

PSet4

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```
library(readstata13)
library(systemfit)
```

```
## Loading required package: Matrix
## Loading required package: car
## Loading required package: lmtest
## Loading required package: zoo
##
## Attaching package: 'zoo'
##
## The following objects are masked from 'package:base':
##
##      as.Date, as.Date.numeric
##
## Please cite the 'systemfit' package as:
## Arne Henningsen and Jeff D. Hamann (2007). systemfit: A Package for Estimating Systems of Simultaneous
##
## If you have questions, suggestions, or comments regarding the 'systemfit' package, please use a forum
## https://r-forge.r-project.org/projects/systemfit/
```

```
library(AER)
```

```
## Loading required package: sandwich
## Loading required package: survival
```

```
library(ivpack)
library(ggplot2)
```

1.

a. The SUR model for the 3 response variables points, rebound, and assists is shown below. Marital status appears to have a positive effect on points, a negative effect on rebounds, and a positive effect on assists. However, the effect is not statistically significant at the five percent level in any equation, and only statistically significant at the ten percent level in the third equation (assists).

```
nbasal <- read.dta13("/Users/Any/Documents/Senior Year/Econometrics/PSet 4/nbasal.dta")
```

```
eq1 <- points ~ age + exper + expersq + educ + guard + forward + black + marr
eq2 <- rebounds ~ age + exper + expersq + educ + guard + forward + black + marr
eq3 <- assists ~ age + exper + expersq + educ + guard + forward + black + marr
```

```
Mod.SUR.A <- systemfit(list(eq1,eq2,eq3), method = "SUR", data = nbasal)
summary(Mod.SUR.A)
```

```
##
## systemfit results
## method: SUR
```

```

##
##          N   DF      SSR detRCov   OLS-R2 McElroy-R2
## system 807 780 10017.8   201.13 0.214136   0.349917
##
##          N   DF      SSR      MSE   RMSE      R2   Adj R2
## eq1 269 260 7748.473 29.80182 5.45910 0.169616 0.144066
## eq2 269 260 1546.774  5.94913 2.43908 0.310199 0.288975
## eq3 269 260  722.584  2.77917 1.66708 0.384511 0.365572
##
## The covariance matrix of the residuals used for estimation
##          eq1      eq2      eq3
## eq1 29.80182 8.94734 4.59908
## eq2  8.94734 5.94913 1.43918
## eq3  4.59908 1.43918 2.77917
##
## The covariance matrix of the residuals
##          eq1      eq2      eq3
## eq1 29.80182 8.94734 4.59908
## eq2  8.94734 5.94913 1.43918
## eq3  4.59908 1.43918 2.77917
##
## The correlations of the residuals
##          eq1      eq2      eq3
## eq1 1.000000 0.671964 0.505349
## eq2 0.671964 1.000000 0.353941
## eq3 0.505349 0.353941 1.000000
##
##
## SUR estimates for 'eq1' (equation 1)
## Model Formula: points ~ age + exper + expersq + educ + guard + forward + black +
##      marr
##
##          Estimate Std. Error  t value  Pr(>|t|)
## (Intercept) 32.8882681  7.2075365  4.56304 7.7792e-06 ***
## age         -1.0699348  0.3008572 -3.55629 0.00044679 ***
## exper        2.2268992  0.4047705  5.50163 9.0024e-08 ***
## expersq     -0.0692578  0.0235565 -2.94007 0.00357663 **
## educ        -1.2971882  0.4494268 -2.88632 0.00422515 **
## guard        2.0178022  0.9821196  2.05454 0.04092314 *
## forward     1.2206069  0.9853065  1.23881 0.21653329
## black        1.0885383  0.8733608  1.24638 0.21374720
## marr        1.0001717  0.7315674  1.36716 0.17275513
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 5.459104 on 260 degrees of freedom
## Number of observations: 269 Degrees of Freedom: 260
## SSR: 7748.472664 MSE: 29.801818 Root MSE: 5.459104
## Multiple R-Squared: 0.169616 Adjusted R-Squared: 0.144066
##
##
## SUR estimates for 'eq2' (equation 2)
## Model Formula: rebounds ~ age + exper + expersq + educ + guard + forward + black +
##      marr

```

```
##
##               Estimate Std. Error  t value   Pr(>|t|)
## (Intercept) 10.0162331  3.2202701  3.11037  0.0020766 **
## age         -0.2181295  0.1344206 -1.62274  0.1058571
## exper        0.7568996  0.1808482  4.18528 3.9003e-05 ***
## expersq      -0.0312520  0.0105248 -2.96935  0.0032630 **
## educ         -0.4773627  0.2008003 -2.37730  0.0181637 *
## guard        -2.7454627  0.4388032 -6.25671 1.6102e-09 ***
## forward      0.0209398  0.4402271  0.04757  0.9620987
## black        0.9259896  0.3902107  2.37305  0.0183695 *
## marr         -0.3684894  0.3268585 -1.12737  0.2606268
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.439084 on 260 degrees of freedom
## Number of observations: 269 Degrees of Freedom: 260
## SSR: 1546.774469 MSE: 5.949133 Root MSE: 2.439084
## Multiple R-Squared: 0.310199 Adjusted R-Squared: 0.288975
##
##
## SUR estimates for 'eq3' (equation 3)
## Model Formula: assists ~ age + exper + expersq + educ + guard + forward + black +
##      marr
##
##               Estimate Std. Error  t value   Pr(>|t|)
## (Intercept)  7.3560182  2.2010145  3.34210 0.00095366 ***
## age          -0.2788751  0.0918748 -3.03538 0.00264612 **
## exper         0.6985965  0.1236075  5.65173 4.1676e-08 ***
## expersq       -0.0259822  0.0071936 -3.61185 0.00036480 ***
## educ          -0.2961077  0.1372445 -2.15752 0.03188146 *
## guard         2.5399347  0.2999166  8.46880 1.7764e-15 ***
## forward       0.4980099  0.3008898  1.65512 0.09910587 .
## black        -0.3024001  0.2667041 -1.13384 0.25790559
## marr          0.3854668  0.2234037  1.72543 0.08563877 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.667084 on 260 degrees of freedom
## Number of observations: 269 Degrees of Freedom: 260
## SSR: 722.583806 MSE: 2.779168 Root MSE: 1.667084
## Multiple R-Squared: 0.384511 Adjusted R-Squared: 0.365572
```

Since each equation has the same explanatory variables, the SUR model is identical to OLS:

```
Mod.LM1 <- lm(eq1, nbasal)
Mod.LM2 <- lm(eq2, nbasal)
Mod.LM3 <- lm(eq3, nbasal)

summary(Mod.LM1)
```

```
##
## Call:
## lm(formula = eq1, data = nbasal)
##
## Residuals:
```

```
##      Min      1Q   Median      3Q      Max
## -11.7423 -3.9934 -0.8857   3.0149  21.6368
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 32.88827    7.20754   4.563 7.78e-06 ***
## age         -1.06993    0.30086  -3.556 0.000447 ***
## exper        2.22690    0.40477   5.502 9.00e-08 ***
## expersq     -0.06926    0.02356  -2.940 0.003577 **
## educ        -1.29719    0.44943  -2.886 0.004225 **
## guard        2.01780    0.98212   2.055 0.040923 *
## forward      1.22061    0.98531   1.239 0.216533
## black        1.08854    0.87336   1.246 0.213747
## marr         1.00017    0.73157   1.367 0.172755
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 5.459 on 260 degrees of freedom
## Multiple R-squared:  0.1696, Adjusted R-squared:  0.1441
## F-statistic: 6.639 on 8 and 260 DF,  p-value: 6.725e-08
```

```
summary(Mod.LM2)
```

```
##
## Call:
## lm(formula = eq2, data = nbasal)
##
## Residuals:
##      Min      1Q   Median      3Q      Max
## -4.6845 -1.5855 -0.4369   1.2061  11.3895
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 10.01623    3.22027   3.110 0.00208 **
## age         -0.21813    0.13442  -1.623 0.10586
## exper        0.75690    0.18085   4.185 3.90e-05 ***
## expersq     -0.03125    0.01052  -2.969 0.00326 **
## educ        -0.47736    0.20080  -2.377 0.01816 *
## guard       -2.74546    0.43880  -6.257 1.61e-09 ***
## forward      0.02094    0.44023   0.048 0.96210
## black        0.92599    0.39021   2.373 0.01837 *
## marr        -0.36849    0.32686  -1.127 0.26063
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.439 on 260 degrees of freedom
## Multiple R-squared:  0.3102, Adjusted R-squared:  0.289
## F-statistic: 14.62 on 8 and 260 DF,  p-value: < 2.2e-16
```

```
summary(Mod.LM3)
```

```
##
## Call:
## lm(formula = eq3, data = nbasal)
##
```

```
## Residuals:
##      Min       1Q   Median       3Q      Max
## -3.3427 -1.1911 -0.2956  0.7365  8.0393
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  7.356018   2.201015   3.342 0.000954 ***
## age         -0.278875   0.091875  -3.035 0.002646 **
## exper        0.698596   0.123608   5.652 4.17e-08 ***
## expersq      -0.025982   0.007194  -3.612 0.000365 ***
## educ        -0.296108   0.137245  -2.158 0.031881 *
## guard        2.539935   0.299917   8.469 1.85e-15 ***
## forward      0.498010   0.300890   1.655 0.099106 .
## black       -0.302400   0.266704  -1.134 0.257906
## marr         0.385467   0.223404   1.725 0.085639 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.667 on 260 degrees of freedom
## Multiple R-squared:  0.3845, Adjusted R-squared:  0.3656
## F-statistic: 20.3 on 8 and 260 DF, p-value: < 2.2e-16
```

b. The null hypothesis is that the coefficient in front of marriage in all three models is equal to 0. The test results are shown below.

```
Rmat <- matrix(0, nrow = 1, ncol = 27)
Rmat[c(9,18,27)] <- 1
qvec <- c(0)

linearHypothesis(Mod.SUR.A, Rmat, qvec)

## Linear hypothesis test (Theil's F test)
##
## Hypothesis:
## eq1_marr + eq2_marr + eq3_marr = 0
##
## Model 1: restricted model
## Model 2: Mod.SUR.A
##
##   Res.Df Df    F Pr(>F)
## 1     781
## 2     780  1 0.841 0.3594
```

This results in a p-value of 0.3594. At $\alpha = 0.05$, we fail to reject the null hypothesis that all three coefficients are equal to 0, and thus can exclude marriage from the model. The updated model is shown below.

```
eq1 <- points ~ age + exper + expersq + educ + guard + forward + black
eq2 <- rebounds ~ age + exper + expersq + educ + guard + forward + black
eq3 <- assists ~ age + exper + expersq + educ + guard + forward + black

Mod.SUR.B <- systemfit(list(eq1,eq2,eq3), method = "SUR", data = nbasal)
summary(Mod.SUR.B)

##
## systemfit results
## method: SUR
```

```

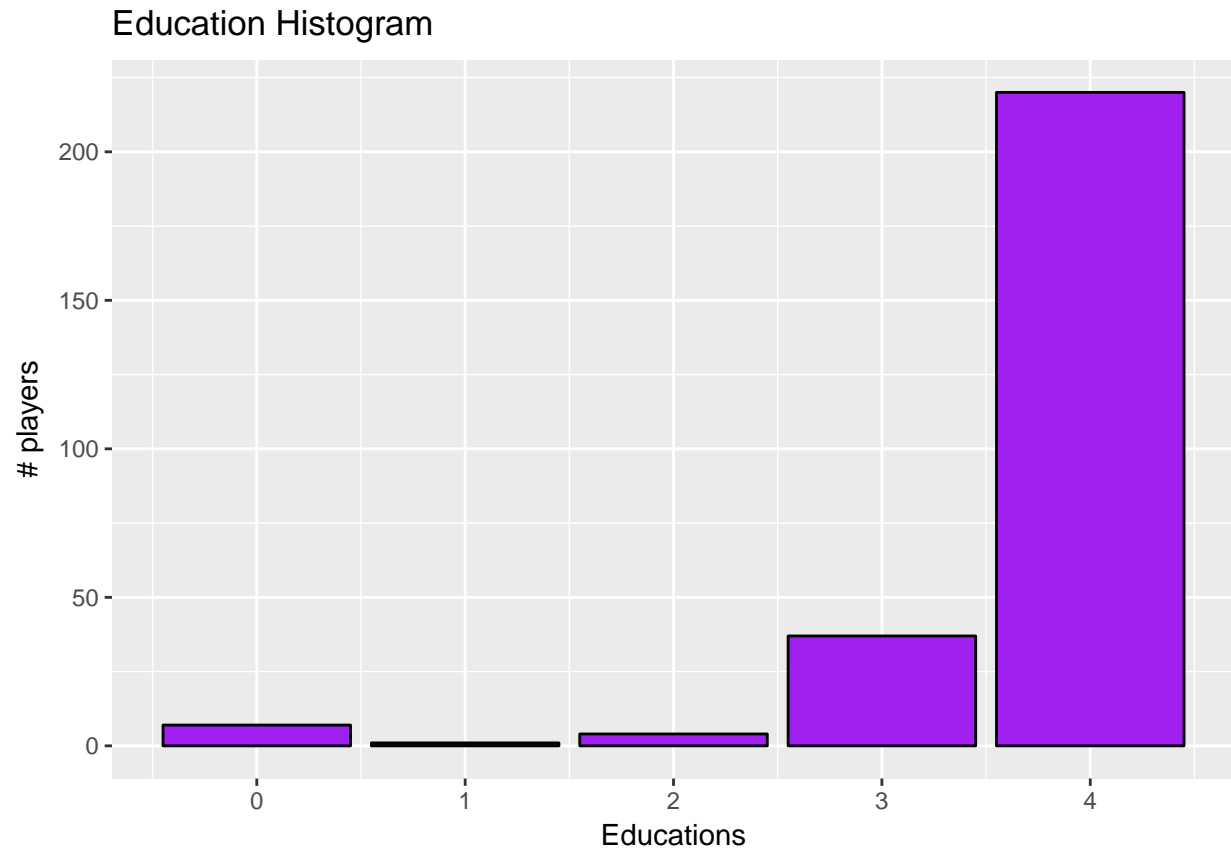
##
##          N   DF      SSR detRCov   OLS-R2 McElroy-R2
## system 807 783 10089.4  207.31 0.208524   0.337006
##
##          N   DF      SSR      MSE      RMSE      R2   Adj R2
## eq1 269 261 7804.176 29.90106 5.46819 0.163646 0.141215
## eq2 269 261 1554.336  5.95531 2.44035 0.306827 0.288236
## eq3 269 261  730.858  2.80022 1.67339 0.377463 0.360767
##
## The covariance matrix of the residuals used for estimation
##          eq1      eq2      eq3
## eq1 29.90106 8.83443 4.66371
## eq2  8.83443 5.95531 1.40336
## eq3  4.66371 1.40336 2.80022
##
## The covariance matrix of the residuals
##          eq1      eq2      eq3
## eq1 29.90106 8.83443 4.66371
## eq2  8.83443 5.95531 1.40336
## eq3  4.66371 1.40336 2.80022
##
## The correlations of the residuals
##          eq1      eq2      eq3
## eq1 1.000000 0.662039 0.509673
## eq2 0.662039 1.000000 0.343654
## eq3 0.509673 0.343654 1.000000
##
##
## SUR estimates for 'eq1' (equation 1)
## Model Formula: points ~ age + exper + expersq + educ + guard + forward + black
##
##          Estimate Std. Error  t value  Pr(>|t|)
## (Intercept) 31.5121590  7.1487809  4.40805 1.5251e-05 ***
## age         -0.9948376  0.2962924 -3.35762 0.00090334 ***
## exper        2.2492645  0.4051126  5.55220 6.9347e-08 ***
## expersq     -0.0725784  0.0234699 -3.09240 0.00220085 **
## educ        -1.3511842  0.4484329 -3.01312 0.00283994 **
## guard        2.1005341  0.9818843  2.13929 0.03334019 *
## forward     1.2504622  0.9867032  1.26731 0.20617283
## black       0.9966652  0.8722203  1.14268 0.25422026
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 5.468186 on 261 degrees of freedom
## Number of observations: 269 Degrees of Freedom: 261
## SSR: 7804.176252 MSE: 29.901058 Root MSE: 5.468186
## Multiple R-Squared: 0.163646 Adjusted R-Squared: 0.141215
##
##
## SUR estimates for 'eq2' (equation 2)
## Model Formula: rebounds ~ age + exper + expersq + educ + guard + forward + black
##
##          Estimate Std. Error  t value  Pr(>|t|)
## (Intercept) 10.52322767  3.19036844  3.29844 0.0011075 **

```

```
## age          -0.24579727  0.13222982 -1.85886  0.0641719 .
## exper        0.74865961  0.18079424  4.14095  4.6737e-05 ***
## expersq      -0.03002858  0.01047419 -2.86691  0.0044831 **
## educ         -0.45746921  0.20012729 -2.28589  0.0230624 *
## guard        -2.77594331  0.43819677 -6.33492  1.0343e-09 ***
## forward      0.00994038  0.44034736  0.02257  0.9820074
## black        0.95983802  0.38925577  2.46583  0.0143133 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.44035 on 261 degrees of freedom
## Number of observations: 269 Degrees of Freedom: 261
## SSR: 1554.335554 MSE: 5.955309 Root MSE: 2.44035
## Multiple R-Squared: 0.306827 Adjusted R-Squared: 0.288236
##
##
## SUR estimates for 'eq3' (equation 3)
## Model Formula: assists ~ age + exper + expersq + educ + guard + forward + black
##
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  6.82566496  2.18768532  3.12004 0.00201122 **
## age          -0.24993263  0.09067205 -2.75645 0.00625545 **
## exper        0.70721608  0.12397343  5.70458 3.1552e-08 ***
## expersq      -0.02726196  0.00718231 -3.79571 0.00018309 ***
## educ         -0.31691780  0.13723040 -2.30938 0.02170333 *
## guard        2.57181956  0.30047835  8.55908 8.8818e-16 ***
## forward      0.50951608  0.30195304  1.68740 0.09272079 .
## black        -0.33780805  0.26691874 -1.26558 0.20679070
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.673386 on 261 degrees of freedom
## Number of observations: 269 Degrees of Freedom: 261
## SSR: 730.857662 MSE: 2.800221 Root MSE: 1.673386
## Multiple R-Squared: 0.377463 Adjusted R-Squared: 0.360767
```

c. The histogram of education levels is shown below. Since the distribution is skewed left so much (there are only 7 players with educ = 0, 1 player with educ = 1, 4 players with educ = 2, and 37 players with educ = 3, yet 220 players with educ = 4), then if the few with a small amount of education happen to have better basketball statistics (points, rebounds, and assists in this case) on average for whatever reason than those with a higher amount of education, then the effect of education will be biased. Essentially, a few outliers with low education and better than average basketball statistics would make it seem like there was a negative correlation between education and basketball performance.

```
ggplot(nbasal) + geom_bar(aes(educ), color = "black", fill = "purple") + xlab("Educations") + ylab("# p
```



2.

The 3SLS model is shown below.

```
classdata <- read.dta13("/Users/Any/Documents/Senior Year/Econometrics/Lecture 15/mus06data.dta")
classdata$newssiratio <- ifelse(classdata$ssiratio < 0 | classdata$ssiratio > 1, NA, classdata$ssiratio)
func1 <- ldrugexp ~ hi_empunion + totchr + age + female + blhisp + linc
func2 <- hi_empunion ~ ldrugexp + totchr + female + blhisp + newssiratio
iv <- ~ totchr + age + female + blhisp + linc + newssiratio

Mod.3SLS <- systemfit(formula = list(func1,func2), inst = iv, method = "3SLS", data = classdata)
summary(Mod.3SLS)
```

```
##
## systemfit results
## method: 3SLS
##
##          N    DF      SSR detRCov   OLS-R2 McElroy-R2
## system 20136 20123 44264.8 1.35053 -1.10363    0.508599
##
##          N    DF      SSR      MSE      RMSE          R2      Adj R2
## eq1 10068 10061 17027.2 1.69240 1.30092    0.087717    0.087173
## eq2 10068 10062 27237.6 2.70698 1.64529 -10.455165 -10.460857
##
## The covariance matrix of the residuals used for estimation
##          eq1      eq2
## eq1  1.70103 -1.79300
```



```

## eq2 -1.79300  2.70698
##
## The covariance matrix of the residuals
##      eq1      eq2
## eq1  1.69240 -1.79743
## eq2 -1.79743  2.70698
##
## The correlations of the residuals
##      eq1      eq2
## eq1  1.000000 -0.839766
## eq2 -0.839766  1.000000
##
##
## 3SLS estimates for 'eq1' (equation 1)
## Model Formula: ldrugexp ~ hi_empunion + totchr + age + female + blhisp + linc
## Instruments: ~totchr + age + female + blhisp + linc + newssiratio
##
##      Estimate Std. Error t value Pr(>|t|)
## (Intercept)  6.77310368  0.22225121 30.47499 < 2.22e-16 ***
## hi_empunion -0.78904946  0.18754099 -4.20734 2.6063e-05 ***
## totchr       0.44915684  0.01029053 43.64759 < 2.22e-16 ***
## age         -0.01310187  0.00254688 -5.14428 2.7362e-07 ***
## female      -0.01262649  0.03048915 -0.41413  0.67879
## blhisp      -0.21140094  0.03782588 -5.58879 2.3461e-08 ***
## linc         0.07248232  0.01799654  4.02757 5.6771e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.300921 on 10061 degrees of freedom
## Number of observations: 10068 Degrees of Freedom: 10061
## SSR: 17027.199649 MSE: 1.692396 Root MSE: 1.300921
## Multiple R-Squared: 0.087717 Adjusted R-Squared: 0.087173
##
##
## 3SLS estimates for 'eq2' (equation 2)
## Model Formula: hi_empunion ~ ldrugexp + totchr + female + blhisp + newssiratio
## Instruments: ~totchr + age + female + blhisp + linc + newssiratio
##
##      Estimate Std. Error t value Pr(>|t|)
## (Intercept) -6.6684021  1.7805802 -3.74507 0.00018135 ***
## ldrugexp     1.2908770  0.3170603  4.07139 4.7091e-05 ***
## totchr      -0.5529128  0.1388827 -3.98115 6.9065e-05 ***
## female      -0.1292064  0.0354415 -3.64562 0.00026809 ***
## blhisp       0.1506070  0.0683273  2.20420 0.02753284 *
## newssiratio -0.4440772  0.0594636 -7.46805 8.8152e-14 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.645291 on 10062 degrees of freedom
## Number of observations: 10068 Degrees of Freedom: 10062
## SSR: 27237.646382 MSE: 2.706981 Root MSE: 1.645291
## Multiple R-Squared: -10.455165 Adjusted R-Squared: -10.460857

```

The 2SLS model (first for both equations, and then just for the ldrugexp) is shown below. (The ldrugexp

model in each is identical, I was just trying both ways out to compare them.)

```
Mod.2SLS.A <- systemfit(formula = list(func1,func2), inst = iv, method = "2SLS", data = classdata)
Mod.2SLS.B <- ivreg(formula = func1, instruments = iv, data = classdata)
```

```
summary(Mod.2SLS.A)
```

```
##
## systemfit results
## method: 2SLS
##
##           N      DF      SSR detRCov   OLS-R2 McElroy-R2
## system 20136 20123 44351.7 1.38983 -1.10776   0.494473
##
##           N      DF      SSR      MSE      RMSE           R2      Adj R2
## eq1 10068 10061 17114.1 1.70103 1.30424   0.083062   0.082515
## eq2 10068 10062 27237.6 2.70698 1.64529 -10.455165 -10.460857
##
## The covariance matrix of the residuals
##           eq1      eq2
## eq1  1.70103 -1.79300
## eq2 -1.79300  2.70698
##
## The correlations of the residuals
##           eq1      eq2
## eq1  1.000000 -0.835566
## eq2 -0.835566  1.000000
##
##
## 2SLS estimates for 'eq1' (equation 1)
## Model Formula: ldrugexp ~ hi_empunion + totchr + age + female + blhisp + linc
## Instruments: ~totchr + age + female + blhisp + linc + newssiratio
##
##           Estimate Std. Error t value Pr(>|t|)
## (Intercept)  6.69254778  0.24149085 27.71346 < 2.22e-16 ***
## hi_empunion -0.81150151  0.18937982 -4.28505 1.8440e-05 ***
## totchr       0.44921347  0.01029074 43.65218 < 2.22e-16 ***
## age         -0.01224148  0.00273942 -4.46864 7.9579e-06 ***
## female      -0.01405071  0.03053486 -0.46015  0.64542
## blhisp      -0.20895726  0.03793426 -5.50841 3.7101e-08 ***
## linc        0.08154723  0.02090111  3.90157 9.6192e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.304237 on 10061 degrees of freedom
## Number of observations: 10068 Degrees of Freedom: 10061
## SSR: 17114.094205 MSE: 1.701033 Root MSE: 1.304237
## Multiple R-Squared: 0.083062 Adjusted R-Squared: 0.082515
##
##
## 2SLS estimates for 'eq2' (equation 2)
## Model Formula: hi_empunion ~ ldrugexp + totchr + female + blhisp + newssiratio
## Instruments: ~totchr + age + female + blhisp + linc + newssiratio
##
##           Estimate Std. Error t value Pr(>|t|)
```

```
## (Intercept) -6.6684021  1.7805802 -3.74507 0.00018135 ***
## ldrugexp     1.2908770  0.3170603  4.07139 4.7091e-05 ***
## totchr      -0.5529128  0.1388827 -3.98115 6.9065e-05 ***
## female      -0.1292064  0.0354415 -3.64562 0.00026809 ***
## blhisp       0.1506070  0.0683273  2.20420 0.02753284 *
## newssiratio -0.4440772  0.0594636 -7.46805 8.8152e-14 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.645291 on 10062 degrees of freedom
## Number of observations: 10068 Degrees of Freedom: 10062
## SSR: 27237.64687 MSE: 2.706981 Root MSE: 1.645291
## Multiple R-Squared: -10.455165 Adjusted R-Squared: -10.460857
```

```
summary(Mod.2SLS.B)
```

```
##
## Call:
## ivreg(formula = ldrugexp ~ hi_empunion + totchr + age + female +
##       blhisp + linc | totchr + age + female + blhisp + linc + newssiratio,
##       data = classdata)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -6.7222 -0.7435  0.1314  0.8842  4.0135
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  6.692548   0.241491  27.713 < 2e-16 ***
## hi_empunion -0.811502   0.189380  -4.285 1.84e-05 ***
## totchr       0.449213   0.010291  43.652 < 2e-16 ***
## age         -0.012241   0.002739  -4.469 7.96e-06 ***
## female      -0.014051   0.030535  -0.460  0.645
## blhisp      -0.208957   0.037934  -5.508 3.71e-08 ***
## linc         0.081547   0.020901   3.902 9.62e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.304 on 10061 degrees of freedom
## Multiple R-Squared:  0.08306, Adjusted R-squared:  0.08251
## Wald test: 325.3 on 6 and 10061 DF,  p-value: < 2.2e-16
```

The coefficient estimates in each the 3SLS and 2SLS for ldrugexp are extremely close, but not exactly the same. The standard errors in 3SLS are slightly smaller than in 2SLS, meaning it is more efficient. This is similar to the second equation.