Regression II
Vanderbilt University
Prof. Sean P. Corcoran

September 21, 2021
65 total points

Problem Set 2 *Solutions*

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1. Provide some basic descriptive information about the students in this dataset. How many observations are there? What proportion attended a Catholic high school? What proportion graduated high school on time? What proportion entered post-secondary education after high school? What are the overall means and standard deviations for 12th grade math and reading scores, respectively? (**5 points**)

   See attached log. There are 5,671 student observations. 10.4% attended a Catholic high school. 91.7% graduated from high school. 70.9% enrolled in post-secondary education. The means (standard deviations) for math and reading are 51.1 (9.5) and 51.0 (9.5).

2. Now provide descriptive statistics (means, standard deviations) *separately* for Catholic and all other students. How do these populations of students differ, if at all? Include all outcomes and background variables that you think are relevant for a comparison of academic achievement between Catholic and all other students. (**5 points**)

   See attached log. Some notable differences between Catholic high school students and non-Catholic high school students include the following. Mean academic outcomes were higher for Catholic school students (test scores in 12th grade, graduation rates, and post-secondary enrollment rates). Their baseline 8th grade scores were also higher. Catholic school students were more likely to be female and white, and their family income was about $8,000 higher on average. Parents of Catholic school students were more likely to be college-educated, and had higher educational aspirations for their child.

3. Estimate simple bivariate regressions relating each of the following outcomes to Catholic high school attendance: math z-score, reading z-score, on-time high school graduation, enrolled in post-secondary education. Provide a brief explanation of what you find. Does there appear to be a Catholic high school "advantage"? If so, is the difference statistically significant? Practically significant? Is the slope coefficient here a plausible estimate of the average treatment effect on the treated (ATT)? Why or why not? (**5 points**)

   See attached log. For all four outcomes, Catholic high school graduates fared better than other high school graduates. All estimated slope coefficients are statistically significant at the 1% level or better. Catholic high school students performed 0.41 and 0.37 standard deviations higher in math and reading, on average, than other students, were 6.4 percentage points

more likely to graduate from high school, and were 17 percentage points more likely to be enrolled in post-secondary education. These are all large and practically significant effects. For perspective on practical significance, compare these effects to the sample standard deviations in the outcomes.

The ATT assumes we have a comparison group that is on average equivalent to the treatment group. (Its potential outcomes in the untreated state should be the same in expectation as those of the treated group). It seems unlikely that students who did not attend Catholic school have the same potential outcomes, on average, as those who attended Catholic school. Our comparison of observable characteristics in part (2) suggests these populations are actually quite different. Thus, any direct comparison of their mean outcomes is likely to be affected by selection bias.

4. Provide a brief rationale for why one might prefer matching or a re-weighting approach to a regression model. What conditions must be satisfied for a treatment effect estimate based on matching or re-weighting to be convincing as a causal estimate? (**5 points**)

   Matching and re-weighting allows us to compare treated cases to "observationally similar" non-treated cases with similar covariates and/or a similar probability of treatment. These analyses strive for unconfoundedness or *conditional independence*. For unbiasedness, it must be the case that potential outcomes are independent of treatment assignment conditional on the covariates or propensity score. (For example, two individuals with the same propensity score should have the same potential outcomes, in expectation, in each treatment state). These approaches also require *common support*, a sufficient number of treated and untreated observations with the same covariates and/or propensity scores.

   As noted in class, these methods are not necessarily "better" at solving the omitted variables bias problem than regression. Both assume that conditioning on observable controls is sufficient. Matching and re-weighting have some advantages over regression, however, since they do not rely on a functional form assumption.

5. Use `teffects nnmatch` to estimate the ATE and ATT (ATET in Stata) of Catholic school attendance by exact matching on family income, using the 3-category version you created above. Use the same four outcomes from part (3). Summarize what you find. (This analysis is comparable to the subclassification example from Table 12.1 in Murnane & Willett—see the lecture notes. If you want to compare your estimates to theirs, do this step again with *math12*, the math score on its original scale). Note you can use Stata's factor variable notation in this command. (**5 points**)

   See attached log and tabular summary of results below. The estimated effects are somewhat smaller than those estimated using OLS in part (3). *math12* is the math test score in its original units. The estimates for *math12*

can be compared to Murnane & Willett's ATE and ATT of 3.01 and 2.74, respectively.

6. Re-estimate the exact matching ATT from part (5) using the math z-score as the outcome. Following that, use the `tebalance summarize` command to check for balance on the following variables: your 3-category family income measure, your family income measure in dollars, and 8th grade math and reading z-scores. (You *can* conduct balance checks on variables that were not included in your original exact matching algorithm). How do the Catholic and public school students in the matched sample compare with respect to their distribution of these variables? In light of your findings here, how comfortable are you interpreting the estimates in part (5) as causal? (**5 points**)

   Results shown in the attached log. Recall that the "standardized difference" is the difference in means between the treated and matched untreated cases, divided by the square root of a pooled variance estimator. (So it can be interpreted as standard deviation units). Family income appears well-balanced across the treated and matched untreated samples—even the continuous measure *faminc8b*. This is not too surprising, as exact matching was conducted on the 3-category income measure. Note the imbalance in the 8th grade math score, however, with Catholic school students still having noticeably higher prior math achievement than matched non-Catholic high school students. Since prior achievement is likely to be associated with 12th grade and post-secondary potential outcomes, we should be concerned about this lack of balance when interpreting these estimates.

7. In this part, you will develop a propensity score model to later estimate the ATT of Catholic school attendance. The first step of a propensity score analysis is to determine which confounding variables should be included in the estimation of the propensity score. You should be able to defend your choices based on theory and your understanding of the likely factors predicting selection into Catholic school *and* subsequent academic outcomes. Ultimately, however, the aim of a propensity score analysis is to create balance in the treated and untreated groups. (**15 points**)

   Your first task will be to settle on a propensity score model, iterating on included covariates and model specifications and checking balance until you are reasonably satisfied with the balance you have attained.

   My final model is shown in the attached log (yours will likely differ). Of the confounders, I prioritized balance on baseline test scores, family income, and parental education, given the results of prior studies which demonstrate the importance of these in explaining later outcomes. The probit model results confirm these are important predictors of Catholic school enrollment as well. I experimented with several different specifications and variable definitions; these included models linear in prior test scores, models that used the highest education of either parent, models without interactions

between gender and race, and models with a continuous measure of risk factors. The covariate balance was quite good for most specifications, but this one seemed especially good, as the `pstest` results show. (The log file also shows the `tebalance summarize` for the same propensity score match).

The figure shows the distribution of estimated propensity scores for both the untreated and treated groups. These graphs are typically produced for the full dataset (i.e., not just the matched sample). I include some code that shows these distributions for the matched sample only.

8. Using your final propensity score model in part (5), answer the following:

   (a) Interpret your propensity score model. What types of students are more or less likely to be "treated" (i.e., attend Catholic high school)? You do not need to interpret the specific probit or logit coefficients since these do not have a natural interpretation. Hint: if you used `teffects psmatch`, you will not see the coefficient estimates from the propensity score model. In this case I recommend estimating your model in `psmatch2` or using `logit` or `probit` directly. (**5 points**)

   The probit model results are included in the log. Reading achievement is a strong predictor of Catholic high school enrollment, although math is not (when simultaneously controlling for reading achievement). Hispanic and white students are more likely to attend Catholic school than Black, Asian, and other race/ethnic groups, and in general girls are more likely to have attended Catholic school. Catholic school enrollment is positively related to family income, parents' education (especially that of the mother), and expectations of college enrollment. Students deemed at risk of drop out and those with a history of not completing homework are less likely to have attended Catholic school.

   (b) Calculate a ATT estimate for each of the four outcome variables (math and reading test scores, high school graduation, and post-secondary enrollment). Provide a written interpretation of your treatment effect estimates. How do these differ from those you estimated using earlier methods (regression and exact matching)? (**5 points**)

   The results are shown in the attached log and summarized in the table below. Attending a Catholic high school is estimated to have a 0.120 standard deviation effect on math scores and a -0.003 standard deviation effect on reading scores. Only the math effect is statistically significant. The ATT estimate is positive and statistically insignificant for high school graduation (1.2 percentage points) and positive and significant for post-secondary enrollment (5.7 points). These are much smaller effects than those estimated in part (3), although the treatment effects for post-secondary enrollment remains sizable.

(c) Keeping in mind that an untreated observation may be matched multiple times, how many *unique* students not enrolled in Catholic school were used as matches in your analysis? (**2 points**)

Results shown in the log using the *_treat* and *_weight* variables created by psmatch2. There are 521 unique students who did not attend Catholic school who are used as matches.

9. Using the same propensity score model from part (7), estimate the ATE and ATET using inverse probability weighting (`teffects ipw`). How do your results differ from those in part (8)? How many students not enrolled in Catholic school were used in this analysis? (**5 points**)

Results are shown in the attached log and in the summary table below. The point estimates are in the same ballpark as those obtained from propensity score matching.

Below is a table containing the point estimates and standard errors (in parentheses) from different estimation strategies, for comparison:

	math12z	read12z	hsgrad	inpse	math	read
OLS	0.410***	0.367***	0.0644***	0.170***		
	(0.0431)	(0.0432)	(0.0120)	(0.0196)		
Exact matching (ATE)	0.314***	0.305***	0.0515***	0.143***	2.979***	2.888***
	(0.0436)	(0.0459)	(0.0111)	(0.0189)	(0.414)	(0.435)
Exact matching (ATT)	0.283***	0.259***	0.0453***	0.119***	2.692***	2.459***
	(0.0389)	(0.0406)	(0.00737)	(0.0156)	(0.369)	(0.384)
Propensity score match (ATT)	0.120**	-0.00310	0.0118	0.0574**		
	(0.0417)	(0.0437)	(0.0109)	(0.0211)		
IPW (ATT)	0.116***	0.0380	0.0210**	0.0637***		
	(0.0234)	(0.0279)	(0.00713)	(0.0149)		

```
.
. // ************************************************************************
. // LPO-8852 Problem set 2 solutions
. // Last updated: September 15, 2021
. // ************************************************************************
.
. use https://stats.idre.ucla.edu/stat/stata/examples/methods_matter/chapter12/catholic, c
> lear
.
.
. // ***********
. // Question 1
. // ***********
.
. summ, sep(0)
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
          id |      5,671     4626664     2700654     124902    7979086
      read12 |      5,671    51.00126    9.476733      29.15      68.09
      math12 |      5,671    51.05124    9.502415      29.88      71.37
      hsgrad |      5,671    .9169459    .2759884          0          1
       inpse |      5,671    .7092224    .4541612          0          1
    catholic |      5,671    .1043908    .3057938          0          1
       read8 |      5,671    51.54138    9.695829      32.05      70.55
       math8 |      5,671    51.48952    9.683425      34.48       77.2
      female |      5,671    .5200141    .4996433          0          1
        race |      5,671    3.532887    .9537466          1          5
       white |      5,671    .6892964    .4628225          0          1
       black |      5,671    .0975137    .2966821          0          1
        hisp |      5,671    .1162053    .3204992          0          1
         api |      5,671    .0585435    .2347889          0          1
     nativam |      5,671    .0384412    .1922758          0          1
     parmar8 |      5,671    5.344384    1.576191          1          6
     faminc8 |      5,671    9.526186    2.217688          1         12
     fathed8 |      5,671    3.606948    2.267043          1          8
     mothed8 |      5,671    3.380356    2.141246          1          8
     fhowfar |      5,671    4.818198    1.105028          1          6
     mhowfar |      5,671    4.858226    1.074148          1          6
      fight8 |      5,671    .2191853    .5005381          0          2
       nohw8 |      5,671     .143361    .3504715          0          1
    disrupt8 |      5,671    .1795098    .3838125          0          1
   riskdrop8 |      5,671    .6236995    .9031568          0          5
.
. // ***********
. // Question 2
. // ***********
.
. // some re-coded variables for analysis
```

```
. tabulate faminc8
   total annual |
  family income |
   in 8th grade |      Freq.     Percent        Cum.
----------------+-----------------------------------
           none |         18        0.32        0.32
         <$1000 |         42        0.74        1.06
    $1000-$2999 |         84        1.48        2.54
    $3000-$4999 |         85        1.50        4.04
    $5000-$7499 |        144        2.54        6.58
     7500-$9999 |        175        3.09        9.66
  $10000-$14999 |        447        7.88       17.55
  $15000-$19999 |        441        7.78       25.32
  $20000-$24999 |        655       11.55       36.87
  $25000-$34999 |      1,267       22.34       59.21
   35000-$49999 |      1,419       25.02       84.24
   50000-$74999 |        894       15.76      100.00
----------------+-----------------------------------
          Total |      5,671      100.00
. tabulate faminc8, nolabel
      total |
     annual |
     family |
  income in |
  8th grade |      Freq.     Percent        Cum.
------------+-----------------------------------
          1 |         18        0.32        0.32
          2 |         42        0.74        1.06
          3 |         84        1.48        2.54
          4 |         85        1.50        4.04
          5 |        144        2.54        6.58
          6 |        175        3.09        9.66
          7 |        447        7.88       17.55
          8 |        441        7.78       25.32
          9 |        655       11.55       36.87
         10 |      1,267       22.34       59.21
         11 |      1,419       25.02       84.24
         12 |        894       15.76      100.00
------------+-----------------------------------
      Total |      5,671      100.00
.
. gen faminc8b=0 if faminc8==1
(5,653 missing values generated)
. replace faminc8b = (0+1000)/2 if faminc8==2
(42 real changes made)
. replace faminc8b = (1000+2999)/2 if faminc8==3
(84 real changes made)
. replace faminc8b = (3000+4999)/2 if faminc8==4
(85 real changes made)
. replace faminc8b = (5000+7499)/2 if faminc8==5
(144 real changes made)
. replace faminc8b = (7500+9999)/2 if faminc8==6
(175 real changes made)
. replace faminc8b = (10000+14999)/2 if faminc8==7
(447 real changes made)
. replace faminc8b = (15000+19999)/2 if faminc8==8
(441 real changes made)
```

```
. replace faminc8b = (20000+24999)/2 if faminc8==9
(655 real changes made)
. replace faminc8b = (25000+34999)/2 if faminc8==10
(1,267 real changes made)
. replace faminc8b = (35000+49999)/2 if faminc8==11
(1,419 real changes made)
. replace faminc8b = (50000+74999)/2 if faminc8==12
(894 real changes made)
. label var faminc8b "family income in 8th grade (dollars)"
.
. gen faminc8c = 1 if faminc8<=7
(4,676 missing values generated)
. replace faminc8c = 2 if faminc8>=8 & faminc8<=10
(2,363 real changes made)
. replace faminc8c = 3 if faminc8>10 & faminc8~=.
(2,313 real changes made)
. label var faminc8c "family income in 8th grade (three categories)"
.
. codebook fathed8
-------------------------------------------------------------------------------
fathed8                                        father^s highest level of education
-------------------------------------------------------------------------------

                  type:  numeric (byte)
                 label:  farcat
                 range:  [1,8]                        units:  1
         unique values:  8                        missing .:  0/5,671
            tabulation:  Freq.   Numeric  Label
                           873         1  not finish hs
                         1,778         2  hs grad
                           660         3  junior coll
                           443         4  coll <4
                           743         5  coll grad
                           346         6  masters
                           141         7  doctorate
                           687         8  dont know
. gen fathed1 = fathed8==1 /* hs dropout */
. gen fathed2 = fathed8==2 /* hs grad */
. gen fathed3 = (fathed8>=3 & fathed8<=4) /* some college */
. gen fathed4 = (fathed8>=5 & fathed8<=8) /* 4yr college or more */
. label var fathed1 "father's highest ed: hs dropout"
. label var fathed2 "father's highest ed: hs grad"
. label var fathed3 "father's highest ed: some college"
. label var fathed4 "father's highest ed: 4yr college or more"
.
```

```
. codebook mothed8
-------------------------------------------------------------------------------
mothed8                                        mother^s highest level of education
-------------------------------------------------------------------------------

                  type:  numeric (byte)
                 label:  farcat
                 range:  [1,8]                        units:  1
         unique values:  8                        missing .:  0/5,671
            tabulation:  Freq.   Numeric  Label
                           815         1  not finish hs
                         2,091         2  hs grad
                           686         3  junior coll
                           468         4  coll <4
                           655         5  coll grad
                           299         6  masters
                            82         7  doctorate
                           575         8  dont know
. gen mothed1 = mothed8==1 /* hs dropout */
. gen mothed2 = mothed8==2 /* hs grad */
. gen mothed3 = (mothed8>=3 & mothed8<=4) /* some college */
. gen mothed4 = (mothed8>=5 & mothed8<=8) /* 4yr college or more */
. label var mothed1 "mother's highest ed: hs dropout"
. label var mothed2 "mother's highest ed: hs grad"
. label var mothed3 "mother's highest ed: some college"
. label var mothed4 "mother's highest ed: 4yr college or more"
.
. forvalues j=1/4 {
  2.    replace fathed`j'=. if fathed8==.
  3.    replace mothed`j'=. if mothed8==.
  4.    }
(0 real changes made)
(0 real changes made)
(0 real changes made)
(0 real changes made)
(0 real changes made)
(0 real changes made)
(0 real changes made)
(0 real changes made)
.
. egen pared8=rowmax(fathed8 mothed8)
. gen pared1 = pared8==1 /* hs dropout */
. gen pared2 = pared8==2 /* hs grad */
. gen pared3 = (pared8>=3 & pared8<=4) /* some college */
. gen pared4 = (pared8>=5 & pared8<=8) /* 4yr college or more */
. label var pared1 "parent's highest ed: hs dropout"
. label var pared2 "parent's highest ed: hs grad"
. label var pared3 "parent's highest ed: some college"
. label var pared4 "parent's highest ed: 4yr college or more"
.
```

```
. codebook parmar8
-------------------------------------------------------------------------------
parmar8                                      parents marital status in 8th grade
-------------------------------------------------------------------------------

                  type:  numeric (byte)
                 label:  parmarcat
                 range:  [1,6]                        units:  1
         unique values:  6                        missing .:  0/5,671
            tabulation:  Freq.   Numeric  Label
                           543         1  divorced
                            77         2  widowed
                           140         3  separated
                            91         4  never married
                            93         5  not married but cohabit
                         4,727         6  married
. gen parmar1 = parmar8==1 | parmar8==3 /* divorced or separated */
. gen parmar2 = parmar8==2 | parmar8==4 | parmar8==5 /* widow never married or cohabit */
. gen parmar3 = parmar8==6
. label var parmar1 "parents divorced or separated"
. label var parmar2 "parents widowed never married or cohabit"
. label var parmar3 "parents married"
.
. codebook fhowfar mhowfar
-------------------------------------------------------------------------------
fhowfar                                  how far in schl r^s father wants r to go
-------------------------------------------------------------------------------

                  type:  numeric (byte)
                 label:  farcat2
                 range:  [1,6]                        units:  1
         unique values:  6                        missing .:  0/5,671
            tabulation:  Freq.   Numeric  Label
                            47         1  not finish hs
                           309         2  hs grad
                           384         3  junior coll
                           595         4  coll <4
                         2,889         5  coll grad
                         1,447         6  postsec ed
-------------------------------------------------------------------------------
mhowfar                                  how far in schl r^s mother wants r to go
-------------------------------------------------------------------------------

                  type:  numeric (byte)
                 label:  farcat2
                 range:  [1,6]                        units:  1
         unique values:  6                        missing .:  0/5,671
            tabulation:  Freq.   Numeric  Label
                            42         1  not finish hs
                           275         2  hs grad
                           361         3  junior coll
                           577         4  coll <4
                         2,928         5  coll grad
                         1,488         6  postsec ed
. gen collegexp=(fhowfar>=5 & fhowfar<.) | (mhowfar>=5 & mhowfar<.)
. label var collegexp "=1 if mother or father expects college+"
.
```

```
. codebook riskdrop8
-------------------------------------------------------------------------------
riskdrop8                                  # of risk factors for later dropout
-------------------------------------------------------------------------------

                  type:  numeric (byte)
                 range:  [0,5]                        units:  1
         unique values:  6                    missing .:  0/5,671
            tabulation:  Freq.  Value
                         3,369  0
                         1,406  1
                           623  2
                           214  3
                            52  4
                             7  5
. gen riskdrop1=riskdrop8==1
. gen riskdrop2=(riskdrop8>=2 & riskdrop8<=5)
.
. foreach j in read12 math12 read8 math8 {
  2.    egen `j'z = std(`j')
  3.    label var `j'z "standardized `j'"
  4.    }
.
```

```
. summ read12-female white-nativam fight8-collegexp if catholic==0, sep(0)
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
      read12 |      5,079    50.63865    9.495149      29.15      68.09
      math12 |      5,079    50.64465    9.534295      29.88      71.37
      hsgrad |      5,079    .9102185    .2858965          0          1
       inpse |      5,079    .6914747    .4619301          0          1
    catholic |      5,079           0           0          0          0
       read8 |      5,079    51.11096    9.653501      32.05      70.55
       math8 |      5,079    51.23648    9.747724      34.48       77.2
      female |      5,079    .5174247    .4997455          0          1
       white |      5,079    .6759205     .468076          0          1
       black |      5,079    .1019886    .3026631          0          1
        hisp |      5,079    .1193148    .3241905          0          1
         api |      5,079    .0626108    .2422854          0          1
     nativam |      5,079    .0401654    .1963663          0          1
      fight8 |      5,079    .2234692    .5074014          0          2
       nohw8 |      5,079    .1523922     .359436          0          1
    disrupt8 |      5,079    .1815318    .3854961          0          1
   riskdrop8 |      5,079    .6601693     .927189          0          5
    faminc8b |      5,079    31854.35    17282.99          0    62499.5
    faminc8c |      5,079    2.199646    .7320868          1          3
     fathed1 |      5,079    .1636149    .3699622          0          1
     fathed2 |      5,079    .3124631    .4635431          0          1
     fathed3 |      5,079    .1925576    .3943473          0          1
     fathed4 |      5,079    .3313644    .4707501          0          1
     mothed1 |      5,079    .1543611    .3613301          0          1
     mothed2 |      5,079    .3673952    .4821428          0          1
     mothed3 |      5,079    .2012207    .4009521          0          1
     mothed4 |      5,079     .277023     .447572          0          1
      pared8 |      5,079    4.036031    2.293045          1          8
      pared1 |      5,079    .0874188    .2824756          0          1
      pared2 |      5,079    .2862768    .4520649          0          1
      pared3 |      5,079    .2205158    .4146353          0          1
      pared4 |      5,079    .4057885    .4910923          0          1
     parmar1 |      5,079    .1265997    .3325568          0          1
     parmar2 |      5,079    .0490254    .2159423          0          1
     parmar3 |      5,079    .8243749    .3805384          0          1
   collegexp |      5,079    .7914944    .4062801          0          1
```

```
. summ read12-female white-nativam fight8-collegexp if catholic==1, sep(0)
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
      read12 |        592    54.11226    8.725462      29.86      68.09
      math12 |        592    54.53951    8.463153      32.92      71.08
      hsgrad |        592    .9746622     .157282          0          1
       inpse |        592    .8614865    .3457303          0          1
    catholic |        592           1           0          1          1
       read8 |        592    55.23412    9.271124      33.07      70.55
       math8 |        592    53.66039     8.82731      35.53       77.2
      female |        592    .5422297    .4986348          0          1
       white |        592    .8040541    .3972628          0          1
       black |        592    .0591216    .2360516          0          1
        hisp |        592     .089527    .2857444          0          1
         api |        592    .0236486    .1520804          0          1
     nativam |        592    .0236486    .1520804          0          1
      fight8 |        592    .1824324    .4359041          0          2
       nohw8 |        592    .0658784    .2482792          0          1
    disrupt8 |        592    .1621622    .3689112          0          1
   riskdrop8 |        592    .3108108    .5741334          0          3
    faminc8b |        592    39534.13    16291.77          0    62499.5
    faminc8c |        592    2.513514    .6209701          1          3
     fathed1 |        592    .0709459    .2569516          0          1
     fathed2 |        592    .3226351    .4678798          0          1
     fathed3 |        592    .2111486    .4084688          0          1
     fathed4 |        592    .3952703    .4893221          0          1
     mothed1 |        592    .0523649    .2229501          0          1
     mothed2 |        592    .3800676    .4858136          0          1
     mothed3 |        592     .222973    .4165923          0          1
     mothed4 |        592    .3445946    .4756378          0          1
      pared8 |        592    4.407095      2.0612          1          8
      pared1 |        592    .0202703    .1410425          0          1
      pared2 |        592    .2516892    .4343506          0          1
      pared3 |        592    .2280405    .4199237          0          1
      pared4 |        592          .5    .5004228          0          1
     parmar1 |        592    .0675676    .2512146          0          1
     parmar2 |        592    .0202703    .1410425          0          1
     parmar3 |        592    .9121622    .2832983          0          1
   collegexp |        592    .8851351    .3191284          0          1
.
.
. // ***********
. // Question 3
. // ***********
.
```

```
. foreach j in math12z read12z hsgrad inpse {
  2.    _eststo ols`j': reg `j' catholic
  3.    }
      Source |       SS           df       MS      Number of obs   =     5,671
-------------+----------------------------------   F(1, 5669)      =     90.48
       Model |  89.0750063         1  89.0750063   Prob > F        =    0.0000
    Residual |    5580.925     5,669  .984463751   R-squared       =    0.0157
-------------+----------------------------------   Adj R-squared   =    0.0155
       Total |  5670.00001     5,670           1   Root MSE        =     .9922
------------------------------------------------------------------------------
     math12z |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    catholic |    .409881   .0430903     9.51   0.000     .3254075    .4943545
       _cons |  -.0427878   .0139223    -3.07   0.002    -.0700808   -.0154948
------------------------------------------------------------------------------
      Source |       SS           df       MS      Number of obs   =     5,671
-------------+----------------------------------   F(1, 5669)      =     72.13
       Model |  71.2338805         1  71.2338805   Prob > F        =    0.0000
    Residual |  5598.76612     5,669  .987610887   R-squared       =    0.0126
-------------+----------------------------------   Adj R-squared   =    0.0124
       Total |        5670     5,670  .999999999   Root MSE        =    .99379
------------------------------------------------------------------------------
     read12z |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    catholic |   .3665415   .0431591     8.49   0.000     .2819331    .4511499
       _cons |  -.0382635   .0139445    -2.74   0.006    -.0656002   -.0109269
------------------------------------------------------------------------------
      Source |       SS           df       MS      Number of obs   =     5,671
-------------+----------------------------------   F(1, 5669)      =     29.05
       Model |  2.20191254         1  2.20191254   Prob > F        =    0.0000
    Residual |   429.67959     5,669    .0757946   R-squared       =    0.0051
-------------+----------------------------------   Adj R-squared   =    0.0049
       Total |  431.881502     5,670  .076169577   Root MSE        =    .27531
------------------------------------------------------------------------------
      hsgrad |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    catholic |   .0644436   .0119564     5.39   0.000     .0410046    .0878827
       _cons |   .9102185    .003863   235.62   0.000     .9026455    .9177916
------------------------------------------------------------------------------
      Source |       SS           df       MS      Number of obs   =     5,671
-------------+----------------------------------   F(1, 5669)      =     75.27
       Model |  15.3249242         1  15.3249242   Prob > F        =    0.0000
    Residual |  1154.18275     5,669  .203595475   R-squared       =    0.0131
-------------+----------------------------------   Adj R-squared   =    0.0129
       Total |  1169.50767     5,670  .206262376   Root MSE        =    .45122
------------------------------------------------------------------------------
       inpse |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    catholic |   .1700118   .0195958     8.68   0.000     .1315964    .2084271
       _cons |   .6914747   .0063313   109.21   0.000     .6790629    .7038865
------------------------------------------------------------------------------
.
.
. // ***********
. // Question 5
. // ***********
.
```

```
. foreach j in math12 read12 math12z read12z hsgrad inpse {
  2.    display in red "Outcome: `j'"
  3.    _eststo em`j'ate: teffects nnmatch (`j' i.faminc8c) (catholic), ematch(i.faminc8c)
> ate
  4.    _eststo em`j'att: teffects nnmatch (`j' i.faminc8c) (catholic), ematch(i.faminc8c)
> atet
  5.    }
Outcome: math12
Treatment-effects estimation                   Number of obs      =      5,671
Estimator      : nearest-neighbor matching     Matches: requested =          1
Outcome model  : matching                                  min =         40
Distance metric: Mahalanobis                               max =       2155
------------------------------------------------------------------------------
             |               AI Robust
      math12 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATE          |
    catholic |
(yes vs no)  |   2.979077   .4139935     7.20   0.000     2.167664    3.790489
------------------------------------------------------------------------------
Treatment-effects estimation                   Number of obs      =      5,671
Estimator      : nearest-neighbor matching     Matches: requested =          1
Outcome model  : matching                                  min =         40
Distance metric: Mahalanobis                               max =       2155
------------------------------------------------------------------------------
             |               AI Robust
      math12 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATET         |
    catholic |
(yes vs no)  |   2.692406   .3694927     7.29   0.000     1.968214    3.416599
------------------------------------------------------------------------------
Outcome: read12
Treatment-effects estimation                   Number of obs      =      5,671
Estimator      : nearest-neighbor matching     Matches: requested =          1
Outcome model  : matching                                  min =         40
Distance metric: Mahalanobis                               max =       2155
------------------------------------------------------------------------------
             |               AI Robust
      read12 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATE          |
    catholic |
(yes vs no)  |   2.887636   .4354489     6.63   0.000     2.034172      3.7411
------------------------------------------------------------------------------
Treatment-effects estimation                   Number of obs      =      5,671
Estimator      : nearest-neighbor matching     Matches: requested =          1
Outcome model  : matching                                  min =         40
Distance metric: Mahalanobis                               max =       2155
------------------------------------------------------------------------------
             |               AI Robust
      read12 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATET         |
    catholic |
(yes vs no)  |   2.459126   .3844986     6.40   0.000     1.705523     3.21273
------------------------------------------------------------------------------
Outcome: math12z
Treatment-effects estimation                   Number of obs      =      5,671
```

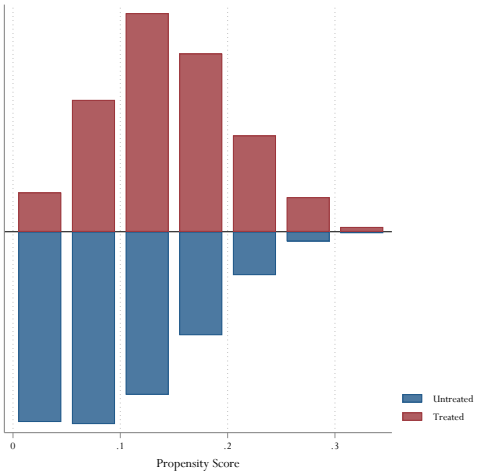
```
             |              AI Robust
     math12z |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATE          |
    catholic |
(yes vs no)  |   .3135073   .0435672     7.20   0.000     .2281172    .3988974
------------------------------------------------------------------------------
Treatment-effects estimation                   Number of obs      =      5,671
Estimator      : nearest-neighbor matching     Matches: requested =          1
Outcome model  : matching                                  min =         40
Distance metric: Mahalanobis                               max =       2155
------------------------------------------------------------------------------
             |              AI Robust
     math12z |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATET         |
    catholic |
(yes vs no)  |   .2833391   .0388841     7.29   0.000     .2071277    .3595505
------------------------------------------------------------------------------
Outcome: read12z
Treatment-effects estimation                   Number of obs      =      5,671
Estimator      : nearest-neighbor matching     Matches: requested =          1
Outcome model  : matching                                  min =         40
Distance metric: Mahalanobis                               max =       2155
------------------------------------------------------------------------------
             |              AI Robust
     read12z |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATE          |
    catholic |
(yes vs no)  |    .304708   .0459493     6.63   0.000     .2146491    .3947669
------------------------------------------------------------------------------
Treatment-effects estimation                   Number of obs      =      5,671
Estimator      : nearest-neighbor matching     Matches: requested =          1
Outcome model  : matching                                  min =         40
Distance metric: Mahalanobis                               max =       2155
------------------------------------------------------------------------------
             |              AI Robust
     read12z |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATET         |
    catholic |
(yes vs no)  |   .2594909   .0405729     6.40   0.000     .1799695    .3390124
------------------------------------------------------------------------------
Outcome: hsgrad
Treatment-effects estimation                   Number of obs      =      5,671
Estimator      : nearest-neighbor matching     Matches: requested =          1
Outcome model  : matching                                  min =         40
Distance metric: Mahalanobis                               max =       2155
------------------------------------------------------------------------------
             |              AI Robust
      hsgrad |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATE          |
    catholic |
(yes vs no)  |   .0515404   .0110895     4.65   0.000     .0298054    .0732754
------------------------------------------------------------------------------
Treatment-effects estimation                   Number of obs      =      5,671
Estimator      : nearest-neighbor matching     Matches: requested =          1
```

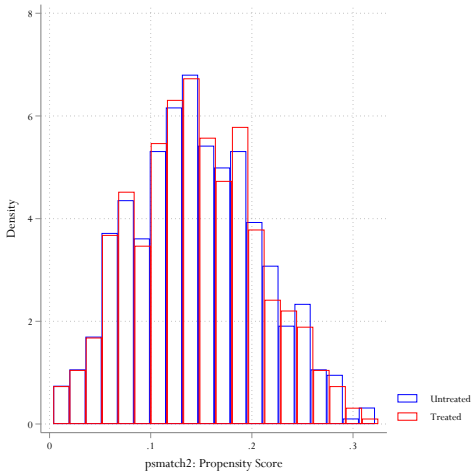
```
      hsgrad |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATET         |
    catholic |
(yes vs no)  |   .0452857   .0073688     6.15   0.000     .0308431    .0597283
------------------------------------------------------------------------------
Outcome: inpse
Treatment-effects estimation                   Number of obs      =      5,671
Estimator      : nearest-neighbor matching     Matches: requested =          1
Outcome model  : matching                                  min =         40
Distance metric: Mahalanobis                               max =       2155
------------------------------------------------------------------------------
             |              AI Robust
       inpse |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATE          |
    catholic |
(yes vs no)  |   .1430061   .0189111     7.56   0.000      .105941    .1800712
------------------------------------------------------------------------------
Treatment-effects estimation                   Number of obs      =      5,671
Estimator      : nearest-neighbor matching     Matches: requested =          1
Outcome model  : matching                                  min =         40
Distance metric: Mahalanobis                               max =       2155
------------------------------------------------------------------------------
             |              AI Robust
       inpse |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATET         |
    catholic |
(yes vs no)  |   .1193482   .0155742     7.66   0.000     .0888234    .1498731
------------------------------------------------------------------------------
.
.
. // ***********
. // Question 6
. // ***********
. teffects nnmatch (math12 i.faminc8c) (catholic), ematch(i.faminc8c) ate
Treatment-effects estimation                   Number of obs      =      5,671
Estimator      : nearest-neighbor matching     Matches: requested =          1
Outcome model  : matching                                  min =         40
Distance metric: Mahalanobis                               max =       2155
------------------------------------------------------------------------------
             |              AI Robust
      math12 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATE          |
    catholic |
(yes vs no)  |   2.979077   .4139935     7.20   0.000     2.167664    3.790489
------------------------------------------------------------------------------
```

```
. tebalance summarize faminc8b i.faminc8c math8z
note: refitting the model using the generate() option
  Covariate balance summary
                                                  Raw      Matched
                          ----------------------------------------
                          Number of obs =        5,671       11,342
                          Treated obs   =          592        5,671
                          Control obs   =        5,079        5,671
                          ----------------------------------------
  ------------------------------------------------------------------
                  |Standardized differences          Variance ratio
                  |        Raw     Matched           Raw    Matched
  ----------------+-------------------------------------------------
         faminc8b |   .4572743    .0489535      .8885848   1.009359
                  |
         faminc8c |
               2  |  -.1500581   -1.35e-15      .9343974          1
               3  |   .3942688    3.28e-15      1.026989          1
                  |
           math8z |   .2606656     .181422      .8200688   .8230263
  ------------------------------------------------------------------
.
.
. // ***********
. // Question 7
. // ***********
. // uses psmatch2 (default is probit model, 1 nn match). I use the "ties" option
. // to line up with teffects psmatch (used later). If there are multiple nearest
. // neighbors with the same pscore, all of them will be matched.
.
```

```
. psmatch2 catholic c.math8z##c.math8z c.read8z##c.read8z female black hisp api ///   nati
> vam riskdrop1 riskdrop2 disrupt nohw8 faminc8b fathed2-fathed4 ///   mothed2-mothed4 par
> mar1 parmar2 collegexp, ties
Probit regression                                 Number of obs     =      5,671
                                                  LR chi2(23)       =     270.89
                                                  Prob > chi2       =     0.0000
Log likelihood = -1762.2102                       Pseudo R2         =     0.0714
------------------------------------------------------------------------------
    catholic |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      math8z |  -.0334847   .0375223    -0.89   0.372     -.107027    .0400576
             |
    c.math8z#|
    c.math8z |  -.0852282   .0251197    -3.39   0.001     -.134462   -.0359944
             |
      read8z |   .1766125   .0345038     5.12   0.000     .1089862    .2442387
             |
    c.read8z#|
    c.read8z |   .0128866    .025047     0.51   0.607    -.0362045    .0619777
             |
      female |   .0207307    .050002     0.41   0.678    -.0772715    .1187328
       black |   -.124419   .0969725    -1.28   0.199    -.3144816    .0656435
        hisp |  -.0186785   .0820854    -0.23   0.820     -.179563    .1422059
         api |   -.554642    .129953    -4.27   0.000    -.8093452   -.2999388
     nativam |  -.2416373   .1417836    -1.70   0.088     -.519528    .0362535
   riskdrop1 |  -.0060125   .0633419    -0.09   0.924    -.1301603    .1181352
   riskdrop2 |  -.2225268   .1159476    -1.92   0.055    -.4497798    .0047262
    disrupt8 |   .0966356   .0675578     1.43   0.153    -.0357753    .2290466
       nohw8 |  -.3036905   .0848934    -3.58   0.000    -.4700786   -.1373025
    faminc8b |   7.40e-06   1.66e-06     4.47   0.000     4.15e-06    .0000106
     fathed2 |   .1835301   .0932529     1.97   0.049     .0007578    .3663024
     fathed3 |   .1129928    .101119     1.12   0.264    -.0851969    .3111824
     fathed4 |   .1260127   .0986007     1.28   0.201    -.0672412    .3192665
     mothed2 |   .2766157   .1005447     2.75   0.006     .0795518    .4736796
     mothed3 |   .2626728   .1087212     2.42   0.016     .0495831    .4757624
     mothed4 |   .3072885    .107914     2.85   0.004      .095781    .5187959
     parmar1 |  -.1165539   .0997515    -1.17   0.243    -.3120631    .0789554
     parmar2 |    -.11798   .1497204    -0.79   0.431    -.4114266    .1754665
   collegexp |   .1585568   .0706054     2.25   0.025     .0201728    .2969408
       _cons |  -1.899869   .1401612   -13.55   0.000     -2.17458   -1.625159
------------------------------------------------------------------------------
```

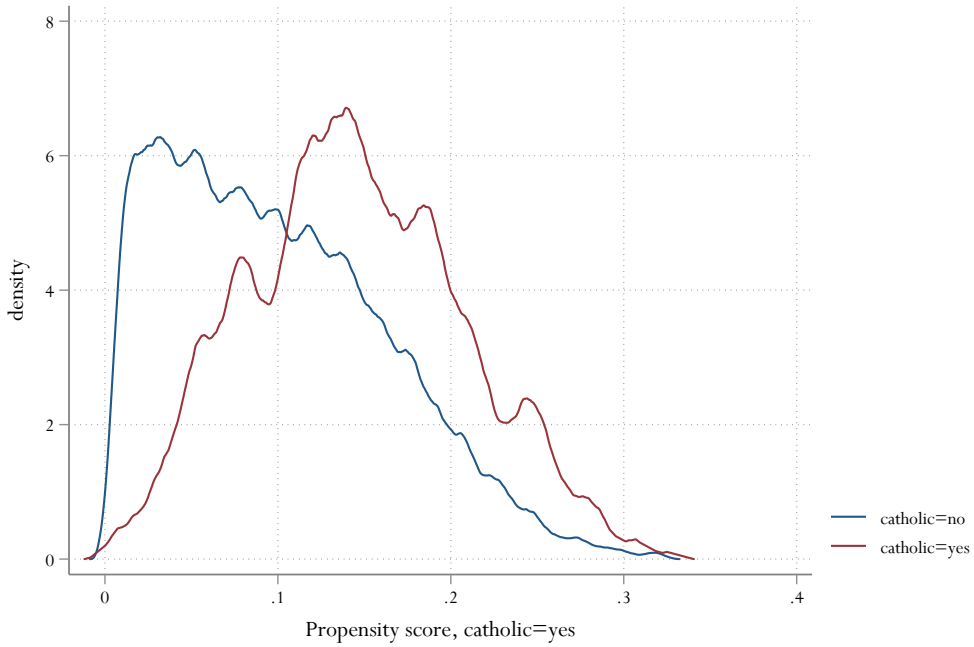
```
. pstest
------------------------------------------------------------------------------
                         |       Mean               |     t-test    |  V(T)/
Variable                 | Treated Control    %bias |    t    p>|t| |  V(C)
-------------------------+--------------------------+---------------+----------
math8z                   | .22418   .18838      3.7 |   0.67  0.502 |  0.98
c.math8z#c.math8z        | .87985   .88282     -0.3 |  -0.05  0.963 |  1.05
read8z                   | .38086   .36124      2.0 |   0.35  0.723 |  1.02
c.read8z#c.read8z        | 1.0578   1.0254      3.0 |   0.50  0.616 |  1.00
female                   | .54223   .57264     -6.1 |  -1.05  0.293 |     .
black                    | .05912    .0625     -1.2 |  -0.24  0.808 |     .
hisp                     | .08953   .11149     -7.2 |  -1.26  0.209 |     .
api                      | .02365   .01689      3.3 |   0.82  0.410 |     .
nativam                  | .02365   .03041     -3.8 |  -0.72  0.474 |     .
riskdrop1                | .21115   .23311     -5.2 |  -0.91  0.364 |     .
riskdrop2                |  .0473   .04561      0.6 |   0.14  0.890 |     .
disrupt8                 | .16216   .15203      2.7 |   0.48  0.632 |     .
nohw8                    | .06588   .06926     -1.1 |  -0.23  0.817 |     .
faminc8b                 |  39534    39587     -0.3 |  -0.06  0.955 |  0.97
fathed2                  | .32264   .31588      1.5 |   0.25  0.803 |     .
fathed3                  | .21115   .21622     -1.3 |  -0.21  0.832 |     .
fathed4                  | .39527   .40878     -2.8 |  -0.47  0.636 |     .
mothed2                  | .38007   .36486      3.1 |   0.54  0.589 |     .
mothed3                  | .22297   .22973     -1.7 |  -0.28  0.781 |     .
mothed4                  | .34459   .35473     -2.2 |  -0.37  0.715 |     .
parmar1                  | .06757   .08108     -4.6 |  -0.89  0.376 |     .
parmar2                  | .02027   .02872     -4.6 |  -0.94  0.348 |     .
collegexp                | .88514   .90541     -5.5 |  -1.14  0.255 |     .
------------------------------------------------------------------------------
* if variance ratio outside [0.85; 1.18]
-----------------------------------------------------------------------
Ps R2   LR chi2   p>chi2   MeanBias   MedBias      B       R     %Var
-----------------------------------------------------------------------
0.006      9.67    0.993      3.0       2.8      18.1    1.01       0
-----------------------------------------------------------------------
* if B>25%, R outside [0.5; 2]
. tabulate _treated _weight
 psmatch2: |
 Treatment |    psmatch2: weight of matched controls
assignment |         1          2          3          4 |     Total
-----------+--------------------------------------------+----------
 Untreated |       456         60          4          1 |       521
   Treated |       592          0          0          0 |       592
-----------+--------------------------------------------+----------
     Total |     1,048         60          4          1 |     1,113
. count if _treated==0 & _weight~=.
  521
.
. psgraph, name(psg, replace)
.
. twoway (histogram _pscore if catholic==0 [fweight = _weight], ///   bin(20) fcolor(none)
> lcolor(blue)) (histogram _pscore if catholic==1, ///   bin(20) fcolor(none) lcolor(red))
> , legend(label(1 Untreated) label(2 Treated)) ///   name(psg2, replace)
.
. graph combine psg psg2, row(1) xsize(8) ysize(4) name(q7, replace)
. graph export q7.pdf, name(q7) as(pdf) replace
(file q7.pdf written in PDF format)
```





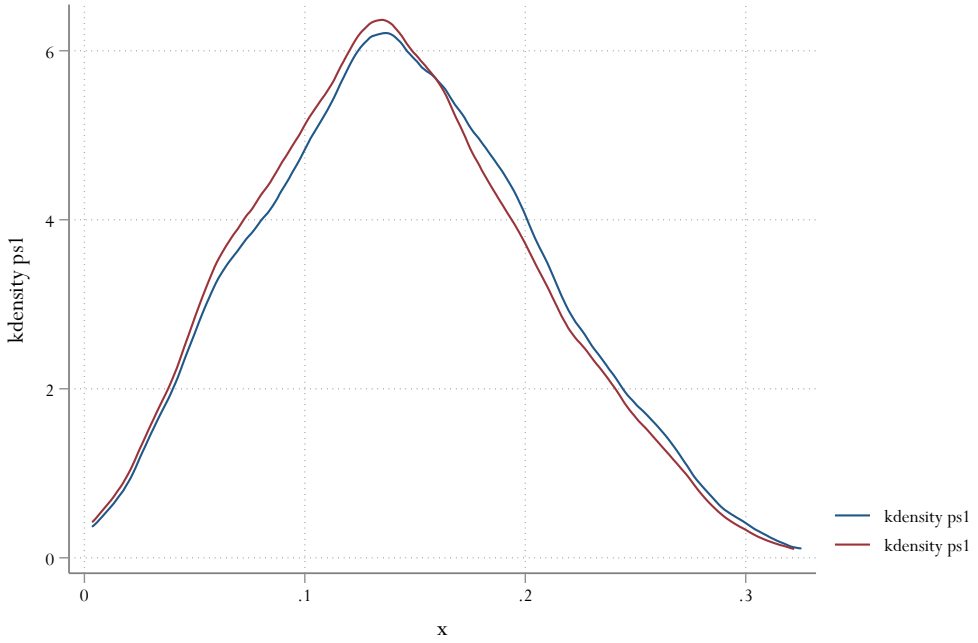

```
.
. // now show tebalance and overlap after teffects psmatch
.
. capture drop _*
. capture drop nn*
. quietly teffects psmatch (math12z) (catholic c.math8z##c.math8z c.read8z##c.read8z ///
> female black hisp api nativam riskdrop1 riskdrop2 disrupt nohw8 faminc8b ///   fathed2-f
> athed4 mothed2-mothed4 parmar1 parmar2 collegexp, probit), atet gen(nn)
```

```
. tebalance summarize math8z read8z female black hisp api nativam riskdrop1 ///   riskdrop
> 2 disrupt nohw8 faminc8b fathed2-fathed4 mothed2-mothed4 parmar1 ///   parmar2 collegexp
  Covariate balance summary
                                                  Raw      Matched
                          ----------------------------------------
                          Number of obs =        5,671        1,184
                          Treated obs   =          592          592
                          Control obs   =        5,079          592
                          ----------------------------------------
  ------------------------------------------------------------------------
                  |Standardized differences          Variance ratio
                  |        Raw     Matched           Raw    Matched
  ----------------+-------------------------------------------------------
           math8z |   .2606656    .0390663      .8200688   .9790608
           read8z |   .4356571    .0206151      .9223486   1.019996
           female |   .0496905   -.0611929      .9955598   1.014271
            black |  -.1579425   -.0141249      .6082682   .9493548
             hisp |  -.0974819    -.073021      .7768816   .8228771
              api |  -.1926191    .0479196      .3939964   1.390378
          nativam |  -.0940456   -.0416405      .5998088   .7831978
        riskdrop1 |  -.0974069    -.052802      .8844729    .931734
        riskdrop2 |  -.4043775    .0080193      .3184886   1.035202
         disrupt8 |  -.0513382    .0278314      .9158064   1.053918
            nohw8 |  -.2800718   -.0134485      .4771307   .9546722
         faminc8b |   .4572743   -.0032443      .8885848   .9738385
          fathed2 |   .0218417    .0144817      1.018799   1.011303
          fathed3 |   .0463075   -.0123526      1.072902   .9828765
          fathed4 |   .1331022   -.0275406       1.08046   .9890437
          mothed2 |   .0261837    .0314228      1.015285   1.016733
          mothed3 |   .0532039   -.0161333      1.079537   .9791022
          mothed4 |   .1463164    -.021237      1.129346   .9866866
          parmar1 |  -.2003089   -.0514933      .5706348   .8455882
          parmar2 |   -.157667   -.0546141      .4266036   .7120205
        collegexp |   .2563305   -.0661787      .6169925     1.1871
  ------------------------------------------------------------------------
. teffects overlap, ptlevel(1)
. graph export q7b.pdf, as(pdf) replace
(file q7b.pdf written in PDF format)
```




```
. predict ps0 ps1, ps
.
. gen ob=_n
. preserve
. tempfile treated
. keep if catholic==1
(5,079 observations deleted)
. keep nn1
. bysort nn1: gen weight=_N
. by nn1: keep if _n==1
(71 observations deleted)
. rename nn1 ob
. save ‘treated’
file C:\Users\corcorsp\AppData\Local\Temp\ST_42dcc_000002.tmp saved
. restore
. merge m:1 ob using ‘treated’
(note: variable ob was float, now double to accommodate using data’s values)
    Result                           # of obs.
    -----------------------------------------
    not matched                         5,150
        from master                     5,150  (_merge==1)
        from using                          0  (_merge==2)
    matched                               521  (_merge==3)
    -----------------------------------------
. replace weight=1 if catholic==1
(592 real changes made)
.
```

```
. tabstat  ps1 if weight~=., by(catholic)
Summary for variables: ps1
     by categories of: catholic (attended catholic hs?)
catholic |      mean
---------+----------
      no |  .1408053
     yes |  .1448398
---------+----------
   Total |  .1429512
--------------------
. twoway (kdensity ps1 if catholic==1) (kdensity ps1 if catholic==0 & weight~=.), ///   na
> me(q7c, replace)
. graph export q7c.pdf, as(pdf) replace
(file q7c.pdf written in PDF format)
```




```
.
.
. // ***********
. // Question 8
. // ***********
.
. foreach j in math12z read12z hsgrad inpse {
  2.    display in red "Outcome: `j'"
  3.    _eststo psm`j': teffects psmatch (`j') (catholic c.math8z##c.math8z c.read8z##c.re
> ad8z ///      female black hisp api nativam riskdrop1 riskdrop2 disrupt nohw8 faminc8b /
> //      fathed2-fathed4 mothed2-mothed4 parmar1 parmar2 collegexp, probit), atet
  4.
```

```
.    psmatch2 catholic c.math8z##c.math8z c.read8z##c.read8z female black hisp ///      ap
> i nativam riskdrop1 riskdrop2 disrupt nohw8 faminc8b fathed2-fathed4 ///          mothed
> 2-mothed4 parmar1 parmar2 collegexp, outcome(‘j’)
  5.    }
Outcome: math12z
Treatment-effects estimation                    Number of obs      =      5,671
Estimator      : propensity-score matching      Matches: requested =          1
Outcome model  : matching                                   min =          1
Treatment model: probit                                     max =          1
------------------------------------------------------------------------------
             |               AI Robust
     math12z |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATET         |
    catholic |
(yes vs no)  |   .1204992   .0417063     2.89   0.004     .0387563    .2022421
------------------------------------------------------------------------------
Probit regression                               Number of obs     =      5,671
                                                LR chi2(23)       =     270.89
                                                Prob > chi2       =     0.0000
Log likelihood = -1762.2102                     Pseudo R2         =     0.0714
------------------------------------------------------------------------------
    catholic |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      math8z |  -.0334847   .0375223    -0.89   0.372     -.107027    .0400576
             |
    c.math8z#|
    c.math8z |  -.0852282   .0251197    -3.39   0.001     -.134462   -.0359944
             |
      read8z |   .1766125   .0345038     5.12   0.000     .1089862    .2442387
             |
    c.read8z#|
    c.read8z |   .0128866    .025047     0.51   0.607    -.0362045    .0619777
             |
      female |   .0207307    .050002     0.41   0.678    -.0772715    .1187328
       black |   -.124419   .0969725    -1.28   0.199    -.3144816    .0656435
        hisp |  -.0186785   .0820854    -0.23   0.820     -.179563    .1422059
         api |   -.554642    .129953    -4.27   0.000    -.8093452   -.2999388
     nativam |  -.2416373   .1417836    -1.70   0.088     -.519528    .0362535
   riskdrop1 |  -.0060125   .0633419    -0.09   0.924    -.1301603    .1181352
   riskdrop2 |  -.2225268   .1159476    -1.92   0.055    -.4497798    .0047262
    disrupt8 |   .0966356   .0675578     1.43   0.153    -.0357753    .2290466
       nohw8 |  -.3036905   .0848934    -3.58   0.000    -.4700786   -.1373025
    faminc8b |   7.40e-06   1.66e-06     4.47   0.000     4.15e-06    .0000106
     fathed2 |   .1835301   .0932529     1.97   0.049     .0007578    .3663024
     fathed3 |   .1129928    .101119     1.12   0.264    -.0851969    .3111824
     fathed4 |   .1260127   .0986007     1.28   0.201    -.0672412    .3192665
     mothed2 |   .2766157   .1005447     2.75   0.006     .0795518    .4736796
     mothed3 |   .2626728   .1087212     2.42   0.016     .0495831    .4757624
     mothed4 |   .3072885    .107914     2.85   0.004      .095781    .5187959
     parmar1 |  -.1165539   .0997515    -1.17   0.243    -.3120631    .0789554
     parmar2 |    -.11798   .1497204    -0.79   0.431    -.4114266    .1754665
   collegexp |   .1585568   .0706054     2.25   0.025     .0201728    .2969408
       _cons |  -1.899869   .1401612   -13.55   0.000     -2.17458   -1.625159
------------------------------------------------------------------------------
------------------------------------------------------------------------------------
        Variable     Sample |    Treated     Controls   Difference         S.E.   T-stat
---------------------------+--------------------------------------------------------
         math12z  Unmatched | .367093217   -.04278779   .409881007   .043090321     9.51
                       ATT | .367093217   .246503091   .120590126   .054733479     2.20
```

```
 psmatch2: |   Common
 Treatment |  support
assignment | On suppor |     Total
-----------+-----------+----------
 Untreated |     5,079 |     5,079
   Treated |       592 |       592
-----------+-----------+----------
     Total |     5,671 |     5,671
Outcome: read12z
Treatment-effects estimation                   Number of obs      =      5,671
Estimator      : propensity-score matching     Matches: requested =          1
Outcome model  : matching                                  min =          1
Treatment model: probit                                    max =          1
------------------------------------------------------------------------------
             |              AI Robust
     read12z |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATET         |
    catholic |
(yes vs no)  |  -.0031015   .0437156    -0.07   0.943    -.0887824    .0825794
------------------------------------------------------------------------------
Probit regression                              Number of obs     =      5,671
                                               LR chi2(23)       =     270.89
                                               Prob > chi2       =     0.0000
Log likelihood = -1762.2102                    Pseudo R2         =     0.0714
------------------------------------------------------------------------------
    catholic |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      math8z |  -.0334847   .0375223    -0.89   0.372     -.107027    .0400576
             |
    c.math8z#|
    c.math8z |  -.0852282   .0251197    -3.39   0.001     -.134462   -.0359944
             |
      read8z |   .1766125   .0345038     5.12   0.000     .1089862    .2442387
             |
    c.read8z#|
    c.read8z |   .0128866    .025047     0.51   0.607    -.0362045    .0619777
             |
      female |   .0207307    .050002     0.41   0.678    -.0772715    .1187328
       black |   -.124419   .0969725    -1.28   0.199    -.3144816    .0656435
        hisp |  -.0186785   .0820854    -0.23   0.820     -.179563    .1422059
         api |   -.554642    .129953    -4.27   0.000    -.8093452   -.2999388
     nativam |  -.2416373   .1417836    -1.70   0.088     -.519528    .0362535
   riskdrop1 |  -.0060125   .0633419    -0.09   0.924    -.1301603    .1181352
   riskdrop2 |  -.2225268   .1159476    -1.92   0.055    -.4497798    .0047262
    disrupt8 |   .0966356   .0675578     1.43   0.153    -.0357753    .2290466
       nohw8 |  -.3036905   .0848934    -3.58   0.000    -.4700786   -.1373025
    faminc8b |   7.40e-06   1.66e-06     4.47   0.000     4.15e-06    .0000106
     fathed2 |   .1835301   .0932529     1.97   0.049     .0007578    .3663024
     fathed3 |   .1129928    .101119     1.12   0.264    -.0851969    .3111824
     fathed4 |   .1260127   .0986007     1.28   0.201    -.0672412    .3192665
     mothed2 |   .2766157   .1005447     2.75   0.006     .0795518    .4736796
     mothed3 |   .2626728   .1087212     2.42   0.016     .0495831    .4757624
     mothed4 |   .3072885    .107914     2.85   0.004      .095781    .5187959
     parmar1 |  -.1165539   .0997515    -1.17   0.243    -.3120631    .0789554
     parmar2 |    -.11798   .1497204    -0.79   0.431    -.4114266    .1754665
   collegexp |   .1585568   .0706054     2.25   0.025     .0201728    .2969408
       _cons |  -1.899869   .1401612   -13.55   0.000     -2.17458   -1.625159
------------------------------------------------------------------------------
```

```
                        ATT | .328277963   .331379442  -.003101478   .055027185    -0.06
----------------------------+-----------------------------------------------------------
Note: S.E. does not take into account that the propensity score is estimated.
           | psmatch2:
 psmatch2: |   Common
 Treatment |  support
assignment | On suppor |     Total
-----------+-----------+----------
 Untreated |     5,079 |     5,079
   Treated |       592 |       592
-----------+-----------+----------
     Total |     5,671 |     5,671
Outcome: hsgrad
Treatment-effects estimation                   Number of obs      =      5,671
Estimator      : propensity-score matching     Matches: requested =          1
Outcome model  : matching                                  min =          1
Treatment model: probit                                    max =          1
------------------------------------------------------------------------------
             |               AI Robust
      hsgrad |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATET         |
    catholic |
(yes vs no)  |   .0118243    .010934     1.08   0.280    -.0096059    .0332545
------------------------------------------------------------------------------
Probit regression                              Number of obs     =      5,671
                                               LR chi2(23)       =     270.89
                                               Prob > chi2       =     0.0000
Log likelihood = -1762.2102                    Pseudo R2         =     0.0714
------------------------------------------------------------------------------
    catholic |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      math8z |  -.0334847   .0375223    -0.89   0.372     -.107027    .0400576
             |
    c.math8z#|
    c.math8z |  -.0852282   .0251197    -3.39   0.001     -.134462   -.0359944
             |
      read8z |   .1766125   .0345038     5.12   0.000     .1089862    .2442387
             |
    c.read8z#|
    c.read8z |   .0128866    .025047     0.51   0.607    -.0362045    .0619777
             |
      female |   .0207307    .050002     0.41   0.678    -.0772715    .1187328
       black |   -.124419   .0969725    -1.28   0.199    -.3144816    .0656435
        hisp |  -.0186785   .0820854    -0.23   0.820     -.179563    .1422059
         api |   -.554642    .129953    -4.27   0.000    -.8093452   -.2999388
     nativam |  -.2416373   .1417836    -1.70   0.088     -.519528    .0362535
   riskdrop1 |  -.0060125   .0633419    -0.09   0.924    -.1301603    .1181352
   riskdrop2 |  -.2225268   .1159476    -1.92   0.055    -.4497798    .0047262
    disrupt8 |   .0966356   .0675578     1.43   0.153    -.0357753    .2290466
       nohw8 |  -.3036905   .0848934    -3.58   0.000    -.4700786   -.1373025
    faminc8b |   7.40e-06   1.66e-06     4.47   0.000     4.15e-06    .0000106
     fathed2 |   .1835301   .0932529     1.97   0.049     .0007578    .3663024
     fathed3 |   .1129928    .101119     1.12   0.264    -.0851969    .3111824
     fathed4 |   .1260127   .0986007     1.28   0.201    -.0672412    .3192665
     mothed2 |   .2766157   .1005447     2.75   0.006     .0795518    .4736796
     mothed3 |   .2626728   .1087212     2.42   0.016     .0495831    .4757624
     mothed4 |   .3072885    .107914     2.85   0.004      .095781    .5187959
     parmar1 |  -.1165539   .0997515    -1.17   0.243    -.3120631    .0789554
```

```
------------------------------------------------------------------------------
    Variable     Sample |    Treated     Controls   Difference         S.E.   T-stat
-------------------------+----------------------------------------------------------
      hsgrad  Unmatched | .974662162   .910218547   .064443615    .01195636     5.39
                    ATT | .974662162   .962837838   .011824324   .010813283     1.09
-------------------------+----------------------------------------------------------
Note: S.E. does not take into account that the propensity score is estimated.
           | psmatch2:
 psmatch2: |   Common
 Treatment |  support
assignment | On suppor |     Total
-----------+-----------+----------
 Untreated |     5,079 |     5,079
   Treated |       592 |       592
-----------+-----------+----------
     Total |     5,671 |     5,671
Outcome: inpse
Treatment-effects estimation                   Number of obs      =      5,671
Estimator      : propensity-score matching     Matches: requested =          1
Outcome model  : matching                                  min =          1
Treatment model: probit                                    max =          1
------------------------------------------------------------------------------
             |              AI Robust
       inpse |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATET         |
    catholic |
(yes vs no)  |   .0574324   .0210931     2.72   0.006     .0160907    .0987742
------------------------------------------------------------------------------
Probit regression                               Number of obs     =      5,671
                                                LR chi2(23)       =     270.89
                                                Prob > chi2       =     0.0000
Log likelihood = -1762.2102                     Pseudo R2         =     0.0714
------------------------------------------------------------------------------
    catholic |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      math8z |  -.0334847   .0375223    -0.89   0.372     -.107027    .0400576
             |
    c.math8z#|
    c.math8z |  -.0852282   .0251197    -3.39   0.001     -.134462   -.0359944
             |
      read8z |   .1766125   .0345038     5.12   0.000     .1089862    .2442387
             |
    c.read8z#|
    c.read8z |   .0128866    .025047     0.51   0.607    -.0362045    .0619777
             |
      female |   .0207307    .050002     0.41   0.678    -.0772715    .1187328
       black |   -.124419   .0969725    -1.28   0.199    -.3144816    .0656435
        hisp |  -.0186785   .0820854    -0.23   0.820     -.179563    .1422059
         api |   -.554642    .129953    -4.27   0.000    -.8093452   -.2999388
     nativam |  -.2416373   .1417836    -1.70   0.088     -.519528    .0362535
   riskdrop1 |  -.0060125   .0633419    -0.09   0.924    -.1301603    .1181352
   riskdrop2 |  -.2225268   .1159476    -1.92   0.055    -.4497798    .0047262
    disrupt8 |   .0966356   .0675578     1.43   0.153    -.0357753    .2290466
       nohw8 |  -.3036905   .0848934    -3.58   0.000    -.4700786   -.1373025
    faminc8b |   7.40e-06   1.66e-06     4.47   0.000     4.15e-06    .0000106
     fathed2 |   .1835301   .0932529     1.97   0.049     .0007578    .3663024
     fathed3 |   .1129928    .101119     1.12   0.264    -.0851969    .3111824
     fathed4 |   .1260127   .0986007     1.28   0.201    -.0672412    .3192665
```

```
     parmar2 |    -.11798   .1497204    -0.79   0.431    -.4114266    .1754665
   collegexp |   .1585568   .0706054     2.25   0.025     .0201728    .2969408
       _cons |  -1.899869   .1401612   -13.55   0.000     -2.17458   -1.625159
------------------------------------------------------------------------------
------------------------------------------------------------------------------------------
        Variable     Sample |    Treated     Controls   Difference         S.E.   T-stat
-----------------------------+------------------------------------------------------------
           inpse  Unmatched | .861486486     .6914747   .170011787   .019595842     8.68
                        ATT | .861486486   .804054054   .057432432   .023261301     2.47
-----------------------------+------------------------------------------------------------
Note: S.E. does not take into account that the propensity score is estimated.
           | psmatch2:
 psmatch2: |   Common
 Treatment |  support
assignment | On suppor |     Total
-----------+-----------+----------
 Untreated |     5,079 |     5,079
   Treated |       592 |       592
-----------+-----------+----------
     Total |     5,671 |     5,671
.
. table _treated _weight, row col
-------------------------------------------
psmatch2: |
Treatment |    psmatch2: weight of matched
assignmen |             controls
t         |     1      2      3      4  Total
----------+--------------------------------
Untreated |   456     60      4      1    521
  Treated |   592                          592
          |
    Total | 1,048     60      4      1  1,113
-------------------------------------------
. count if _treated==0 & _weight~=.
  521
.
.
. // ***********
. // Question 9
. // ***********
.
```

```
. foreach j in math12z read12z hsgrad inpse {
  2.    display in red "Outcome: `j'"
  3.    _eststo ipw`j': teffects ipw (`j') (catholic c.math8z##c.math8z c.read8z##c.read8z
> ///      female black hisp api nativam riskdrop1 riskdrop2 disrupt nohw8 faminc8b ///
> fathed2-fathed4 mothed2-mothed4 parmar1 parmar2 collegexp, probit), atet
  4. }
Outcome: math12z
Iteration 0:   EE criterion =  3.162e-24
Iteration 1:   EE criterion =  4.938e-33
Treatment-effects estimation                    Number of obs     =      5,671
Estimator      : inverse-probability weights
Outcome model  : weighted mean
Treatment model: probit
------------------------------------------------------------------------------
             |               Robust
     math12z |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATET         |
    catholic |
(yes vs no)  |   .1156927   .0233943     4.95   0.000     .0698407    .1615447
-------------+----------------------------------------------------------------
POmean       |
    catholic |
         no  |   .2514005   .0316755     7.94   0.000     .1893178    .3134833
------------------------------------------------------------------------------
Outcome: read12z
Iteration 0:   EE criterion =  3.162e-24
Iteration 1:   EE criterion =  8.060e-34
Treatment-effects estimation                    Number of obs     =      5,671
Estimator      : inverse-probability weights
Outcome model  : weighted mean
Treatment model: probit
------------------------------------------------------------------------------
             |               Robust
     read12z |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATET         |
    catholic |
(yes vs no)  |   .0379625     .02795     1.36   0.174    -.0168185    .0927435
-------------+----------------------------------------------------------------
POmean       |
    catholic |
         no  |   .2903155   .0292765     9.92   0.000     .2329346    .3476964
------------------------------------------------------------------------------
Outcome: hsgrad
Iteration 0:   EE criterion =  3.162e-24
Iteration 1:   EE criterion =  4.743e-34
Treatment-effects estimation                    Number of obs     =      5,671
Estimator      : inverse-probability weights
Outcome model  : weighted mean
Treatment model: probit
------------------------------------------------------------------------------
             |               Robust
      hsgrad |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATET         |
    catholic |
(yes vs no)  |   .0210462   .0071286     2.95   0.003     .0070743    .0350181
-------------+----------------------------------------------------------------
POmean       |
```

```
Outcome: inpse
Iteration 0:   EE criterion =  3.162e-24
Iteration 1:   EE criterion =  2.194e-33
Treatment-effects estimation                    Number of obs     =      5,671
Estimator      : inverse-probability weights
Outcome model  : weighted mean
Treatment model: probit
------------------------------------------------------------------------------
             |               Robust
       inpse |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ATET         |
    catholic |
(yes vs no)  |   .0637249   .0149414     4.26   0.000     .0344404    .0930095
-------------+----------------------------------------------------------------
POmean       |
    catholic |
         no  |   .7977616   .0089675    88.96   0.000     .7801857    .8153374
------------------------------------------------------------------------------
.
. esttab _all using PS2estimates.csv, se paren csv replace
(note: file PS2estimates.csv not found)
(output written to PS2estimates.csv)
. capture log close
```