Econ 675 Assignment 3

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Contents

1 Question 1: Estimating Equations

1.1 Q1 Part 1

To show that these are valid moment conditions we just need to show that they are all equal to zero. We start with the IPW condition

$$\mathrm{E}\left[\psi_{IPW}(\boldsymbol{Z}_i;\theta_t(g))\right] = \mathrm{E}\left[\frac{D_i(t)\cdot g(Y_i(t))}{p_t(\boldsymbol{X}_i)} - \theta(g)\right] = \mathrm{E}\left[\mathrm{E}\left[\frac{D_i(t)\cdot g(Y_i(t))}{p_t(\boldsymbol{X}_i)}|\boldsymbol{X}_i\right]\right] - \theta(g)$$

$$= \mathrm{E}\left[\frac{1}{p_t(\boldsymbol{X}_i)}\mathrm{E}\left[D_i(t)\cdot g(Y_i(t))|\boldsymbol{X}_i\right]\right] - \theta(g)$$

Now notice that

$$\mathrm{E}[D_i(t)|\boldsymbol{X}_i] = Pr[D_i(t)=1|\boldsymbol{X}_i] = Pr[T_i = t|\boldsymbol{X}_i] = p_t(\boldsymbol{X}_i)$$

using this we get

$$\mathrm{E}\left[\psi_{IPW}(\boldsymbol{Z}_i;\theta_t(g))\right] = \mathrm{E}\left[\mathrm{E}\left[g(Y_i(t))|\boldsymbol{X}_i\right]\right] - \theta(g) = \mathrm{E}\left[g(Y_i(t))\right] - \theta(g) = 0$$

*Shouts out to Ani for the help with this. Could not have done it without you!

Next we check $\psi_{RI1,t}$

$$\mathrm{E}[\psi_{RI1,t}(\boldsymbol{Z}_i;\theta_t(g))] = \mathrm{E}[e_t(g;\boldsymbol{X}_i)] - \theta_t(g) = \mathrm{E}[\mathrm{E}[g(Y_i(t))|\boldsymbol{X}_i]] - \theta_t(g) = \mathrm{E}[g(Y_i(t))] - \theta_t(g) = 0$$

Next check $\psi_{RI2,t}$

$$\mathrm{E}[\psi_{RI2,t}(\boldsymbol{Z}_i;\theta_t(g))] = \mathrm{E}\left[\frac{D_i(t)\cdot e_t(g;\boldsymbol{X_i})}{p_t(\boldsymbol{X}_i)}\right] - \theta(g) = \mathrm{E}\left[\mathrm{E}\left[\frac{D_i(t)\cdot e_t(g;\boldsymbol{X_i})}{p_t(\boldsymbol{X}_i)}|\boldsymbol{X}_i\right]\right] - \theta(g) = \mathrm{E}[e_t(g;\boldsymbol{X}_i)] - \theta_t(g) = 0$$

Finally we check $\psi_{DR,t}$

$$\mathrm{E}[\psi_{DR,t}(\boldsymbol{Z}_i;\theta_t(g))] = \mathrm{E}\left[\frac{D_i(t)\cdot g(Y_i(t))}{p_t(\boldsymbol{X}_i)} - \theta(g)\right] - \mathrm{E}\left[\frac{e_t(g;\boldsymbol{X}_i)}{p_t(\boldsymbol{X}_i)}(D_i(t) - p_t(\boldsymbol{X}_i))\right]$$

This first terms are identical to the IPW condition so we need only check the following.

$$\mathrm{E}\left[\frac{e_t(g;\boldsymbol{X}_i)}{p_t(\boldsymbol{X}_i)}(D_i(t) - p_t(\boldsymbol{X}_i))\right] = \mathrm{E}\left[\frac{e_t(g;\boldsymbol{X}_i)D_i(t)}{p_t(\boldsymbol{X}_i)} - pe_t(g;\boldsymbol{X}_i)\right] = \theta_t(g) - \theta_t(g) = 0$$

So all functions are valid moment conditions

1.2 Q1 Part 2

The plug-in IPW estimator is

$$\hat{\theta}_{\texttt{IPW},t}(g) = \frac{1}{n}\sum_{i=1}^{n}\frac{D_i(t)g(Y_i)}{\hat{p}_t(\boldsymbol{X}_i)}$$

$\hat{p}_t(\boldsymbol{X}_i)$ is the estimated propensity score. Because this has multiple treatment levels we can estimate the propensity score with any suitable discrete choice model. For example the multinomial logit model.

The RD1 estimator is

$$\begin{aligned}\hat{\theta}_{\texttt{RI1},t}(g) = \hat{\mathrm{E}}[e_t(g;\boldsymbol{X}_i)] = \frac{1}{n}\sum_{i=1}^{n}\hat{\mathrm{E}}[g(Y_i(t))|\boldsymbol{X}_i] &= \frac{1}{n}\sum_{i=1}^{n}\hat{\mathrm{E}}[g(Y_i(t))|\boldsymbol{X}_i, D_i(t)=1] \\ &= \frac{1}{n}\sum_{i=1}^{n}\hat{\mathrm{E}}[g(Y_i)|\boldsymbol{X}_i, D_i(t)=1],\end{aligned}$$

where the second last equality uses the ignorability assumption. We just need to decide how to estimate this last term. We could probably use NLS or some nonparametric methid.
The plug-in 'hybrid' imputation estimator is

$$\hat{\theta}_{\texttt{RI2},t}(g) = \frac{1}{n}\sum_{i=1}^{n}\frac{D_i(t)\widehat{\mu}_t(\boldsymbol{X}_i)}{\hat{p}_t(\boldsymbol{X}_i)}.$$

Finally, the plug-in doubly robust estimator is given by

$$\begin{aligned}\hat{\theta}_{\texttt{DR},t}(g) &= \frac{1}{n}\sum_{i=1}^{n}\frac{D_i(t)g(Y_i)}{\hat{p}_t(\boldsymbol{X}_i)} - \frac{1}{n}\sum_{i=1}^{n}\frac{\widehat{\mu}_t(\boldsymbol{X}_i)}{\hat{p}_t(\boldsymbol{X}_i)}(D_i(t) - \hat{p}_t(\boldsymbol{X}_i)) \\ &= \frac{1}{n}\sum_{i=1}^{n}\left(\frac{D_i(t)(g(Y_i) - \widehat{\mu}_t(\boldsymbol{X}_i))}{\hat{p}_t(\boldsymbol{X}_i)} + \widehat{\mu}_t(\boldsymbol{X}_i)\right).\end{aligned}$$

As discussed in Abadie and Catteneo (2018), the relative performance of the above estimators depends on the features of the data generating process. In finite samples, IPW estimators become unstable when the propensity score approaches zero or one and regression imputation estimators may suffer from extrapolation biases. Doubly robust estimators include safeguards against bias caused by misspecification but impose additional specification choices that may affect the resulting estimate.

1.3 Q1 Part 3

Note that

$$\sigma_t^2 = \mathrm{V}[Y_i(t)] = \mathrm{E}\left[Y_i(t) - \mathrm{E}[Y_i(t)]\right]^2$$

Thus, we can estimate σ_t^2 using any of the Methods from 1.2, with $g(Y_i(t)) = \mathrm{E}\left[Y_i(t) - \mathrm{E}[Y_i(t)]\right]^2$. This would be a two-step estimator, since we would need to estimate $\mathrm{E}[Y_i(t)]$. To conduct the hypothesis test of $H_0 : \sigma_t^2 = \sigma^2 \ \forall t \in \mathcal{T}$ we would need to use an appropriate joint hypothesis testing procedure. One way to proceed would be test $H_0 : \sigma_t^2 - \sigma^2 = 0 \ \forall t \in \mathcal{T}$ and construct the vector $\widehat{\boldsymbol{\theta}} = (\hat{\sigma}_1^2 - \sigma^2, ..., \hat{\sigma}_T^2 - \sigma^2)'$, and then show $\sqrt{n}(\widehat{\boldsymbol{\theta}} - \boldsymbol{\theta}_0) \to \mathcal{N}(0, V)$. Then, the Delta method implies $\sqrt{n}(||\widehat{\boldsymbol{\theta}}||^2 - ||\boldsymbol{\theta}_0||^2) \to \mathcal{N}(0, 4\boldsymbol{\theta}_0' V \boldsymbol{\theta}_0)$. Note that under the null $\boldsymbol{\theta}_0 = 0$, so we can now conduct the hypothesis test $H_0 : \boldsymbol{\theta}_0 = 0$ in the usual way, using an estimator for the asymptotic variance.

1.4 Q1 Part 4

No Thanks

2 Question 2: Estimating Average Treatment Effects

A few things didn't run in R but it all went through in STATA. Results are below. I only did one table because making it is tedious but the code for both programs is in the appendix

ATE

statistic	specificaiton	estimate_exp	std.error_exp	CI_L	CI_U	estimate_PSID	std.error_PSID	CI_L	CI_U
Mean Diff		1794	670	479	3109	-15204	656	-16490	-13919
OLS	a	1582	659	291	2873	6302	1209	3932	8673
OLS	b	1507	657	219	2795	4699	1027	2686	6712
OLS	c	1501	663	202	2800	4284	1031	2263	6306
Reg. Impute	a	1462	630	228	2697	-11195	1741	-14608	-7782
Reg. Impute	b	1454	631	218	2690	-10398	3549	-17355	-3442
Reg. Impute	c	1428	642	170	2685	-11920	3498	-18776	-5065
IPW	a	1537	630	303	2772	-13507	2800	-18996	-8019
IPW	b	1470	631	234	2706	-7246	3550	-14204	-288
IPW	c	1468	642	210	2726	-7487	3499	-14344	-629
D. Robust	a	1473	630	239	2707	-13507	2800	-18996	-8019
D. Robust	b	1451	631	215	2687	-11419	3549	-18376	-4463
D. Robust	c	1423	642	166	2682	-12504	3498	-19360	-5649
N1 Match	a	1829	780	302	3358	-15619	1153	-17880	-13359
N1 Match	b	1876	735	435	3316	-9350	3975	-17140	-1559
N1 Match	c	1672	726	248	3095	-9560	4034	-17467	-1656
P Match	a	1542	646	275	2808	-15859	6750	-29089	-2629
P Match	b	1489	765	-12	2989	8646	15056	-20863	38156
P Match	c	1257	677	-70	2584	-9562	4034	-17468	1657

ATT

statistic	specificaiton	estimate_exp	std.error_exp	CI_L	CI_U	estimate_PSID	std.error_PSID	CI_L	CI_U
Mean Diff		1794	670	479	3109	-15204	656	-16490	-13919
OLS	a	1582	659	291	2873	6302	1209	3932	8673
OLS	b	1507	657	219	2795	4699	1027	2686	6712
OLS	c	1501	663	202	2800	4284	1031	2263	6306
Reg. Impute	a	1462	630	228	2697	-11195	1741	-14608	-7782
Reg. Impute	b	1454	631	218	2690	-10398	3549	-17355	-3442
Reg. Impute	c	1428	642	170	2685	-11920	3498	-18776	-5065
IPW	a	1537	630	303	2772	-13507	2800	-18996	-8019
IPW	b	1470	631	234	2706	-7246	3550	-14204	-288
IPW	c	1468	642	210	2726	-7487	3499	-14344	-629
D. Robust	a	1473	630	239	2707	-13507	2800	-18996	-8019
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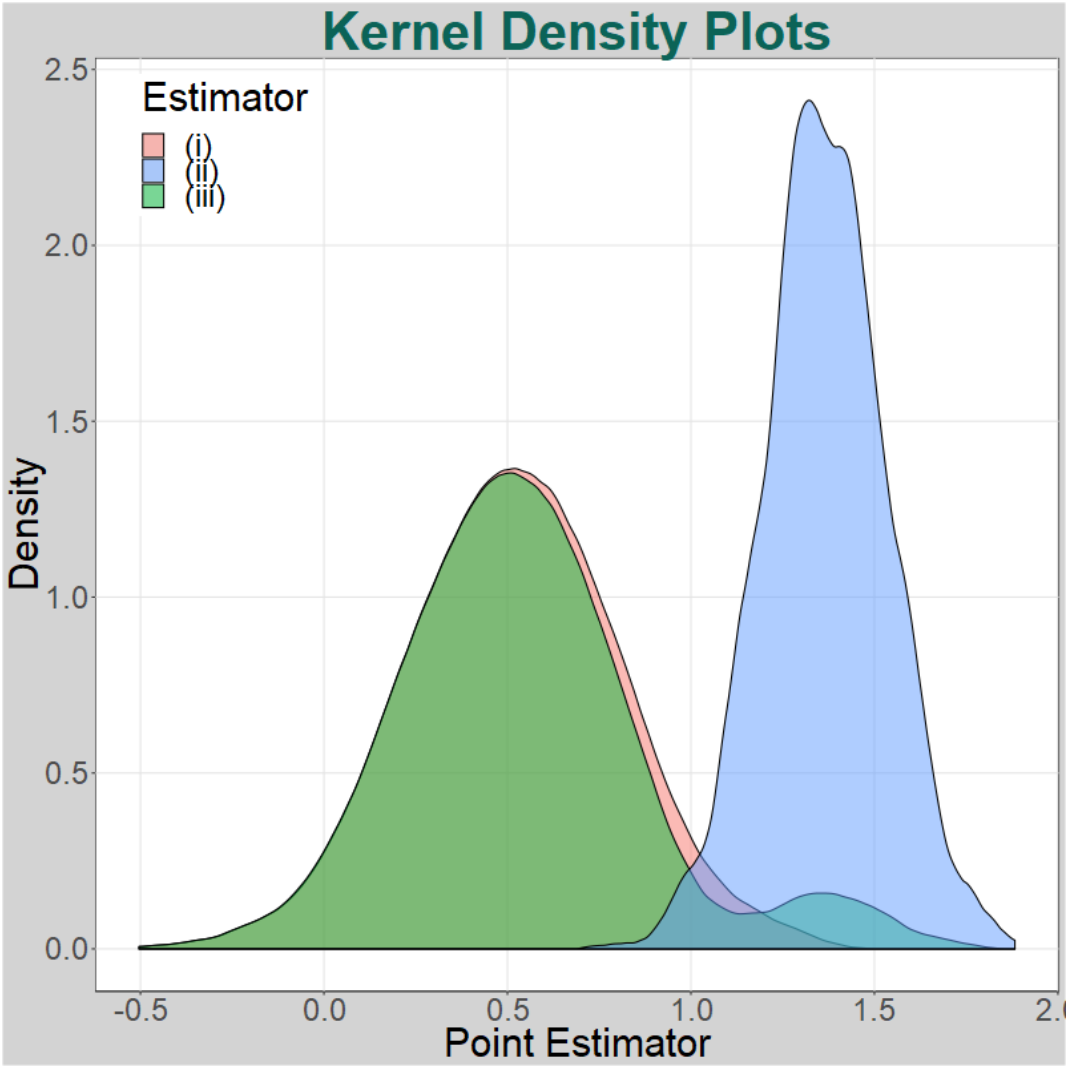
D. Robust	c	1423	642	166	2682	-12504	3498	-19360	-5649
N1 Match	a	1829	780	302	3358	-15619	1153	-17880	-13359
N1 Match	b	1876	735	435	3316	-9350	3975	-17140	-1559
N1 Match	c	1672	726	248	3095	-9560	4034	-17467	-1656
P Match	a	1542	646	275	2808	-15859	6750	-29089	-2629
P Match	b	1489	765	-12	2989	8646	15056	-20863	38156
P Match	c	1257	677	-70	2584	-9562	4034	-17468	1657

3 Question 3: Post-model Seelction Inference

Summary Stats

estimator	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
i	-0.50	0.32	0.52	0.51	0.71	1.32
ii	0.77	1.26	1.36	1.36	1.47	1.88
iii	-0.50	0.32	0.52	0.54	0.72	1.66



3.1 Q3 Part 2

Coverage Rates

estimator	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
i	-0.50	0.32	0.52	0.51	0.71	1.32
ii	0.77	1.26	1.36	1.36	1.47	1.88
iii	-0.50	0.32	0.52	0.54	0.72	1.66

4 Appendix

4.1 R Code

pset 4 675

```
#============================#
# ==== Metrics 675 ps 4 ====
#============================#


#========================================#
# ==== Load packages, clear workspace ====
#========================================#


  library(foreach)
  library(data.table)
  library(Matrix)
  library(ggplot2)
  library(sandwich)
  library(xtable)
  library(boot)
  library(CausalGAM)
  library(Hmisc)
library(mvtnorm)


  rm(list = ls(pos = ".GlobalEnv"), pos = ".GlobalEnv")
  options(scipen = 999)
  cat("\f")

#=====================================================#
# ==== Input data, add covariates and subset data ====
#=====================================================#

  lal_dt <- fread('C://Users/Nmath_000/Documents/MI_school/Second Year/675 Applied Econometrics/hw/hw4/l

  lal_dt[,log.re74 := log(re74+1)]
  lal_dt[,log.re75 := log(re75+1)]
  lal_dt[,age.sq := age^2]
  lal_dt[,educ.sq := educ^2]
  lal_dt[,age.cu := age^3]
  lal_dt[,black.u74 := black*u74]
  lal_dt[,educ.logre74 := educ*log.re74]

  # subset lal_dt for LaLonde control only
  lal_c1 <-  lal_dt[treat==1 | treat==0]

  # subset lal_dt for PSID control only
  lal_c2 <- lal_dt[treat==1 | treat==2]


  # Recode treatment indicate in PSID control dataset (recode 2's as 0's)
  lal_c2[,treat:=as.numeric(treat==1)]
```

```r
#================================#
# ==== Create covariate lists ====
#================================#


  z.a <- c("age", "educ", "black", "hisp", "married", "nodegr", "log.re74", "log.re75")
  z.b <- c(z.a,"age.sq","educ.sq", "u74", "u75" )
  z.c <- c(z.b, "age.cu", "black.u74", "educ.logre74")

  # make sure I didn't mis-type any (sohuld be empty sets)
  setdiff(z.a, colnames(lal_c1))
  setdiff(z.b, colnames(lal_c1))
  setdiff(z.c, colnames(lal_c1))


#=================================#
# ==== [1] Difference in means ====
#=================================#

  # run diff in diff
  dmeans.ll <- lm(re78~treat, data = lal_c1)
  dmeans.ps <- lm(re78~treat, data = lal_c2)

  # get robust se
  dmeans.ll <- data.table(tidy(coeftest(dmeans.ll, vcov = vcovHC(dmeans.ll, type = "HC1"))))
  dmeans.ps<- data.table(tidy(coeftest(dmeans.ps, vcov = vcovHC(dmeans.ps, type = "HC1"))))

  # just keep treat term
  dmeans.ll <- dmeans.ll[term == "treat", -c("term")]
  dmeans.ps <- dmeans.ps[term == "treat", -c("term")]

  dmeans.ll <- round(dmeans.ll, 2)
  dmeans.ps <- round(dmeans.ps, 2)

  # Compute 95% CIs
  dmeans.ll[, CI_lower := estimate - 1.96*std.error]
  dmeans.ll[, CI_upper := estimate + 1.96*std.error]
  dmeans.ll[, CI := paste0("(", CI_lower, ", ", CI_upper, ")")]

  dmeans.ps[, CI_lower := estimate - 1.96*std.error]
  dmeans.ps[, CI_upper := estimate + 1.96*std.error]
  dmeans.ps[, CI := paste0("(", CI_lower, ", ", CI_upper, ")")]


  # keep what I need and put them in same table
  dmeans.ll <- dmeans.ll[, c("estimate", "std.error", "CI" )]
  dmeans.ps <- dmeans.ps[, c("estimate", "std.error", "CI" )]

  setnames(dmeans.ll, colnames(dmeans.ll), paste0(colnames(dmeans.ll), '_exp'))
  setnames(dmeans.ps, colnames(dmeans.ps), paste0(colnames(dmeans.ps), '_PSID'))

  out_dmeans <- cbind(dmeans.ll, dmeans.ps)
```

```r
#==================#
# ==== [2] OLS ====
#==================#


  # write wrapper function to get what I need
  # # define variables for line by line debug
  # in_dt=lal_c1
  # in_z = z.a
  # in_spec = "a"
  # in_c_label = "exp"

  # start function wrapper
  ols_wrap <- function(in_dt, in_z, in_spec, in_c_label ){

    # run ols
    reg_form <- reg_form <- as.formula(paste("re78~", paste(c("treat", in_z), collapse="+")))
    ols_out <- lm(reg_form, data = in_dt)

    # get robust se
    ols_out <- data.table(tidy(coeftest(ols_out, vcov = vcovHC(ols_out, type = "HC1"))))

    # grab the term we care about
    ols_out <- ols_out[term == "treat", -c("term")]

    # round
    ols_out <- round(ols_out, 2)

    # do CI
    ols_out[, CI_lower := estimate - 1.96*std.error]
    ols_out[, CI_upper := estimate + 1.96*std.error]
    ols_out[, CI := paste0("(", CI_lower, ", ", CI_upper, ")")]
    ols_out <- ols_out[, c("estimate", "std.error", "CI" )]

    # put label in
    setnames(ols_out, colnames(ols_out), paste0(colnames(ols_out),"_", in_c_label )  )
    ols_out[, specification := in_spec]
    return(ols_out[])
  }

  ols_wrap(in_z = z.a, in_spec = "a" ,in_dt=lal_c1, in_c_label = "exp" )

  # run on all expirmental data
  exp_ols <- mapply(ols_wrap,in_z = list(z.a, z.b, z.c), in_spec = list("a", "b", "c") ,in_dt= list(lal
  exp_ols <- rbindlist(exp_ols)

  # run on psid
  psid_ols <- mapply(ols_wrap, in_z = list(z.a, z.b, z.c), in_spec = list("a", "b", "c") ,in_dt= list(la
  psid_ols <- rbindlist(psid_ols)

  # put it in one table
  ols_out <- merge(psid_ols, exp_ols, by = "specification")
```

```
# cant get the standard errors this way. Gonna use a package to do it below
# #================================#
# # ==== Regression Imputation ====
# #================================#
#
#
#   # start function wrapper
#   in_dt = lal_dt
#   in_z = z.a
#   in_spec = "a"
#   reg_imp <- function(in_dt, in_z, in_spec ){
#
#     # run ols reg on each treatment group
#     reg_form <- reg_form <- as.formula(paste("re78~", paste(in_z, collapse="+")))
#     ols.treat     <- lm(reg_form, data = in_dt[treat == 1])
#     ols.control.ll  <- lm(reg_form, data = in_dt[treat == 0])
#     ols.control.ps  <- lm(reg_form, data = in_dt[treat == 2])
#
#     # make matrix of data so I can calculate ATE
#     # y values
#     Y.treat        = lal_dt[treat==1, "re78"]
#     Y.control.ll   = lal_dt[treat==0, "re78"]
#     Y.control.ps   = lal_dt[treat==2, "re78"]
#
#     # x values
#     X.treat <- data.table(const =1 , lal_dt[treat==1, in_z, with = FALSE])
#     X.control.ll <- data.table(const =0 , lal_dt[treat==1, in_z, with = FALSE])
#     X.control.ps <- data.table(const =2 , lal_dt[treat==1, in_z, with = FALSE])
#
#
#     # Impute `individual treatment effects`
#     tvec.ri.treat.ll      = as.matrix(X.treat)%*%(as.vector(ols.treat$coefficients)-as.vector(ols.con
#     tvec.ri.treat.ps      = as.matrix(X.treat)%*%(as.vector(ols.treat$coefficients)-as.vector(ols.con
#
#     tvec.ri.control.ll    = as.matrix(X.control.ll)%*%(as.vector(ols.treat$coefficients)-as.vector(ol
#     tvec.ri.control.ps    = as.matrix(X.control.ps)%*%(as.vector(ols.treat$coefficients)-as.vector(ol
#
#     # Compute ATEs
#     ate.ri.ll       = mean(c(tvec.ri.treat.ll,tvec.ri.control.ll))
#     ate.ri.ps       = mean(c(tvec.ri.treat.ps,tvec.ri.control.ps))
#
#     # Compute ATT
#     att.ri          = mean(tvec.ri.treat.ll)
#
#
#
#   }
#



#=============================================================#
# ==== IPW and Doubly Robust using the "CausalGAM" package ====
```

```r
#============================================================#

  #=======================#
  # ==== run functions ====
  #=======================#


    # Covariates A, Lalonde control
      # make formula
      pscore_form <- as.formula(paste0("treat~", paste(z.a, collapse = " + ")))
      out_form    <- as.formula(paste0("re78~", paste(z.a, collapse = " + ")))
    ATE.ll.A <- estimate.ATE(pscore.formula = pscore_form,
                             pscore.family = binomial,
                             outcome.formula.t = out_form,
                             outcome.formula.c =out_form,
                             outcome.family = gaussian,
                             treatment.var = "treat",
                             data=as.data.frame(lal_c1),
                             divby0.action="t",
                             divby0.tol=0.001,
                             var.gam.plot=FALSE,
                             nboot=0)

    # Covariates B, Lalonde control
    pscore_form <- as.formula(paste0("treat~", paste(z.b, collapse = " + ")))
    out_form    <- as.formula(paste0("re78~", paste(z.b, collapse = " + ")))
    ATE.ll.B <- estimate.ATE(pscore.formula = pscore_form,
                             pscore.family = binomial,
                             outcome.formula.t = out_form,
                             outcome.formula.c =out_form,
                             outcome.family = gaussian,
                             treatment.var = "treat",
                             data=as.data.frame(lal_c1),
                             divby0.action="t",
                             divby0.tol=0.001,
                             var.gam.plot=FALSE,
                             nboot=0)

    # Covariates C, Lalonde control
    pscore_form <- as.formula(paste0("treat~", paste(z.c, collapse = " + ")))
    out_form    <- as.formula(paste0("re78~", paste(z.c, collapse = " + ")))
    ATE.ll.C <- estimate.ATE(pscore.formula = pscore_form,
                             pscore.family = binomial,
                             outcome.formula.t = out_form,
                             outcome.formula.c =out_form,
                             outcome.family = gaussian,
                             treatment.var = "treat",
                             data=as.data.frame(lal_c1),
                             divby0.action="t",
                             divby0.tol=0.001,
                             var.gam.plot=FALSE,
                             nboot=0)
    # # This doesnt run
```

```
  # # Covariates A, PSID control
  # # make formula
  # pscore_form <- as.formula(paste0("treat~", paste(z.a, collapse = " + ")))
  # out_form    <- as.formula(paste0("re78~", paste(z.a, collapse = " + ")))
  # ATE.ps.A <- estimate.ATE(pscore.formula = pscore_form,
  #                          pscore.family = binomial,
  #                          outcome.formula.t = out_form,
  #                          outcome.formula.c =out_form,
  #                          outcome.family = gaussian,
  #                          treatment.var = "treat",
  #                          data=as.data.frame(lal_c2),
  #                          divby0.action="t",
  #                          divby0.tol=0.01,
  #                          var.gam.plot=FALSE,
  #                          nboot=0)

  # Covariates B, PSID control
  pscore_form <- as.formula(paste0("treat~", paste(z.b, collapse = " + ")))
  out_form    <- as.formula(paste0("re78~", paste(z.b, collapse = " + ")))
  ATE.ps.B <- estimate.ATE(pscore.formula = pscore_form,
                           pscore.family = binomial,
                           outcome.formula.t = out_form,
                           outcome.formula.c =out_form,
                           outcome.family = gaussian,
                           treatment.var = "treat",
                           data=as.data.frame(lal_c2),
                           divby0.action="t",
                           divby0.tol=0.001,
                           var.gam.plot=FALSE,
                           nboot=0)

  # Covariates C, PSID control
  pscore_form <- as.formula(paste0("treat~", paste(z.c, collapse = " + ")))
  out_form    <- as.formula(paste0("re78~", paste(z.c, collapse = " + ")))
  ATE.ps.C <- estimate.ATE(pscore.formula = pscore_form,
                           pscore.family = binomial,
                           outcome.formula.t = out_form,
                           outcome.formula.c =out_form,
                           outcome.family = gaussian,
                           treatment.var = "treat",
                           data=as.data.frame(lal_c2),
                           divby0.action="t",
                           divby0.tol=0.001,
                           var.gam.plot=FALSE,
                           nboot=0)



#======================#
# ==== sort output ====
#======================#

  #NOTE this was a dumb way to do this but it is what it is
```

```
  #=========================#
  # ==== reg imputation ====
  #=========================#


    # Reg imputation results
    reg_imp_fun <- function(reg_output, in_spec, in_cont){
    tbl  =   data.table(estimate = reg_output$ATE.reg.hat,
                        std.error = reg_output$ATE.reg.asymp.SE,
                        CI_L = reg_output$ATE.reg.hat-1.96*reg_output$ATE.reg.asymp.SE,
                        CI_U = reg_output$ATE.reg.hat+1.96*reg_output$ATE.reg.asymp.SE)
    tbl <- round(tbl,2)
    tbl[, CI := paste0("(", CI_L, ", ", CI_U, ")")]
    tbl[, CI_L := NULL]
    tbl[, CI_U := NULL]
    setnames(tbl, colnames(tbl), paste0(colnames(tbl),"_", in_cont )  )
    tbl[, specification := in_spec]

    return(tbl[])
    }

    # do it with esp data
    out_RI <- list()
    out_RI[["a"]] <- reg_imp_fun(ATE.ll.A, "a", "exp")
    out_RI[["b"]] <- reg_imp_fun(ATE.ll.B, "b", "exp")
    out_RI[["c"]] <- reg_imp_fun(ATE.ll.C, "c", "exp")

    out_RI <-rbindlist(out_RI)

    # now do it with PSID
    out_RI2 <- list()
    out_RI2[["b"]] <- reg_imp_fun(ATE.ps.B, "b", "PSID")
    out_RI2[["c"]] <- reg_imp_fun(ATE.ps.C, "c", "PSID")

    out_RI2 <-rbindlist(out_RI2)

    # merge them
    out_RI <- merge(out_RI, out_RI2, by = "specification", all = TRUE)

#===============#
# ==== IPW ====
#===============#

    # ipw results
    ipw_fun <- function(reg_output, in_spec, in_cont){
      tbl  =   data.table(estimate = reg_output$ATE.IPW.hat,
                          std.error = reg_output$ATE.IPW.asymp.SE,
                          CI_L = reg_output$ATE.IPW.hat-1.96*reg_output$ATE.IPW.asymp.SE,
                          CI_U = reg_output$ATE.IPW.hat+1.96*reg_output$ATE.IPW.asymp.SE)
      tbl <- round(tbl,2)
      tbl[, CI := paste0("(", CI_L, ", ", CI_U, ")")]
      tbl[, CI_L := NULL]
      tbl[, CI_U := NULL]
```

```
  setnames(tbl, colnames(tbl), paste0(colnames(tbl),"_", in_cont )  )
  tbl[, specification := in_spec]

  return(tbl[])
}

# do it with esp data
out_IPW <- list()
out_IPW[["a"]] <- ipw_fun(ATE.ll.A, "a", "exp")
out_IPW[["b"]] <- ipw_fun(ATE.ll.B, "b", "exp")
out_IPW[["c"]] <- ipw_fun(ATE.ll.C, "c", "exp")

out_IPW <-rbindlist(out_IPW)

# now do it with PSID
out_IPW2 <- list()
out_IPW2[["b"]] <- ipw_fun(ATE.ps.B, "b", "PSID")
out_IPW2[["c"]] <- ipw_fun(ATE.ps.C, "c", "PSID")

out_IPW2 <-rbindlist(out_IPW2)

# merge them
out_IPW <- merge(out_IPW, out_IPW2, by = "specification", all = TRUE)


#================================#
# ==== Doubly robust results ====
#================================#


# DR results
DR_fun <- function(reg_output, in_spec, in_cont){
  tbl  =   data.table(estimate = reg_output$ATE.AIPW.hat,
                      std.error = reg_output$ATE.IPW.asymp.SE,
                      CI_L = reg_output$ATE.AIPW.hat-1.96*reg_output$ATE.AIPW.asymp.SE,
                      CI_U = reg_output$ATE.AIPW.hat+1.96*reg_output$ATE.AIPW.asymp.SE)
  tbl <- round(tbl,2)
  tbl[, CI := paste0("(", CI_L, ", ", CI_U, ")")]
  tbl[, CI_L := NULL]
  tbl[, CI_U := NULL]
  setnames(tbl, colnames(tbl), paste0(colnames(tbl),"_", in_cont )  )
  tbl[, specification := in_spec]

  return(tbl[])
}



# do it with esp data
out_dr <- list()
out_dr[["a"]] <- DR_fun(ATE.ll.A, "a", "exp")
out_dr[["b"]] <- DR_fun(ATE.ll.B, "b", "exp")
out_dr[["c"]] <- DR_fun(ATE.ll.C, "c", "exp")
```

```
      out_dr <-rbindlist(out_dr)

      # now do it with PSID
      out_dr2 <- list()
      out_dr2[["b"]] <- DR_fun(ATE.ps.B, "b", "PSID")
      out_dr2[["c"]] <- DR_fun(ATE.ps.C, "c", "PSID")

      out_dr2 <-rbindlist(out_dr2)

      # merge them
      out_dr <- merge(out_dr, out_dr2, by = "specification", all = TRUE)




#============================#
# ==== CONSTRUCT TABLE 1 ====
#============================#

# fill in statistic and stack data
out_dmeans[, statistic := "Mean Diff"]
ols_out[, statistic := "OLS"]
out_RI[, statistic := "Reg. Impute"]
out_IPW[, statistic := "IPW"]
out_dr[, statistic := "D. Robust"]

# stack them all
out_table <-rbind(out_dmeans, ols_out, out_RI, out_IPW, out_dr, fill = TRUE )

# set the column order
setcolorder(out_table, c("statistic", "specification", setdiff(colnames(out_table), c("statistic", "spe

# save it
write.csv(out_table, "C://Users/Nmath_000/Documents/Code/courses/econ 675/PS_4_tex/q2_results_R.csv", r


#============================================================#
# ==== now load in CSV and make the friggin latex table ====
#============================================================#

# load ATE
ATE_table <- fread("C://Users/Nmath_000/Documents/Code/courses/econ 675/PS_4_tex/Table1_ATE_resultq.csv




print(xtable(ATE_table, type = "latex"),
      file = "C://Users/Nmath_000/Documents/Code/courses/econ 675/PS_4_tex/q2table.tex",
      include.rownames = FALSE,
      floating = FALSE)

# ATT
att_table <- fread("C://Users/Nmath_000/Documents/Code/courses/econ 675/PS_4_tex/Table1_ATT_resultq.csv
```

```
print(xtable(ATE_table, type = "latex"),
      file = "C://Users/Nmath_000/Documents/Code/courses/econ 675/PS_4_tex/q2table_att.tex",
      include.rownames = FALSE,
      floating = FALSE)

# can't get this shit to work
# latex(round(ATE_table, 2),
#       file=paste0("C://Users/Nmath_000/Documents/Code/courses/econ 675/PS_4_tex/q2table.tex"),
#       append=FALSE,
#       table.env=FALSE
#       ,center="none",
#       title="",
#       n.cgroup=c(4, 4),
#       cgroup=c("Experimental Data", "PSID Control"),
#       colheads=c("$\\hat{\\tau}$", "s.e.", "C.I.", "", "$\\hat{\\tau}$", "s.e.", "C.I.", ""),
#       n.rgroup=c(1, rep(3, 6)),
#       rgroup=c("Mean Diff.", "OLS", "Reg. Impute", "IPW", "D. Robust", "N1 Match", "p Match"),
#       rowname=c("", rep(c("a", "b", "c"), 8)))



#=====================#
# ==== question 3 ====
#=====================#

# clear workspace

rm(list = ls(pos = ".GlobalEnv"), pos = ".GlobalEnv")
cat("\f")

# set attributes for plot to default ea theme
plot_attributes <- theme( plot.background = element_rect(fill = "lightgrey"),
                          panel.grid.major.x = element_line(color = "gray90"),
                          panel.grid.minor  = element_blank(),
                          panel.background = element_rect(fill = "white", colour = "black") ,
                          panel.grid.major.y = element_line(color = "gray90"),
                          text = element_text(size= 30),
                          plot.title = element_text(vjust=0, hjust = 0.5, colour = "#0B6357",face = "bo

################################################################################
# Generate random data and simulate
################################################################################

N     = 50
M     = 1000
SIGMA = matrix(c(1,0.85,0.85,1),2,2)

set.seed(1234)

# Generate covariates
W     = replicate(M,rmvnorm(N, mean = c(0,0), sigma = SIGMA, method="chol"))

# Generate errors
```

```r
E     = replicate(M,rnorm(50))

# Generate outcomes
Y     = sapply(1:M,function(i) rep(1,N)+W[,,i]%*%c(0.5,1)+E[,i])

# Get beta.hats
beta.hats = sapply(1:M,function(i) lm(Y[,i]~W[,,i])$coefficients[2])

# Get t-stats for gamma.hats
t.stats   = sapply(1:M,function(i) summary(lm(Y[,i]~W[,,i]))[["coefficients"]][, "t value"][3])

# Get beta.tildes
beta.tildes = sapply(1:M,function(i) lm(Y[,i]~W[,1,i])$coefficients[2])

# Construct betas if the model selection is used
beta.sel    = ifelse(t.stats>=1.96,beta.hats,beta.tildes)

#=========================================================#
# ==== [1] Summary Statistics for the different betas ====
#=========================================================#


# Summary statistics
beta.sum = data.table(rbind(summary(beta.hats),summary(beta.tildes),summary(beta.sel)))

# estimates
beta.sum[, estimator := c("i", "ii", "iii")]

# put in order
setcolorder(beta.sum, c("estimator", setdiff(colnames(beta.sum), "estimator")))

# Make kernenl desity plot
plot.dat = data.frame(beta = c(beta.hats,beta.tildes,beta.sel),Estimator=rep(c("hat", "tilde","sel"), e

densplot = ggplot(plot.dat,aes(x=beta,fill=Estimator))+
  geom_density(alpha=0.5, kernel="e",bw="ucv")+
  ggtitle("Kernel Density Plots")+
  xlab("Point Estimator")+
  ylab("Density")+
  plot_attributes +
  scale_fill_discrete(
    name="Estimator",
    breaks=c("hat", "tilde", "sel"),
    labels=c("(i)", "(ii)", "(iii)"))+
  theme(legend.justification = c(0.05, 0.98), legend.position = c(0.05, 0.98))

# save summary stats and plot
print(xtable(beta.sum, type = "latex"),
      file = "C://Users/Nmath_000/Documents/Code/courses/econ 675/PS_4_tex/q3_sum_stats.tex",
      include.rownames = FALSE,
      floating = FALSE)

png(paste0("c:/Users/Nmath_000/Documents/Code/courses/econ 675/PS_4_tex/q4_den.png"), height = 800, wid
```

```
print(densplot)
dev.off()


#############################################################################
# [2] Coverage rates
#############################################################################

# Compute coverage rate for beta.hat
beta.hats.se       = sapply(1:M,function(i) summary(lm(Y[,i]~W[,,i]))[["coefficients"]][, "Std. Error"]
beta.hats.CIs      = cbind(beta.hats-1.96*beta.hats.se,beta.hats+1.96*beta.hats.se)
beta.hats.covered  = ifelse(0.5>=beta.hats.CIs[,1]&0.5<=beta.hats.CIs[,2],1,0)
beta.hat.cr        = mean(beta.hats.covered)

# Compute coverage rate for beta.tilde
beta.tildes.se       = sapply(1:M,function(i) summary(lm(Y[,i]~W[,1,i]))[["coefficients"]][, "Std. Erro
beta.tildes.CIs      = cbind(beta.tildes-1.96*beta.tildes.se,beta.tildes+1.96*beta.tildes.se)
beta.tildes.covered  = ifelse(0.5>=beta.tildes.CIs[,1]&0.5<=beta.tildes.CIs[,2],1,0)
beta.tilde.cr        = mean(beta.tildes.covered)

# Compute coverage rate for beta.sel
beta.sel.CI.lower    = ifelse(beta.hats==beta.sel,beta.hats-1.96*beta.hats.se,beta.tildes-1.96*beta.til
beta.sel.CI.upper    = ifelse(beta.hats==beta.sel,beta.hats+1.96*beta.hats.se,beta.tildes+1.96*beta.til
beta.sel.CIs         = cbind(beta.sel.CI.lower,beta.sel.CI.upper)
beta.sel.covered     = ifelse(0.5>=beta.sel.CIs[,1]&0.5<=beta.sel.CIs[,2],1,0)
beta.sel.cr          = mean(beta.sel.covered)

# Put results together
cr.results           = rbind(beta.hat.cr,beta.tilde.cr,beta.sel.cr)
rownames(cr.results) = c("beta.hat.cr","beta.tilde.cr","beta.sel.cr")
colnames(cr.results) = c("Coverage Rate")

# save this shiz
print(xtable(cr.results, type = "latex"),
      file = "C://Users/Nmath_000/Documents/Code/courses/econ 675/PS_4_tex/q3_cov_rate.tex",
      include.rownames = FALSE,
      floating = FALSE)
```

4.2 STATA Code

```
1
2
3   ********************************************************************************
4   * Preliminaries
5   ********************************************************************************
6   clear all
7   set more off
8
9
10  ********************************************************************************
11  * Import data, create additional covariates
12  ********************************************************************************
13
14  * Import LaLonde data
15  import delimited using "C:\\Users\Nmath_000\Documents\MI_school\Second Year\675 Applied
    Econometrics\hw\hw4\LaLonde_all.csv"
16
17
18  * set directory
19  cd "C:\Users\Nmath_000\Documents\Code\courses\econ 675\PS_4_tex\"
20  * Generate additional covariates
21  gen log_re74 = log(re74+1)
22  gen log_re75 = log(re75+1)
23  gen age_sq   = age^2
24  gen age_cu   = age^3
25  gen educ_sq  = educ^2
26  gen black_u74 = black*u74
27  gen educ_log_re74 = educ*log_re74
28  gen treat2    = treat if treat==1|treat==2
29  replace treat2=0 if treat2==2
30
31  ********************************************************************************
32  * [1] Difference in means
33  ********************************************************************************
34
35  * Lalonde control
36  reg re78 treat if treat==1|treat==0 , hc2
37
38  * PSID control
39  reg re78 treat if treat==1|treat==2 , hc2
40
41  ********************************************************************************
42  * [2] OLS
43  ********************************************************************************
44
45  * Covariates A, Lalonde control
46  reg re78 treat age educ black hisp married nodegr log_re74 log_re75 if treat==1|treat==0 ,
    hc2
47
48  * Covariates B, Lalonde control
49  reg re78 treat age educ black hisp married nodegr log_re74 log_re75 age_sq educ_sq u74 u75
    if treat==1|treat==0 , hc2
50
51  * Covariates C, Lalonde control
52  reg re78 treat age educ black hisp married nodegr log_re74 log_re75 age_sq educ_sq u74 u75
    age_cu black_u74 educ_log_re74 if treat==1|treat==0 , hc2
53
54  * Covariates A, PSID
55  reg re78 treat age educ black hisp married nodegr log_re74 log_re75 if treat==1|treat==2 ,
    hc2
56
57  * Covariates B, PSID
58  reg re78 treat age educ black hisp married nodegr log_re74 log_re75 age_sq educ_sq u74 u75
    if treat==1|treat==2 , hc2
59
60  * Covariates C, PSID
61  reg re78 treat age educ black hisp married nodegr log_re74 log_re75 age_sq educ_sq u74 u75
    age_cu black_u74 educ_log_re74 if treat==1|treat==2 , hc2
62
63
```

```
64  ********************************************************************************
65  * [3] Regression Imputation
66  ********************************************************************************
67
68  * Covariates A, Lalonde control
69  teffects ra (re78 age educ black hisp married nodegr log_re74 log_re75) (treat) if treat==1|
    treat==0 , ate
70  teffects ra (re78 age educ black hisp married nodegr log_re74 log_re75) (treat) if treat==1|
    treat==0 , atet
71
72  * Covariates B, Lalonde control
73  teffects ra (re78 age educ black hisp married nodegr log_re74 log_re75 age_sq educ_sq u74
    u75) (treat) if treat==1|treat==0 , ate
74  teffects ra (re78 age educ black hisp married nodegr log_re74 log_re75 age_sq educ_sq u74
    u75) (treat) if treat==1|treat==0 , atet
75
76  * Covariates C, Lalonde control
77  teffects ra (re78 age educ black hisp married nodegr log_re74 log_re75 age_sq educ_sq u74
    u75 age_cu black_u74 educ_log_re74) (treat) if treat==1|treat==0 , ate
78  teffects ra (re78 age educ black hisp married nodegr log_re74 log_re75 age_sq educ_sq u74
    u75 age_cu black_u74 educ_log_re74) (treat) if treat==1|treat==0 , atet
79
80
81  * Covariates A, PSID control
82  eststo ri1: teffects ra (re78 age educ black hisp married nodegr log re74 log re75) (treat2)
     if treat2==1|treat2==0 , ate
83  eststo ri2: teffects ra (re78 age educ black hisp married nodegr log_re74 log_re75) (treat2)
     if treat2==1|treat2==0 , atet
84
85  * Covariates B, PSID control
86  teffects ra (re78 age educ black hisp married nodegr log re74 log re75 age sq educ sq u74
    u75) (treat2) if treat2==1|treat2==0 , ate
87  eststo ri3: teffects ra (re78 age educ black hisp married nodegr log_re74 log_re75 age_sq
    educ_sq u74 u75) (treat2) if treat2==1|treat2==0 , atet
88
89  * Covariates C, PSID control
90  eststo ri4: teffects ra (re78 age educ black hisp married nodegr log_re74 log_re75 age_sq
    educ_sq u74 u75 age_cu black_u74 educ_log_re74) (treat2) if treat2==1|treat2==0 , ate
91  eststo ri5: teffects ra (re78 age educ black hisp married nodegr log_re74 log_re75 age_sq
    educ_sq u74 u75 age_cu black_u74 educ_log_re74) (treat2) if treat2==1|treat2==0 , atet
92
93  esttab ri1 using Q2_atematch.csv, se nostar keep(r1vs0.treat2) wide noparentheses nonumber
    noobs plain nomtitles replace
94  esttab ri2 ri3 ri4 using Q2_att.csv, se nostar keep(r1vs0.treat2) wide noparentheses
    nonumber noobs plain nomtitles replace
95
96  ********************************************************************************
97  * [4] IPW
98  ********************************************************************************
99
100 * Covariates A, Lalonde control
101 teffects ipw (re78) (treat age educ black hisp married nodegr log_re74 log_re75, logit) if
    treat==1|treat==0 , ate
102 teffects ipw (re78) (treat age educ black hisp married nodegr log re74 log re75, logit) if
    treat==1|treat==0 , atet
103
104 * Covariates B, Lalonde control
105 teffects ipw (re78) (treat age educ black hisp married nodegr log_re74 log_re75 age_sq
    educ_sq u74 u75, logit) if treat==1|treat==0 , ate
106 teffects ipw (re78) (treat age educ black hisp married nodegr log_re74 log_re75 age_sq
    educ_sq u74 u75, logit) if treat==1|treat==0 , atet
107
108 * Covariates C, Lalonde control
109 teffects ipw (re78) (treat age educ black hisp married nodegr log_re74 log_re75 age_sq
    educ_sq u74 u75 age_cu black_u74 educ_log_re74, logit) if treat==1|treat==0 , ate
110 teffects ipw (re78) (treat age educ black hisp married nodegr log_re74 log_re75 age_sq
    educ_sq u74 u75 age_cu black_u74 educ_log_re74, logit) if treat==1|treat==0 , atet
111
112 * Covariates A, PSID control [doesn't converge, so set maxiter = 50!!!]
113 eststo i1: teffects ipw (re78) (treat2 age educ black hisp married nodegr log_re74 log_re75,
```

```
 logit) if treat2==1|treat2==0 , ate iterate(25)
114 eststo i2: teffects ipw (re78) (treat2 age educ black hisp married nodegr log re74 log re75,
 logit) if treat2==1|treat2==0 , atet iterate(25)
115
116 * Covariates B, PSID control [first need to drop obs with very low prop scores]
117 teffects ipw (re78) (treat2 age educ black hisp married nodegr log_re74 log_re75 age_sq
    educ_sq u74 u75, logit) if treat2==1|treat2==0 , ate osample(viol)
118 teffects ipw (re78) (treat2 age educ black hisp married nodegr log_re74 log_re75 age_sq
    educ_sq u74 u75, logit) if treat2==1|treat2==0 & viol==0 , ate iter(25)
119 eststo i3: teffects ipw (re78) (treat2 age educ black hisp married nodegr log_re74 log_re75
    age_sq educ_sq u74 u75, logit) if treat2==1|treat2==0 & viol==0 , atet iter(25)
120
121 * Covariates C, PSID control [need to drop people]
122 teffects ipw (re78) (treat2 age educ black hisp married nodegr log_re74 log_re75 age_sq
    educ_sq u74 u75 age_cu black_u74 educ_log_re74, logit) if treat2==1|treat2==0 , ate osample(
    violl)
123 teffects ipw (re78) (treat2 age educ black hisp married nodegr log_re74 log_re75 age_sq
    educ_sq u74 u75 age_cu black_u74 educ_log_re74, logit) if treat2==1|treat2==0 & violl==0,
    ate iter(25)
124 eststo i4: teffects ipw (re78) (treat2 age educ black hisp married nodegr log_re74 log_re75
    age_sq educ_sq u74 u75 age_cu black_u74 educ_log_re74, logit) if treat2==1|treat2==0 , atet
    iter(25)
125
126 esttab i1 using Q2_atematch.csv, se nostar keep(r1vs0.treat2) wide noparentheses nonumber
    noobs plain nomtitles append
127 esttab i2 i3 i4 using Q2_att.csv, se nostar keep(r1vs0.treat2) wide noparentheses nonumber
    noobs plain nomtitles append
128
129 ********************************************************************************
130 * [5] Doubly Robust
131 ********************************************************************************
132
133 * Covariates A, Lalonde control
134 teffects ipwra (re78) (treat age educ black hisp married nodegr log_re74 log_re75, logit) if
 treat==1|treat==0 , ate
135 teffects ipwra (re78) (treat age educ black hisp married nodegr log_re74 log_re75, logit) if
 treat==1|treat==0 , atet
136
137 * Covariates B, Lalonde control
138 teffects ipwra (re78) (treat age educ black hisp married nodegr log_re74 log_re75 age_sq
    educ_sq u74 u75, logit) if treat==1|treat==0 , ate
139 teffects ipwra (re78) (treat age educ black hisp married nodegr log_re74 log_re75 age_sq
    educ_sq u74 u75, logit) if treat==1|treat==0 , atet
140
141 * Covariates C, Lalonde control
142 teffects ipwra (re78) (treat age educ black hisp married nodegr log_re74 log_re75 age_sq
    educ_sq u74 u75 age_cu black_u74 educ_log_re74, logit) if treat==1|treat==0 , ate
143 teffects ipwra (re78) (treat age educ black hisp married nodegr log_re74 log_re75 age_sq
    educ_sq u74 u75 age_cu black_u74 educ_log_re74, logit) if treat==1|treat==0 , atet
144
145 * Covariates A, PSID control
146 eststo d1: teffects ipwra (re78) (treat2 age educ black hisp married nodegr log_re74
    log_re75, logit) if treat2==1|treat2==0 , ate iter(25)
147 eststo d2: teffects ipwra (re78) (treat2 age educ black hisp married nodegr log re74
    log_re75, logit) if treat2==1|treat2==0 , atet iter(25)
148
149 * Covariates B, PSID control
150 teffects ipwra (re78) (treat2 age educ black hisp married nodegr log_re74 log_re75 age_sq
    educ_sq u74 u75, logit) if treat2==1|treat2==0 , ate iter(25)
151 eststo d3: teffects ipwra (re78) (treat2 age educ black hisp married nodegr log_re74
    log_re75 age_sq educ_sq u74 u75, logit) if treat2==1|treat2==0 , atet iter(25)
152
153 * Covariates C, PSID control
154 teffects ipwra (re78) (treat2 age educ black hisp married nodegr log_re74 log_re75 age_sq
    educ_sq u74 u75 age_cu black_u74 educ_log_re74, logit) if treat2==1|treat2==0 , ate
155 eststo d4: teffects ipwra (re78) (treat2 age educ black hisp married nodegr log_re74
    log_re75 age_sq educ_sq u74 u75 age_cu black_u74 educ_log_re74, logit) if treat2==1|treat2==
    0 , atet iter(25)
156
157 esttab d1 using Q2_atematch.csv, se nostar keep(r1vs0.treat2) wide noparentheses nonumber
```

```
    noobs plain nomtitles append
158 esttab d2 d3 d4 using Q2 att.csv, se nostar keep(r1vs0.treat2) wide noparentheses nonumber
    noobs plain nomtitles append
159
160 ********************************************************************************
161 * [6] Nearest Neighbour Matching
162 ********************************************************************************
163
164 * Covariates A, Lalonde control
165 eststo n1: teffects nnmatch (re78 age educ black hisp married nodegr log_re74 log_re75) (
    treat) if treat==1|treat==0 , ate nneighbor(1) metric(maha)
166 eststo n2: teffects nnmatch (re78 age educ black hisp married nodegr log_re74 log_re75) (
    treat) if treat==1|treat==0 , atet nneighbor(1) metric(maha)
167
168 * Covariates B, Lalonde control
169 eststo n3: teffects nnmatch (re78 age educ black hisp married nodegr log_re74 log_re75
    age_sq educ_sq u74 u75) (treat) if treat==1|treat==0 , ate nneighbor(1) metric(maha)
170 eststo n4: teffects nnmatch (re78 age educ black hisp married nodegr log_re74 log_re75
    age_sq educ_sq u74 u75) (treat) if treat==1|treat==0 , atet nneighbor(1) metric(maha)
171
172 * Covariates C, Lalonde control
173 eststo n5: teffects nnmatch (re78 age educ black hisp married nodegr log_re74 log_re75
    age_sq educ_sq u74 u75 age_cu black_u74 educ_log_re74) (treat) if treat==1|treat==0 , ate
    nneighbor(1) metric(maha)
174 eststo n6: teffects nnmatch (re78 age educ black hisp married nodegr log_re74 log_re75
    age_sq educ_sq u74 u75 age_cu black_u74 educ_log_re74) (treat) if treat==1|treat==0 , atet
    nneighbor(1) metric(maha)
175
176 * Covariates A, PSID control
177 eststo n7: teffects nnmatch (re78 age educ black hisp married nodegr log_re74 log_re75) (
    treat2) if treat2==1|treat2==0 , ate nneighbor(1) metric(maha)
178 eststo n8:teffects nnmatch (re78 age educ black hisp married nodegr log_re74 log_re75) (
    treat2) if treat2==1|treat2==0 , atet nneighbor(1) metric(maha)
179
180 * Covariates B, PSID control
181 eststo n9:teffects nnmatch (re78 age educ black hisp married nodegr log_re74 log_re75 age_sq
     educ_sq u74 u75) (treat2) if treat2==1|treat2==0 , ate nneighbor(1) metric(maha)
182 eststo n10:teffects nnmatch (re78 age educ black hisp married nodegr log_re74 log_re75
    age_sq educ_sq u74 u75) (treat2) if treat2==1|treat2==0 , atet nneighbor(1) metric(maha)
183
184 * Covariates C, PSID control
185 eststo n11:teffects nnmatch (re78 age educ black hisp married nodegr log_re74 log_re75
    age_sq educ_sq u74 u75 age_cu black_u74 educ_log_re74) (treat2) if treat2==1|treat2==0 , ate
     nneighbor(1) metric(maha)
186 eststo n12:teffects nnmatch (re78 age educ black hisp married nodegr log_re74 log_re75
    age_sq educ_sq u74 u75 age_cu black_u74 educ_log_re74) (treat2) if treat2==1|treat2==0 ,
    atet nneighbor(1) metric(maha)
187
188 esttab n7 using Q2_atematch.csv, se nostar keep(r1vs0.treat2) wide noparentheses nonumber
    noobs plain nomtitles append
189 esttab n8 n10 n12 using Q2_att.csv, se nostar keep(r1vs0.treat2) wide noparentheses nonumber
     noobs plain nomtitles append
190
191 ********************************************************************************
192 * [7] PS matching
193 ********************************************************************************
194
195 * Covariates A, Lalonde control
196 eststo p1: teffects psmatch (re78) (treat age educ black hisp married nodegr log_re74
    log_re75, logit) if treat==1|treat==0 , ate
197 eststo p2: teffects psmatch (re78) (treat age educ black hisp married nodegr log_re74
    log_re75, logit) if treat==1|treat==0 , atet
198
199 * Covariates B, Lalonde control
200 eststo p3: teffects psmatch (re78) (treat age educ black hisp married nodegr log_re74
    log_re75 age_sq educ_sq u74 u75, logit) if treat==1|treat==0 , ate
201 eststo p4: teffects psmatch (re78) (treat age educ black hisp married nodegr log_re74
    log_re75 age_sq educ_sq u74 u75, logit) if treat==1|treat==0 , atet
202
203 * Covariates C, Lalonde control
```

```
204  eststo p5: teffects psmatch (re78) (treat age educ black hisp married nodegr log_re74
     log_re75 age_sq educ_sq u74 u75 age_cu black_u74 educ_log_re74, logit) if treat==1|treat==0
     , ate
205  eststo p6: teffects psmatch (re78) (treat age educ black hisp married nodegr log_re74
     log_re75 age_sq educ_sq u74 u75 age_cu black_u74 educ_log_re74, logit) if treat==1|treat==0
     , atet
206
207  * Covariates A, PSID control
208  eststo p7:teffects psmatch (re78) (treat2 age educ black hisp married nodegr log_re74
     log_re75, logit) if treat2==1|treat2==0 , ate
209  eststo p8:teffects psmatch (re78) (treat2 age educ black hisp married nodegr log_re74
     log_re75, logit) if treat2==1|treat2==0 , atet
210
211  * For the PSID samples below there are some prop scores too close to 1.
212  * First I need to run the treat2ment models, identify the respondents w/ problematic prop
     scores -- this will cause the code to break
213  * Then I drop the violators and estimate the treat2ment effects
214  teffects psmatch (re78) (treat2 age educ black hisp married nodegr log_re74 log_re75 age_sq
     educ_sq u74 u75, logit) if treat2==1|treat2==0 , ate osample(viol2)
215  teffects psmatch (re78) (treat2 age educ black hisp married nodegr log_re74 log_re75 age_sq
     educ_sq u74 u75 age_cu black_u74 educ_log_re74, logit) if treat2==1|treat2==0, ate osample(
     viol3)
216
217
218  * Covariates B, PSID control
219  eststo p9:teffects psmatch (re78) (treat2 age educ black hisp married nodegr log_re74
     log_re75 age_sq educ_sq u74 u75, logit) if treat2==1|treat2==0 & viol2==0 , ate
220  eststo p10:teffects psmatch (re78) (treat2 age educ black hisp married nodegr log_re74
     log_re75 age_sq educ_sq u74 u75, logit) if treat2==1|treat2==0 & viol2==0, atet
221
222  * Covariates C, PSID control
223  eststo p11: teffects psmatch (re78) (treat2 age educ black hisp married nodegr log_re74
     log_re75 age_sq educ_sq u74 u75 age_cu black_u74 educ_log_re74, logit) if treat2==1|treat2==
     0 & viol3==0 , ate
224  eststo p12: teffects psmatch (re78) (treat2 age educ black hisp married nodegr log_re74
     log_re75 age_sq educ_sq u74 u75 age_cu black_u74 educ_log_re74, logit) if treat2==1|treat2==
     0 & viol3==0 , atet
225
226  esttab p1 p3 p5 p7 p9 n11 using Q2_atematch.csv, se nostar keep(r1vs0.treat r1vs0.treat2)
     wide noparentheses nonumber noobs plain nomtitles append
227  esttab p8 p10 p12 using Q2_att.csv, se nostar keep(r1vs0.treat2) wide noparentheses nonumber
      noobs plain nomtitles append
228
229
230
231
232
233  ********************************************************************************
234  * Preliminaries
235  ********************************************************************************
236  clear all
237  set more off
238
239  * Set working directory
240  global dir "/Users/Anirudh/Desktop/GitHub"
241
242
243  set seed 22
244  set obs 50
245
246  ********************************************************************************
247  * [1] Summary stats and density plots
248  ********************************************************************************
249
250  * number of replications
251  local M = 1000
252  set matsize 11000
253
254  * empty matrices to store estimates and indicator of coverage
255  matrix est = J(`M',3,.)
```

```
256   matrix cov = J(`M',3,.)
257
258   * initial values we will replace during replication
259   gen x = rnormal(0,1)
260   gen z = .85*x + sqrt(1-.85)*rnormal(0,1)
261   gen eps = rnormal(0,1)
262   gen y = 1 + .5*x + z + eps
263
264   * loop for M replications
265   forvalues i = 1/`M'{
266       qui replace x = rnormal(0,1)
267       qui replace z = .85*x + sqrt(1-.85)*rnormal(0,1)
268       qui replace eps = rnormal(0,1)
269       qui replace y = 1 + .5*x + z + eps
270
271       * long regression
272       qui reg y x z, r
273
274       * extract first estimate
275       local beta_hat = _b["x"]
276       matrix est[`i',1] = `beta_hat'
277
278       * get SE and calculate coverage of true beta_0 = .5
279       local se_hat = _se["x"]
280       local lb_hat = `beta_hat' - 1.96 * `se_hat'
281       local ub_hat = `beta_hat' + 1.96 * `se_hat'
282       local cov_hat = (.5 >= `lb_hat') & (.5 <= `ub_hat')
283       matrix cov[`i',1] = `cov_hat'
284
285       * save gamma over se gamma
286       local gamma_hat =  b["z"]
287       local gamma_se  = _se["z"]
288       local tstat = `gamma_hat'/`gamma_se'
289
290       * short regression
291       qui reg y x, r
292       local beta_tilde = _b["x"]
293       matrix est[`i',2] = `beta_tilde'
294
295       * get SE and calculate coverage of true beta_0 = .5
296       local se_tilde = _se["x"]
297       local lb_tilde = `beta_tilde' - 1.96 * `se_tilde'
298       local ub_tilde = `beta_tilde' + 1.96 * `se_tilde'
299       local cov_tilde = (.5 >= `lb_tilde') & (.5 <= `ub_tilde')
300       matrix cov[`i',2] = `cov_tilde'
301
302       * third estimate
303       local beta_check = cond(`tstat' >= 1.96, `beta_hat', `beta_tilde')
304       matrix est[`i',3] = cond(`tstat' >= 1.96, `beta_hat', `beta_tilde')
305       matrix cov[`i',3] = cond(`tstat' >= 1.96, `cov_hat', `cov_tilde')
306   }
307
308   * turn results into variables
309   svmat est
310   svmat cov
311
312   * drop old data
313   drop x
314   drop z
315   drop eps
316   drop y
317
318   * rename variables
319   rename est1 beta_hat
320   rename est2 beta_tilde
321   rename est3 beta_check
322   rename cov1 cov_hat
323   rename cov2 cov_tilde
324   rename cov3 cov_check
325
```

```
* write summary statistics to latex
outreg2 using q3.tex, replace sum(log) ///
    keep(beta_hat beta_tilde beta_check) ///
    eqkeep(min mean median max) ///
    dec(2)

* kernel densities
twoway kdensity beta_hat, k(epanechnikov) || ///
 kdensity beta_tilde, k(epanechnikov) || ///
 kdensity beta_check, k(epanechnikov) ///
 leg(lab(1 "beta_hat") lab(2 "beta_tilde") lab(3 "beta_check")) ///
 ytitle("Density") xtitle("")


*******************************************************************************
* [2] Coverage rates
*******************************************************************************

* calculate these here, report them in LaTeX
sum(cov_hat)
sum(cov_tilde)
sum(cov_check)

```