Final project

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Introduction

The National School Lunch program (NSLP) is important to society because it helps to keep more kids in school thereby reducing the rate of crime and securing a better future for kids. The motivation for this evaluation was that I believe children are the future, and this future mostly depends on their education. Quality education on the other hand is influenced by factors such as the availability of food. The idea is that when kids are hungry, they will either not go to school or not focus when they do go. So, this program was implemented to serve as a source of a pulling force for more kids to enroll in schools. Especially those who cannot make it to schools because they do not have money for lunch.The program has many benefits but among them all, i want to know if it has any sort of effect on student's final standardized test scores. I am therefore motivated to perform this evaluation to determine how much of an effect it has on final standardized test scores and how the program can be made more effective.

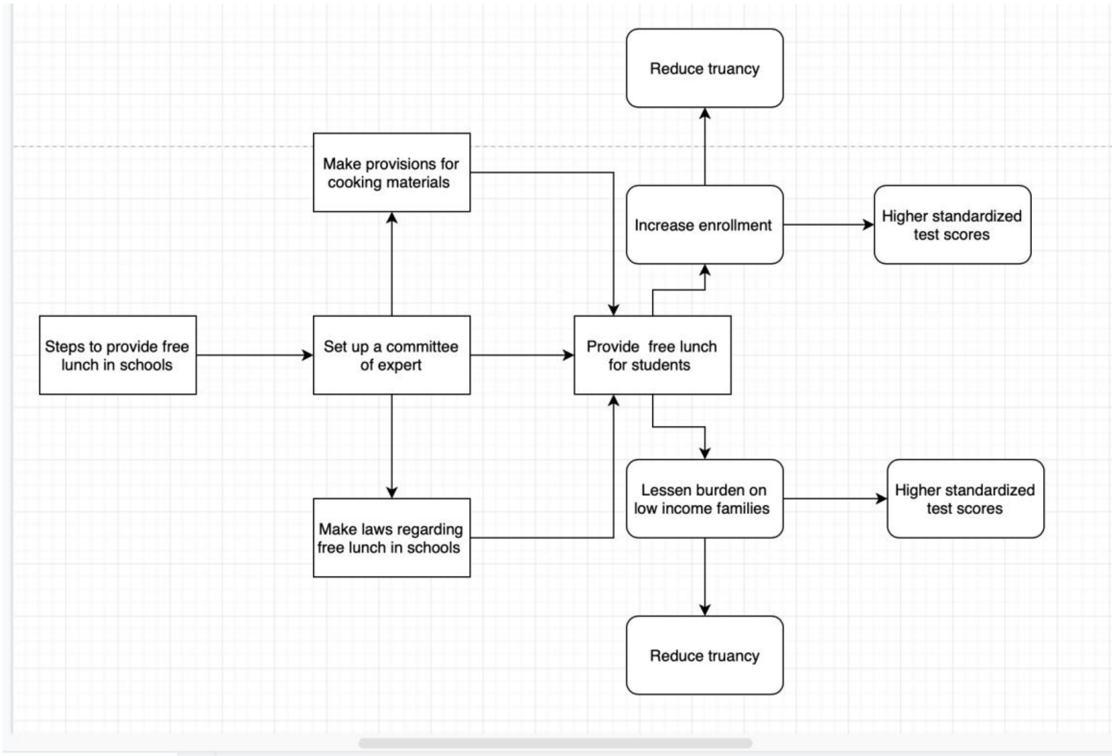
Program overview

The National School Lunch program is a federally assisted meal program operating in public and nonprofit private schools and residential childcare institutions. It was established under the Richard B. Russell National School Lunch Act and was signed into law by President Harry Truman in 1946. It was started to provide nutritionally balanced, low-cost or no-cost lunches to children each school day. It was designed to address truancy and absenteeism in schools due to parent's inability to provide food for children. In essence, this is to influence more students to attend school and also encourage those in school to stay till completion. In 2006, it was reported that the NSLP operated in over 101,000 public and nonprofit private schools and provided over 28 million low-cost or free lunches to children on a typical school day at a Federal cost of $8 billion for the year.

Program theory and implementation

Program theory and impact theory graph

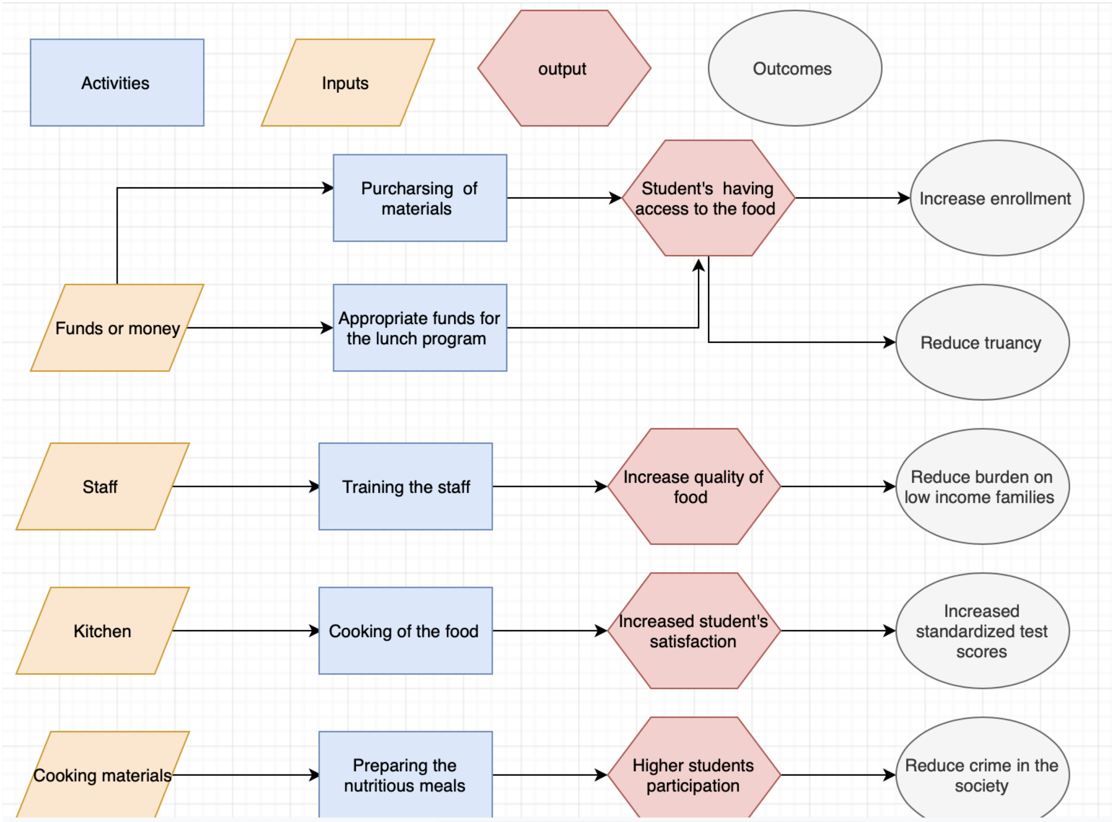
The underlying theory is that, most parents might not feel the urge to send their wards to school especially if they cannot afford lunch for them. The introduction of the program was not only to increase enrollment but also serve nutritious and appealing school lunches, including free and reduced-price lunches for low-income students and in the end lead to higher standardized test scores among students and better job prospects. So, the designers of the program planned that the establishment of the program was to ensure that children, especially those from low-income families will be more attracted to attend schools or stay in schools and remain healthy and nutritious when free or low-cost lunch is provided.



impact model

The program activties includes the purchasing of materials, training the staff and cooking of the food. The inputs includes the kitchen, funds, staff etc. The outputs include increase in food quality, increase in students participation etc. and the outcomes include higher standardized final test scores, reduced truancy,reduction in crime rates etc.

Logic model



logic model

Outcome and causation

Main outcome

The main outcome I want to evaluate is "increased standardized test scores of final scores". This is the most important because I believe this influences their acceptance into higher levels of education and encourages more children to be enrolled in schools as well, this in turn will help to measure how effective our educational policies are working especially with regards to student's performances. I don't think it's the easiest to measure but I believe it has the greatest impact on society and on the children's lives.

Measurement

Possible attributes of the outcome include; • Higher student's grades • Higher student's participation • Increase student enrollment • Higher retention rate • Lower drop-out rate • Higher parent's participation

List further narrowed; Higher student's grades Higher student's participation Lower drop-out rate

I decided on these four because I think these attributes capture the outcome in a more effective way. When student's standardized test score increases, it is going to lead to higher student's grades (all things being equal). This is going to translate into higher student's enrollment also. Again, when student's standardized test score increase, there is a higher possibility that student's participation will also increase as they will be moved to engage in all other school activities that will enhance their lives. Higher enrollment also means students find something interesting in the schools which is going to cause them to not drop out of the school.

Higher student's grades o Measurable definition Six months after the NSLP was implemented, the student's average grades increased by 18%.

o Ideal measurement There will be a control and a treatment group. We will sample the schools who had the NSLP and compare their average student's grades with the school's whose students didn't get the NSLP program to observe the differences.

o Feasible measurement Because there is a budget constraint here, we will reduce our sample size to a small number picked from the population to test if the NSLP program led to higher student's standardized test scores.

o Measurement of Program effect To test that the program is the main cause of the results we are seeing, we will control for all other variables and eliminate all factors that are likely to give us similar results.

Increased student's participation o Measurable definition One year after the program was implemented, student's involvement in school related activities increased by 23 percent.

o Ideal measurement There will be control and a treatment group with students in both and then we compare and determine if students who were selected into the program had participated in more school activities or not. o Feasible measurement For budget and time constraint purposes, this study will be done within just two test score writing periods with a smaller sample size of about just 2500 students.

o Measurement of Program effect All other related variables will be controlled for in the study to get the main program effect.

Lower drop-out rate o Measurable definition Student's drop-out rate decreased by almost 15%, three months after the NSLP was implemented in certain schools.

o Ideal measurement The drop-out rate of schools who had the program will be compared against those who didn't get the program to observe the differences.

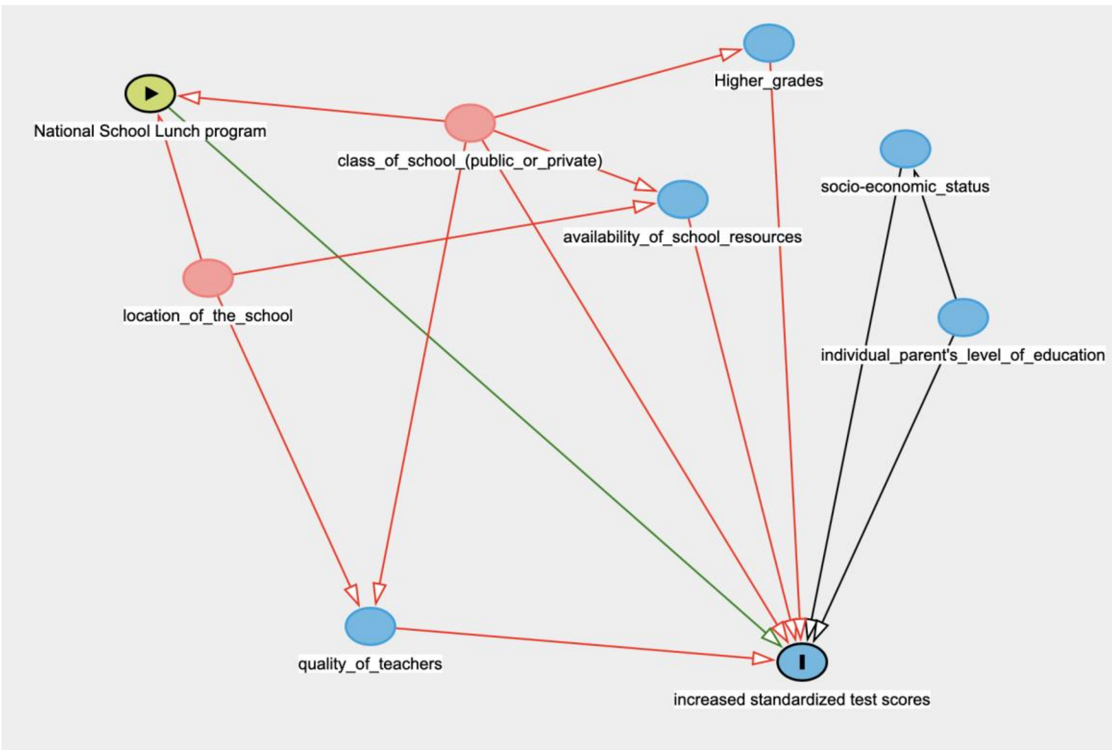
o Feasible measurement There will be a pre-test and a post-test conducted to make the measurement of differences faster and less costly.

o Measurement of Program effect This will be done by ensuring that all other factors that are likely to affect student's drop-out rates are controlled for so that we can confidently link the outcome to the program.

Causal theory

The DAG below shows that aside the National School Lunch Program, factors such as a student's family income, the location of the school, the availability of resources, quality of teachers and the individual parent's level of education affects students final standardized test score.

Dag



the main dag

Hypotheses

After the program has been implemented, student's standarized test scores will increase, and i expect it to increase by more than at least 20%.

Data and methods

Identification strategy

I am going to rely on regression discontinuity because the program has a many cutoff points or an eligibility criterion that precludes students from some households from participating in it. Household income should be less than or equal to 130 percent of the poverty level, or the household should be participating in Temporary Aid to Needy Families (TANF), Food Stamp Program (FSP).For this study, schools should have their average student's standardized test score being below 80 to participate in the program.This approach accounts for selection bias by using simple sampling methods where students are picked randomly to participate in the program, this ensures that students who are picked share some common similarities in terms of their age, grades etc. This model controls for endogeneity by ensuring that all or most outside variables that have the potential to affect the models we add in our study are controlled for.

Data

For this study , i am relying on a goverment-agency collected data because i beleive to a higher extent this data is collected using the best techniques and it has been done to reduce any form of intenal threats and biases. But i will verify this data and be sure that it has variables such as the numebr of males and females in the school, the age of students, and many others.

Synthetic analysis

```
set.seed(1234)
  NSLP_program <- r_data_frame(
  n = 2500,
  id,
  test_score = rbeta(shape1 = 8, shape2 = 2),
  final_score = rbeta(shape1 = 5, shape2 = 3),
  race,
  sex
) %>%
  mutate(test_score = test_score * 100,
         NSLP_program = test_score >= 80) %>%
  mutate(final_score = final_score * 40 + 10 * NSLP_program + test_score / 2)
write_csv(NSLP_program, "data.csv")
```

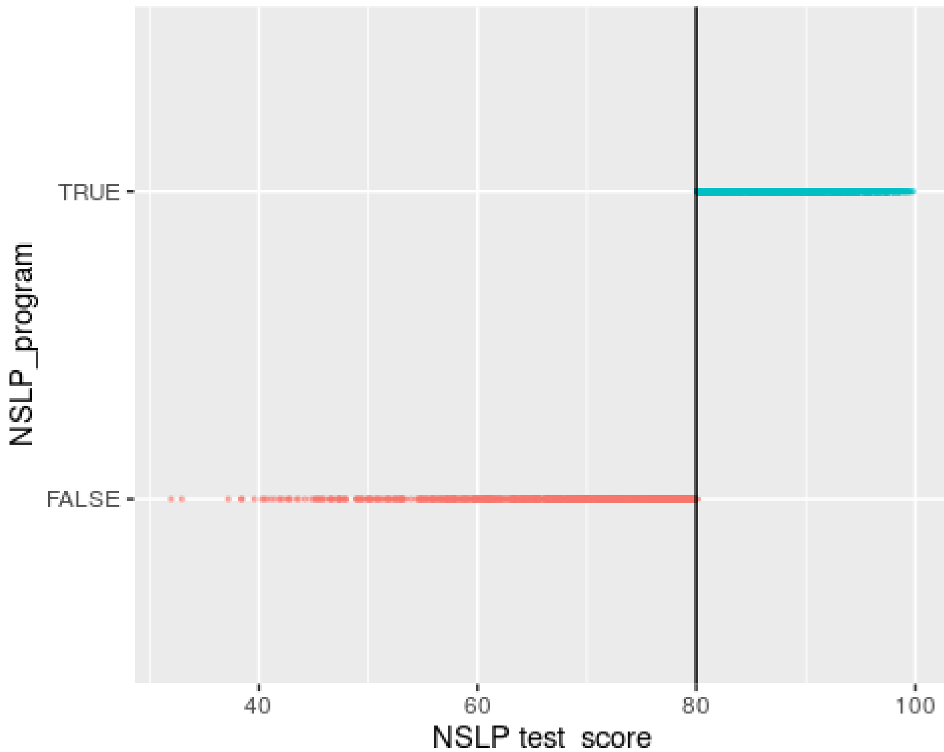
Step 1: Determine if Process of assigning treatment is Rule-based

This program is rule-based because for students to be able to get into the program their household should earn 130 percent below the poverty level depending on the state, and for this study, schools should have an average NSLP test score of less than 80 to be enrolled in the program.

Now that we know selection into the program was based strictly on some rules, we now want to know how strictly this rule was applied. We know there was cutoff for schools having a certain test scores but now we want to know if school's that made a little above that test score were considered or not.

```
ggplot(NSLP_program, aes(x = test_score, y = NSLP_program, color = NSLP_progr
am)) +
geom_point(size = 0.5, alpha = 0.5) +
geom_vline(xintercept = 80) +
```

```
labs(x = "NSLP test_score", y = "NSLP_program") +
guides(color = FALSE)
```




```
options(scipen = 800)
```

This looks very sharp, meaning that for household who earned more than 53760, their children were not accepted into the program.

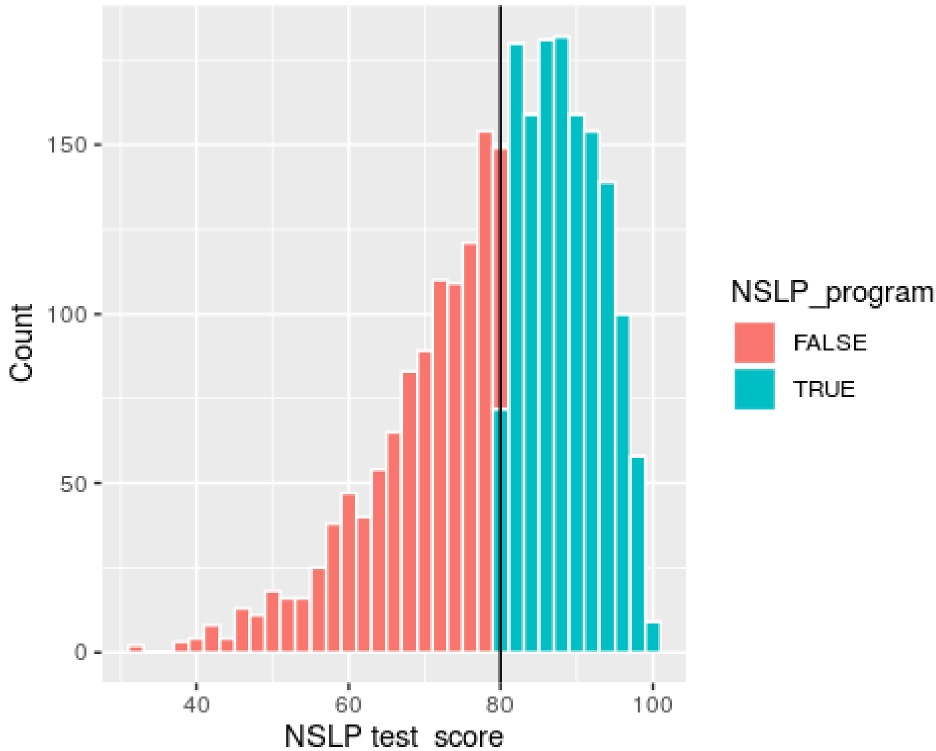
```
NSLP_program %>%
group_by(NSLP_program, test_score <= 80) %>%
  summarize(count = n())

## # A tibble: 2 x 3
## # Groups:   NSLP_program [2]
##   NSLP_program `test_score <= 80` count
##   <lgl>        <lgl>              <int>
## 1 FALSE        TRUE                1107
## 2 TRUE         FALSE               1393
```

Check for Discontinuiy in running varaible around cutpoint

Now we want to see if there was any form of manipulation in the data.

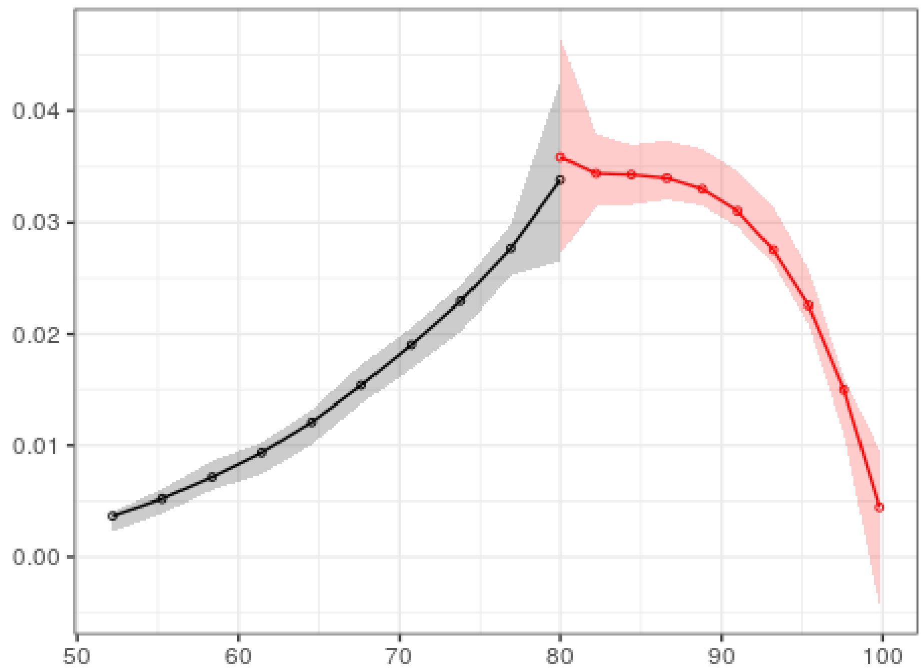
```
ggplot(NSLP_program, aes(x = test_score, fill = NSLP_program)) +
  geom_histogram(binwidth = 2, color = "white") +
  geom_vline(xintercept = 80) +
  labs(x = "NSLP test_score", y = "Count")
```



It look like there's a jump in the running variable around the cutoff. Meaning that we see the heights of the graphs being higher after the cutoff.

We are goig to test if the difference is statisically signifcant by using the McCrary density test. This test is used to put data into bins like a histogram, and then plots the averages and confidence intervals of those bins. If the confidence intervals do not overalp, then there is something wrong systemaicall with how people were accepted into the NSLP program. If the confidence intervals overlap, there is not a significant difference around the threshold and the results are fine.

```
test_density <- rdplotdensity(rdd = rddensity(NSLP_program$test_score, c = 80
),
                              X = NSLP_program$test_score,
                              type = "both")
```

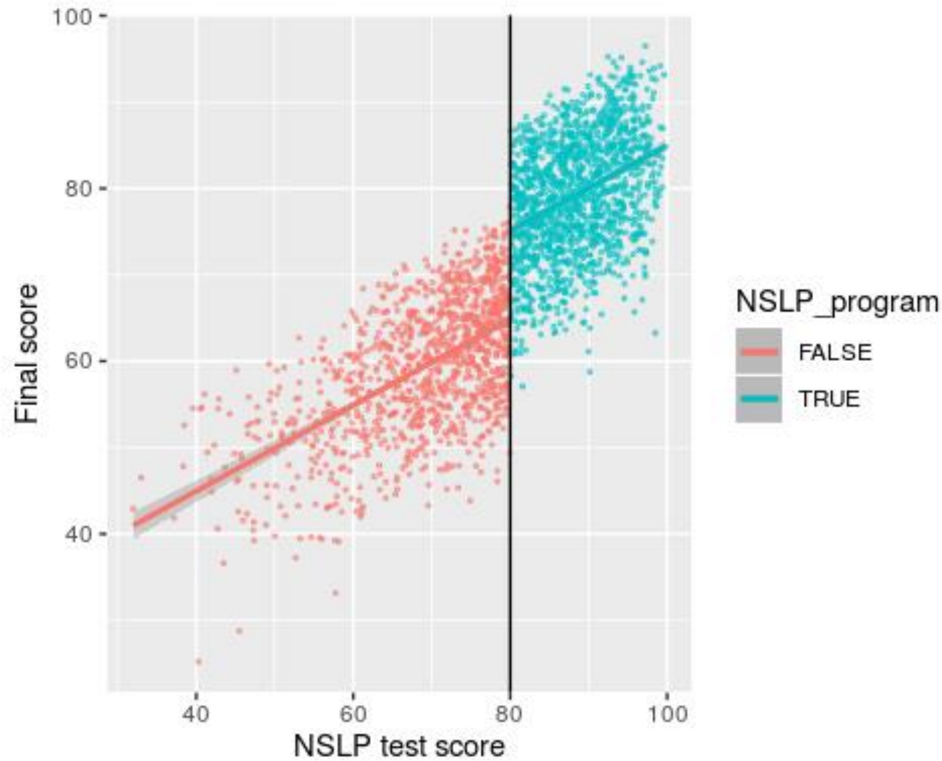


Based on the above, there is no significance difference of test scores around the cutoff so we are good.

Step 4: Check for discontinuity in outcome across running variable

Since the design is sharp and theres no bunching at the test-score threshold, we can finally see if there is a discontinuity in outcome we can finally see if there's a discontinuity in final scores based on participation in the National School Lunch Program. The running variable 'test_score' is plotted on the x axis, and the outcome is final score.

```
ggplot(NSLP_program, aes(x = test_score, y = final_score, color = NSLP_progra
m)) +
  geom_point(size = 0.5, alpha = 0.5) +
  geom_smooth(data = filter(NSLP_program, test_score < 80), method = "lm") +
  geom_smooth(data = filter(NSLP_program, test_score >= 80), method = "lm") +
  geom_vline(xintercept = 80) +
  labs(x = "NSLP test score", y = "Final score")
```



Based on this graph, there's a clear discontinuity! It looks like schools that participated in the National School Lunch program boosted final standardizded test scores

Step 5: Measure the size of the effect

There is disontinuity, but we need to measure how big it is and see if its statistically significant.

We can check the size two different ways: parametrically (i.e. using lm() with specific parameters and coefficients), and nonparametrically (i.e. not using lm() or any kind of straight line and instead drawing lines that fit the data more precisely). We'll do it both ways.

Parametric Estimation

First we'll do it parametrically by using linear regression. Here we want to explain the variation in final standardized test scores based on the NSLP test score and participation in the program:

Final Score = B0 + B1NSLPtest-score + B2NSLPfinal_score + E

To make it easier to interpret coefficients, we can center the test score column so that instead of showing the actual test score, it shows how much above or below 80 the schools recorded.

```
NSLP_program <- NSLP_program %>%
  mutate(test_score_centered = test_score - 80)
```

```
model_simple <- lm(final_score ~ test_score_centered + NSLP_program, data = N
SLP_program)
tidy(model_simple)
```

term	estimate	std.error	statistic	p.value
(Intercep	64.8	0.277	234	0
test_scor	0.496	0.0181	27.4	5.14e-
NSLP_pr	10.2	0.436	23.5	2.74e-

The B0, which is the intercept, is the average and this shows the average final score at the 80-point cutoff. It shows that people who scored 79.99 on the NSLP test will are likely to score an average of 64.8 on the final test score.

The B1, test_score_centered is for every point above 80 that students scored on the NSLP test, they scored 0.496 higher on the final standardized test.

The B2, NSLP_programTRUE is the shift in the intercept when the acceptance in the NSLP is true or the difference between values at the cutoff which is 80. Being in the National School Lunch program increases the likely hood by 10.24.

We can fit the same model but restrict it to people within a smaller window, or bandwidth, like ±10 in income or ±15

```
model_bw_10 <- lm(final_score ~ test_score_centered + NSLP_program,
                  data = filter(NSLP_program, test_score_centered >= -10 & te
st_score_centered <= 10))
tidy(model_bw_10)
```

term	estimate	std.error	statistic	p.value
(Intercep	64.9	0.372	175	0
test_scor	0.496	0.0593	8.36	1.4e-16
NSLP_pr	10.2	0.658	15.4	6.54e-50

```
model_bw_15 <- lm(final_score ~ test_score_centered + NSLP_program,
                 data = filter(NSLP_program, test_score_centered >= -15 & tes
t_score_centered <= 15))
tidy(model_bw_15)
```

term	estimate	std.error	statistic	p.value
(Intercep	65	0.311	209	0
test_scor	0.528	0.0336	15.7	1.28e-52
NSLP_pr	9.88	0.544	18.2	1.45e-68

We can also compare all these models simultaneously with huxreg:

```r
huxreg(list("Simple" = model_simple,
            "Bandwidth = 10" = model_bw_10,
            "Bandwidth = 15" = model_bw_15))
```

	Simple	Bandwidt	Bandwidt
(Intercep	64.822	64.926	65.021
	(0.277)	(0.372)	(0.311)
test_scor	0.496 ***	0.496 ***	0.528 ***
	(0.018)	(0.059)	(0.034)
NSLP_pr	10.245	10.166	9.884 ***
	(0.436)	(0.658)	(0.544)
N	2500	1459	2034
R2	0.726	0.576	0.647
logLik	-	-	-
AIC	16410.0	9571.36	13328.2

*** p < 0.001; ** p < 0.01; * p < 0.05.

The effect of being accepted into the National School Lunch program differs accross these models, from 9.9 to 10.2, you can also see as the bindwidth was narrowed you loo at less observations

Nonparametric estimation

An alternate method of using linear regression is nonparametric methods. This means that R will not try to fit a straight line to the data, but rather it will curve around the points and try to fit everything as smoothly as possible.

```r
rdrobust(y = NSLP_program$final_score, x = NSLP_program$test_score, c = 80) %
>%
  summary()
```

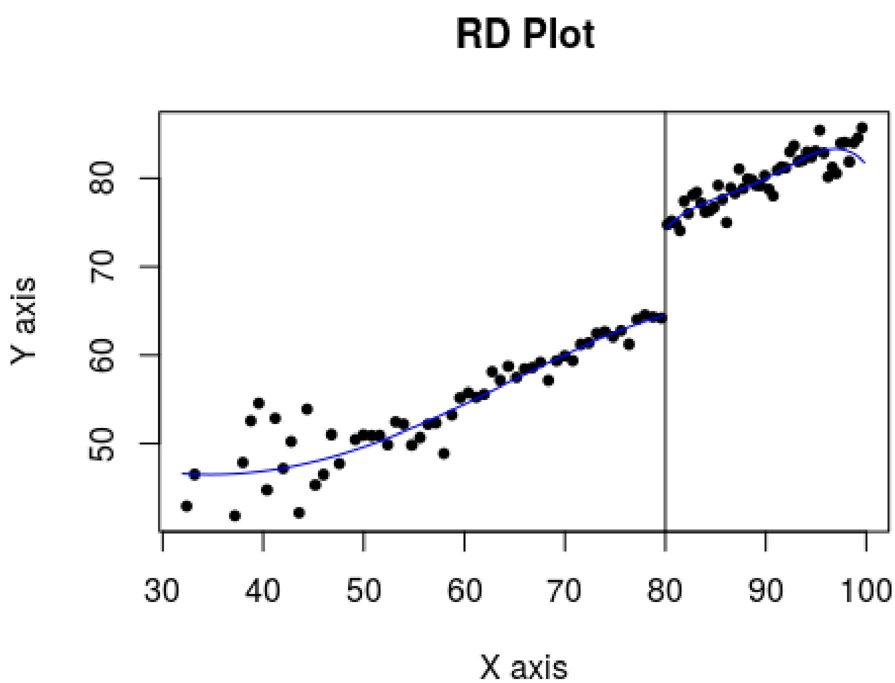
```
## Call: rdrobust
##
## Number of Obs.                 2500
## BW type                       mserd
## Kernel                   Triangular
## VCE method                       NN
##
## Number of Obs.                1107         1393
## Eff. Number of Obs.            334          382
## Order est. (p)                   1            1
## Order bias  (p)                  2            2
## BW est. (h)                  4.628        4.628
## BW bias (b)                  7.667        7.667
## rho (h/b)                    0.604        0.604
##
```

```
## =============================================================================
===
##         Method     Coef. Std. Err.          z     P>|z|      [ 95% C.I. ]
## =============================================================================
===
##   Conventional     9.455     1.158      8.162     0.000     [7.184 , 11.725
]
##         Robust         -         -      6.654     0.000     [6.465 , 11.863
]
## =============================================================================
===
```

The thing we care about the most is the Coventional coeffiecent, which is 9.455 ,which means that being accepted in the National School Lunch program causes 9.455 increase in students final standardized test scores. The model uses a bandwidth of 4.628. Which means it only looked at the test scores of students with test scores of 80 ± 4.628. This bandwidth was decided authomatically.

We are going to use a different model called the triangular kernal now.

```
rdplot(y = NSLP_program$final_score, x = NSLP_program$test_score, c = 80)
```



Here, we see there is a jump at 80.

```
rdbwselect(y = NSLP_program$final_score, x = NSLP_program$test_score, c = 80)
%>%
  summary()
```

```
## Call: rdbwselect
##
## Number of Obs.                  2500
## BW type                        mserd
## Kernel                    Triangular
## VCE method                        NN
##
## Number of Obs.                 1107         1393
## Order est. (p)                    1            1
## Order bias  (q)                   2            2
##
## =======================================================
##                   BW est. (h)    BW bias (b)
##             Left of c Right of c  Left of c Right of c
## =======================================================
##      mserd     4.628      4.628      7.667      7.667
## =======================================================
```

drobust() chooses the bandwidth size automatically, and the rdbwselect() is used to see several potential bindwidths.

Different possible bandwidths to use

```
rdbwselect(y = NSLP_program$final_score, x = NSLP_program$test_score_centered
, all = TRUE) %>%


  summary()
```

```
## Call: rdbwselect
##
## Number of Obs.                  2500
## BW type                          All
## Kernel                    Triangular
## VCE method                        NN
##
## Number of Obs.                 1107         1393
## Order est. (p)                    1            1
## Order bias  (q)                   2            2
##
## =======================================================
##                   BW est. (h)    BW bias (b)
##             Left of c Right of c  Left of c Right of c
## =======================================================
##      mserd     4.628      4.628      7.667      7.667
##     msetwo    10.121      4.074     16.584      7.282
##     msesum     4.784      4.784      7.878      7.878
##   msecomb1     4.628      4.628      7.667      7.667
##   msecomb2     4.784      4.628      7.878      7.667
##      cerrd     3.129      3.129      7.667      7.667
```

```
##     certwo      6.845       2.755      16.584       7.282
##     cersum      3.235       3.235       7.878       7.878
##   cercomb1      3.129       3.129       7.667       7.667
##   cercomb2      3.235       3.129       7.878       7.667
## =======================================================
```

The best bandwidth is shown in mserd: ±4.628

```
rdrobust(y = NSLP_program$final_score, x = NSLP_program$test_score, c = 80, h
= 4.628) %>%
  summary()

## Call: rdrobust
##
## Number of Obs.                 2500
## BW type                      Manual
## Kernel                   Triangular
## VCE method                       NN
##
## Number of Obs.                 1107         1393
## Eff. Number of Obs.             334          382
## Order est. (p)                    1            1
## Order bias  (p)                   2            2
## BW est. (h)                   4.628        4.628
## BW bias (b)                   4.628        4.628
## rho (h/b)                     1.000        1.000
##
## ==========================================================================
===
##         Method     Coef. Std. Err.         z     P>|z|      [ 95% C.I. ]
## ==========================================================================
===
##   Conventional     9.455     1.158     8.163     0.000     [7.185 , 11.725
]
##         Robust         -         -     5.249     0.000     [6.153 , 13.486
]
## ==========================================================================
===
```

Another common approach to sensitivity analysis is to use the ideal bandwidth, twice the ideal, and half the idea

```
rdrobust(y = NSLP_program$final_score, x =NSLP_program$test_score, c = 80, h
= 4.628 * 2) %>%
  summary()

## Call: rdrobust
##
## Number of Obs.                 2500
## BW type                      Manual
## Kernel                   Triangular
```

```
## VCE method                              NN
##
## Number of Obs.                        1107        1393
## Eff. Number of Obs.                    586         788
## Order est. (p)                           1           1
## Order bias  (p)                          2           2
## BW est. (h)                          9.256       9.256
## BW bias (b)                          9.256       9.256
## rho (h/b)                            1.000       1.000
##
## =============================================================================
===
##         Method     Coef. Std. Err.         z     P>|z|      [ 95% C.I. ]
## =============================================================================
===
##   Conventional    10.136     0.770    13.170     0.000     [8.627 , 11.644
]
##         Robust         -         -     7.992     0.000     [7.240 , 11.944
]
## =============================================================================
===
```

```r
rdrobust(y = NSLP_program$final_score, x = NSLP_program$test_score, c = 80, h
= 4.62 / 2) %>%
  summary()
```

```
## Call: rdrobust
##
## Number of Obs.                         2500
## BW type                              Manual
## Kernel                           Triangular
## VCE method                               NN
##
## Number of Obs.                        1107        1393
## Eff. Number of Obs.                    180         193
## Order est. (p)                           1           1
## Order bias  (p)                          2           2
## BW est. (h)                          2.310       2.310
## BW bias (b)                          2.310       2.310
## rho (h/b)                            1.000       1.000
##
## =============================================================================
===
##         Method     Coef. Std. Err.         z     P>|z|      [ 95% C.I. ]
## =============================================================================
===
##   Conventional     9.956     1.802     5.524     0.000     [6.423 , 13.488
]
##         Robust         -         -     3.141     0.002     [3.562 , 15.388
]
```

```
## ============================================================================
===
```

Here is how the coeffoecnients changed slighlty:

Bandwidth: 4.628 (ideal): 9.455 4.628 * 2 (twice): 10.136 4.628 / 2 (half): 9.956

Adjusting by Kernal, rd_robust uses a triangular kernel (more distant observations have less weight linearly), Epanechnikov (more distant observations have less weight following a curve), and uniform (more distant observations have the same weight as closer observations)

```
rdrobust(y = NSLP_program$final_score, x= NSLP_program$test_score, c = 80, ke
rnel = "triangular") %>% summary()

## Call: rdrobust
##
## Number of Obs.                   2500
## BW type                         mserd
## Kernel                     Triangular
## VCE method                         NN
##
## Number of Obs.                  1107         1393
## Eff. Number of Obs.              334          382
## Order est. (p)                     1            1
## Order bias  (p)                    2            2
## BW est. (h)                    4.628        4.628
## BW bias (b)                    7.667        7.667
## rho (h/b)                      0.604        0.604
##
## ============================================================================
===
##         Method     Coef. Std. Err.         z     P>|z|      [ 95% C.I. ]
## ============================================================================
===
##   Conventional     9.455     1.158     8.162     0.000     [7.184 , 11.725
]
##         Robust         -         -     6.654     0.000     [6.465 , 11.863
]
## ============================================================================
===

rdrobust(y = NSLP_program$final_score, x= NSLP_program$test_score, c = 80, ke
rnel = "epanechnikov") %>% summary()

## Call: rdrobust
##
## Number of Obs.                   2500
## BW type                         mserd
## Kernel                   Epanechnikov
## VCE method                         NN
```

```
##
## Number of Obs.                 1107         1393
## Eff. Number of Obs.             307          356
## Order est. (p)                    1            1
## Order bias  (p)                   2            2
## BW est. (h)                   4.174        4.174
## BW bias (b)                   7.360        7.360
## rho (h/b)                     0.567        0.567
##
## =============================================================================
===
##         Method     Coef. Std. Err.         z     P>|z|      [ 95% C.I. ]
## =============================================================================
===
##   Conventional     9.314     1.165     7.994     0.000     [7.030 , 11.597
]
##         Robust         -         -     6.543     0.000     [6.283 , 11.656
]
## =============================================================================
===
```

```
rdrobust(y = NSLP_program$final_score, x= NSLP_program$test_score, c = 80, ke
rnel = "uniform") %>% summary()
```

```
## Call: rdrobust
##
## Number of Obs.                  2500
## BW type                        mserd
## Kernel                       Uniform
## VCE method                        NN
##
## Number of Obs.                 1107         1393
## Eff. Number of Obs.             331          378
## Order est. (p)                    1            1
## Order bias  (p)                   2            2
## BW est. (h)                   4.554        4.554
## BW bias (b)                   8.063        8.063
## rho (h/b)                     0.565        0.565
##
## =============================================================================
===
##         Method     Coef. Std. Err.         z     P>|z|      [ 95% C.I. ]
## =============================================================================
===
##   Conventional     9.624     1.033     9.318     0.000     [7.599 , 11.648
]
##         Robust         -         -     7.715     0.000     [7.077 , 11.898
]
## =============================================================================
===
```

The coeffeocents change slighlty: Triangular: 9.455 Epanechnikov: 9.314
Uniform: 9.624

Step 6 Compare all the effects

Parametric>>Full Data>>unweighted>> Parametric>>10>>unweighted>> Parametric>>15>>unweighted>> Nonparametric>> Nonparametric >> Nonparametric>> Nonparametric>> Nonparametric>>
Nonparametric>>

Conclusion

These findings show that the National School lunch program is really effective in helping improve student's standardized test score and thus, if extended to many places and more students are allowed to benefit from it, they will stand a higher chnace of improving their final standardized test scores which would in effect influence their education and future future.