | Estimate | SE | Estimate | SE | Estimate | SE |
| **Intercept** | 5.25112 | 0.1233 | 5.61891 | 0.0551 | 3.03059 | 0.202 |
| **EXP** | 0.04011 | 0.00407 | 0.11321 | 0.00404 | 0.10915 | 0.00397 |
| **EXP2** | -0.0007 | 9.1E-05 | -0.0004 | 8.2E-05 | -0.0005 | 8.2E-05 |
| **WKS** | 0.00422 | 0.00154 | 0.00084 | 0.00086 | 0.00084 | 0.00086 |
| **OCC** | -0.14 | 0.0272 | -0.0215 | 0.019 | -0.0239 | 0.0187 |
| **IND** | 0.04679 | 0.0236 | 0.01921 | 0.0226 | 0.01545 | 0.0222 |
| **SOUTH** | -0.0556 | 0.0261 | -0.0019 | 0.0891 | 0.0042 | 0.0802 |
| **SMSA** | 0.15167 | 0.024 | -0.0425 | 0.0294 | -0.0464 | 0.0291 |
| **MS** | 0.04845 | 0.0409 | -0.0297 | 0.0268 | -0.0377 | 0.026 |
| **FEM** | -0.3678 | 0.0455 |  |  | -0.1611 | 0.109 |
| **UNION** | 0.09263 | 0.0236 | 0.03279 | 0.025 | 0.03678 | 0.0248 |
| **ED** | 0.0567 | 0.00555 |  |  | 0.13846 | 0.0132 |
| **BLK** | -0.1669 | 0.0442 |  |  | -0.2657 | 0.1575 |

As we can see, depending on the estimators we used, the coefficients and standard errors obtained vary across every variable. Generally, the random effects estimator obtains consistently smaller coefficients for our estimates. This theoretically makes sense, since we are separating individual specific random effects .

On a related note, the estimates obtained from the fixed effects estimator is generally larger than the other two estimators since we have removed 3 variables since they were time invariant. This could mean that the remaining variables explain more of the effect on wages or that the unobservable error term term would be larger.

7.2. Based on the three specification tests performed previously, what would be your preferred model?

From our three tests, if we do not care about the time invariant variables, we should use the fixed effects models for this panel data. From our Hausman test, we had evidence to conclude that the probability limits of our estimates from the random effects estimator and fixed effects estimator are not the same.

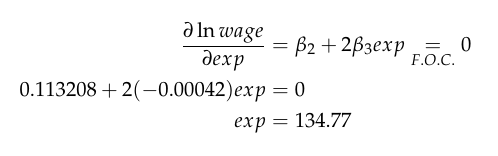
However, if the main interest of this study is still on the effects of education (), then we must choose between pooled and random effects model in order to obtain the coefficient of the effects of education on wages. From our BP test, since we rejected the null, we find there is evidence of heterogeneity, therefore, the random effects model is better than the pooled model, and that the random effects model would be appropriate for capturing this heterogeneity.

7.3. Use the parameters of YOUR PREFFERRED model to:

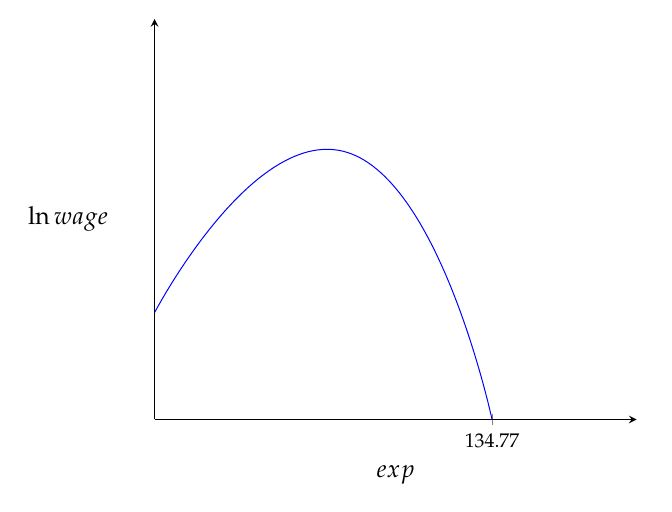
1. Sketch the relationship between experience and wages

Because our model includes both and , our model predicts decreasing returns for experience, therefore we must calculate the following change in wage from a change in experience:

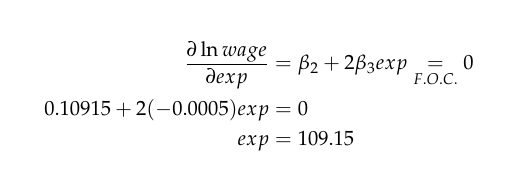
For the fixed effects model:



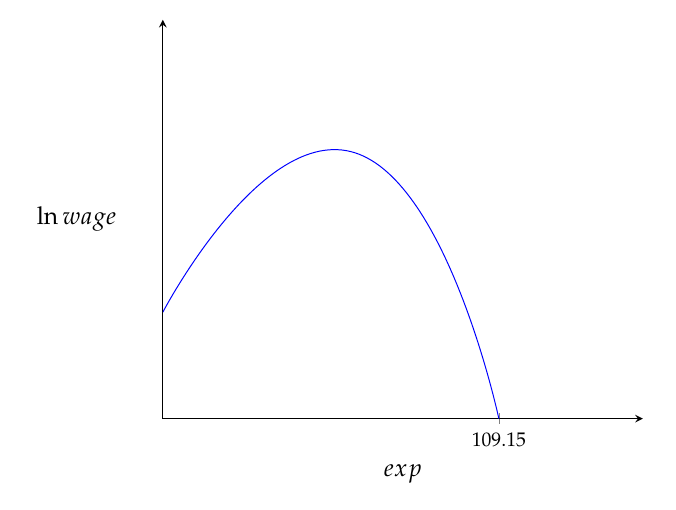
Therefore, on average, we expect the effect of experience on wages to increase from years 0-134.77, then decrease thereafter, ceteris paribus. Graphically, the effect of experience on wages should look something like the following:



For the random effects model:



Therefore, on average, we expect the effect of experience on wages to increase from years 0-109.15, then decrease thereafter, ceteris paribus. And graphically, the effect of experience on wages would look similar to the fixed effects model:



1. Estimate the effect on wages of an additional year of experience

* For the fixed effect model, on average, every additional year of experience increases wages by 0.11321 percent, ceteris paribus.
* For the random effects model, on average, every additional year of experience increases wages by 0.10915 percent, ceteris paribus.

1. Interpret the coefficient related to Education.

* If we are using the fixed effects model, we cannot estimate the effect of education on wages because education is time invariant.
* If we are using the random effects model, on average, for every additional year of education, we expect a 0.13846 percent increase in wages, ceteris paribus.

1. Interpret the coefficient related to Marriage

* For the fixed effects model, on average, if the head of the household is married, there will be a 0.0297 percent decrease in wages, ceteris paribus.
* For the random effects model, on average, if the head of the household is married, there will be a 0.0377 percent decrease in wages, ceteris paribus.