Homework 6

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1 Python

1. Since every vehicle equipped with the technology is significantly less fuel-efficient, I believe it is sharp RD.

2. There is obvious evidence of two bunching around the cutoff length = 225. So visual evidence of discontinuity may exist.

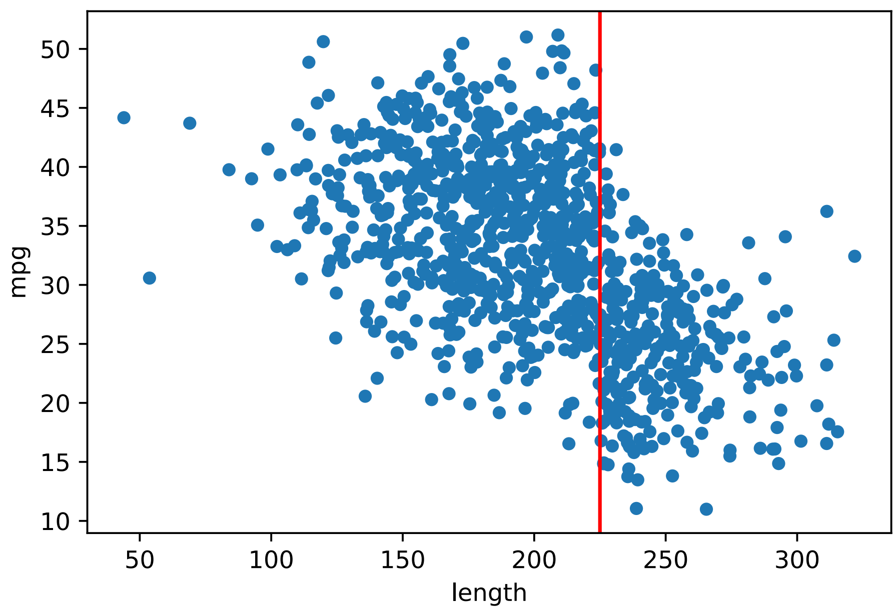

Figure 1: Scatter plot of impact of the policy on fuel efficiency

3. Fit a first-polynomial to both sides of the cut off in a regression discontinuity design.

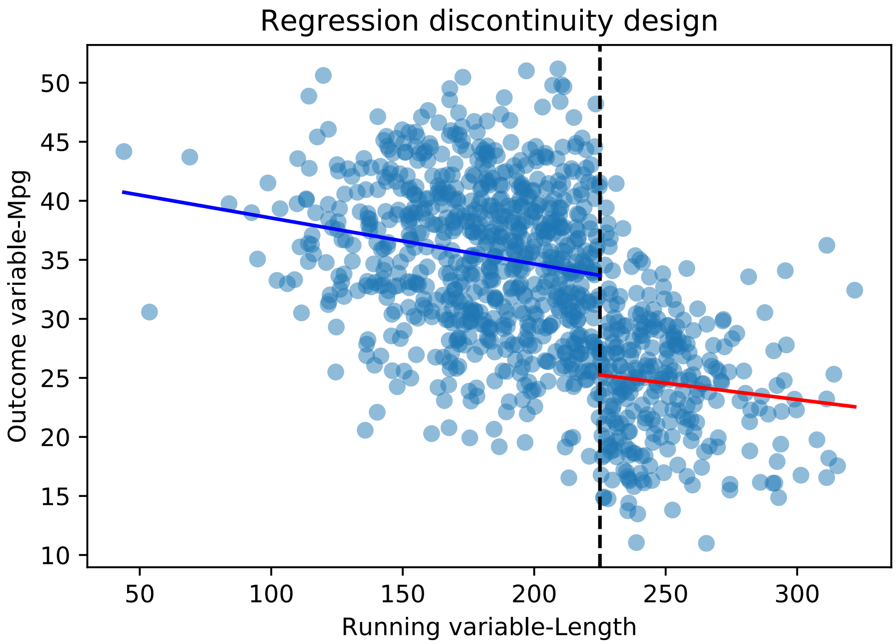

Figure 2: Scatter plot of impact of the policy on fuel efficiency and fitted first polynommial

The first-stage treatment effect is 0.0111, which is obtained by differencing the estimate (-0.0278) using the points above the cutoff and the estimate (-0.0389) using the points below cutoff and means the mpg for the length above 225 cars is 0.0111 higher than the cars with length less than 225.

4. Fit a second-polynomial to both sides of the cut off in a regression discontinuity design.

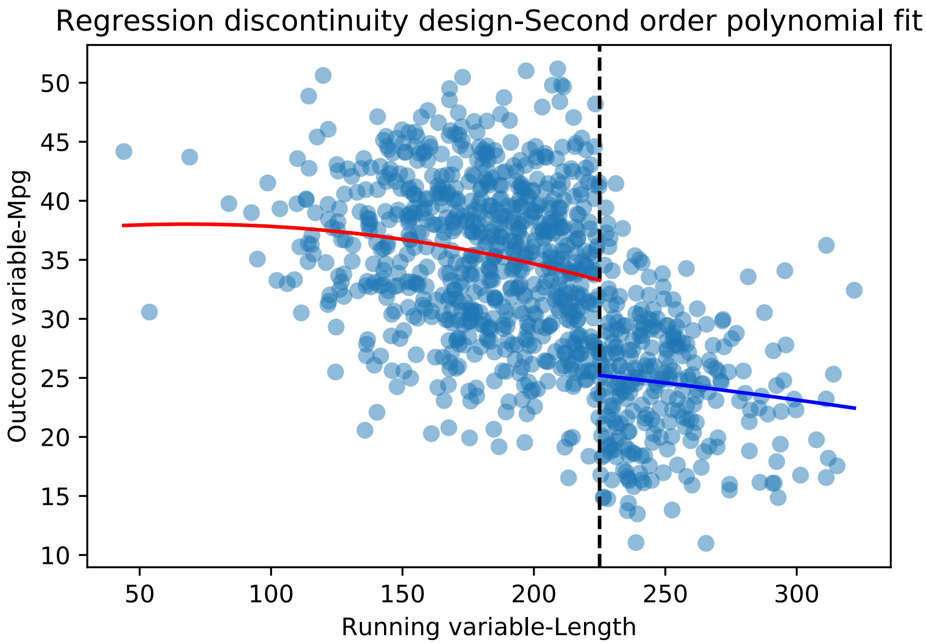

Figure 3: Scatter plot of impact of the policy on fuel efficiency and fitted second polynomial

The treatment effect estimate is shown in the table below.

Dep. Variable:	mpg	**R-squared:**	0.322
Model:	OLS	**Adj. R-squared:**	0.321
Method:	Least Squares	**F-statistic:**	237.2
Date:	Mon, 27 Feb 2023	**Prob (F-statistic):**	5.62e-85
Time:	23:07:15	**Log-Likelihood:**	-3294.2
No. Observations:	1000	**AIC:**	6594.
Df Residuals:	997	**BIC:**	6609.
Df Model:	2		
Covariance Type:	nonrobust		

	coef	**std err**	**t**	**P> |t|**	**[0.025**	**0.975]**
const	35.5552	3.239	10.978	0.000	29.199	41.911
x1	0.0794	0.033	2.421	0.016	0.015	0.144
x2	-0.0005	8.14e-05	-5.610	0.000	-0.001	-0.000

Omnibus:	1.918	**Durbin-Watson:**	1.536
Prob(Omnibus):	0.383	**Jarque-Bera (JB):**	1.776
Skew:	0.008	**Prob(JB):**	0.411
Kurtosis:	2.794	**Cond. No.**	7.05e+05

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The condition number is large, 7.05e+05. This might indicate that there are strong multicollinearity or other numerical problems.

5. Fit a fifth-polynomial to both sides of the cut off in a regression discontinuity design.

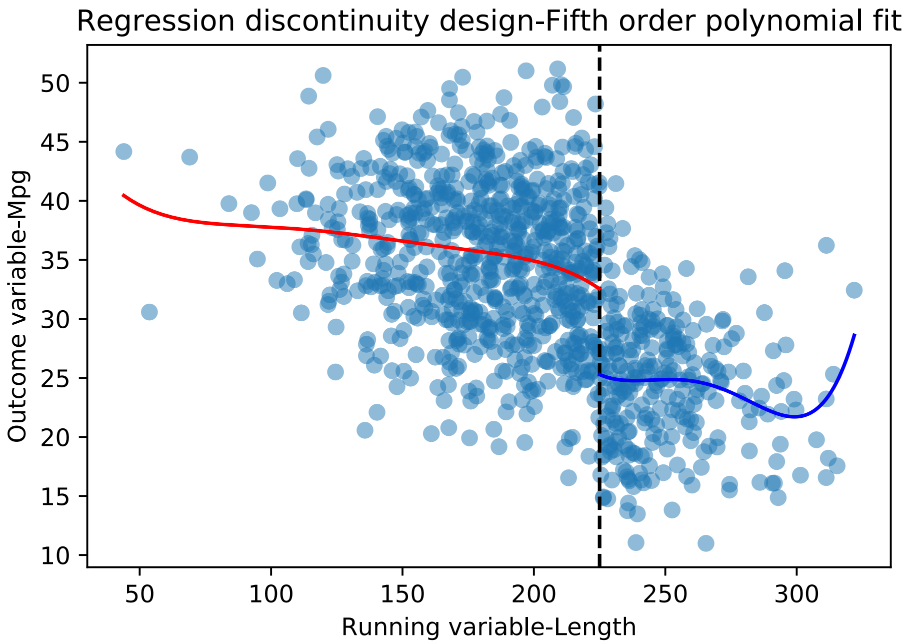

Figure 4: Scatter plot of impact of the policy on fuel efficiency and fitted fifth polynomial

The treatment effect estimate is shown in the table below.

Dep. Variable:	mpg	**R-squared:**	0.356
Model:	OLS	**Adj. R-squared:**	0.352
Method:	Least Squares	**F-statistic:**	109.7
Date:	Mon, 27 Feb 2023	**Prob (F-statistic):**	2.63e-92
Time:	23:12:18	**Log-Likelihood:**	-3269.2
No. Observations:	1000	**AIC:**	6550.
Df Residuals:	994	**BIC:**	6580.
Df Model:	5		
Covariance Type:	nonrobust		

	coef	**std err**	**t**	**P> |t|**	**[0.025**	**0.975]**
const	59.8980	26.869	2.229	0.026	7.171	112.625
x1	-0.5413	0.897	-0.603	0.546	-2.302	1.219
x2	0.0033	0.011	0.294	0.769	-0.019	0.025
x3	5.578e-06	6.59e-05	0.085	0.933	-0.000	0.000
x4	-9.699e-08	1.84e-07	-0.528	0.598	-4.58e-07	2.64e-07
x5	1.905e-10	1.96e-10	0.971	0.332	-1.94e-10	5.75e-10

Omnibus:	4.956	**Durbin-Watson:**	1.501
Prob(Omnibus):	0.084	**Jarque-Bera (JB):**	4.140
Skew:	-0.069	**Prob(JB):**	0.126
Kurtosis:	2.717	**Cond. No.**	8.97e+13

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The condition number is large, 8.97e+13. This might indicate that there are strong multicollinearity or other numerical problems.

6. Using the discontinuity as an instrument for miles per gallon, estimate the impact of mpg on the vehicle's sale price using 2sls by hand. Results from the second stage is shown in table below.

Dep. Variable:	price	**R-squared:**	0.220
Model:	OLS	**Adj. R-squared:**	0.219
Method:	Least Squares	**F-statistic:**	140.9
Date:	Sun, 26 Feb 2023	**Prob (F-statistic):**	1.32e-54
Time:	23:13:02	**Log-Likelihood:**	-9557.3
No. Observations:	1000	**AIC:**	1.912e+04
Df Residuals:	997	**BIC:**	1.914e+04
Df Model:	2		
Covariance Type:	nonrobust		

	coef	**std err**	**t**	**P>|t|**	**[0.025**	**0.975]**
Intercept	1.741e+04	747.885	23.275	0.000	1.59e+04	1.89e+04
predictedmpg	158.2799	26.029	6.081	0.000	107.201	209.359
car	-4743.0637	310.432	-15.279	0.000	-5352.238	-4133.889

Omnibus:	4.452	**Durbin-Watson:**	1.986
Prob(Omnibus):	0.108	**Jarque-Bera (JB):**	4.538
Skew:	0.112	**Prob(JB):**	0.103
Kurtosis:	3.242	**Cond. No.**	235.

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

2 Stata

1. (a) The average treatment effect of mpg on price is 135.41.

VARIABLES	(1) Impact of Mpg on Price by using predicted length from RDD
rdplot_hat_y	135.41**
	(22.98)
car	-3,693.27**
	(225.09)
Constant	17,622.91**
	(739.75)
Observations	1,000
R-squared	0.22

Robust standard errors in parentheses
** p<0.01, * p<0.05

(b)

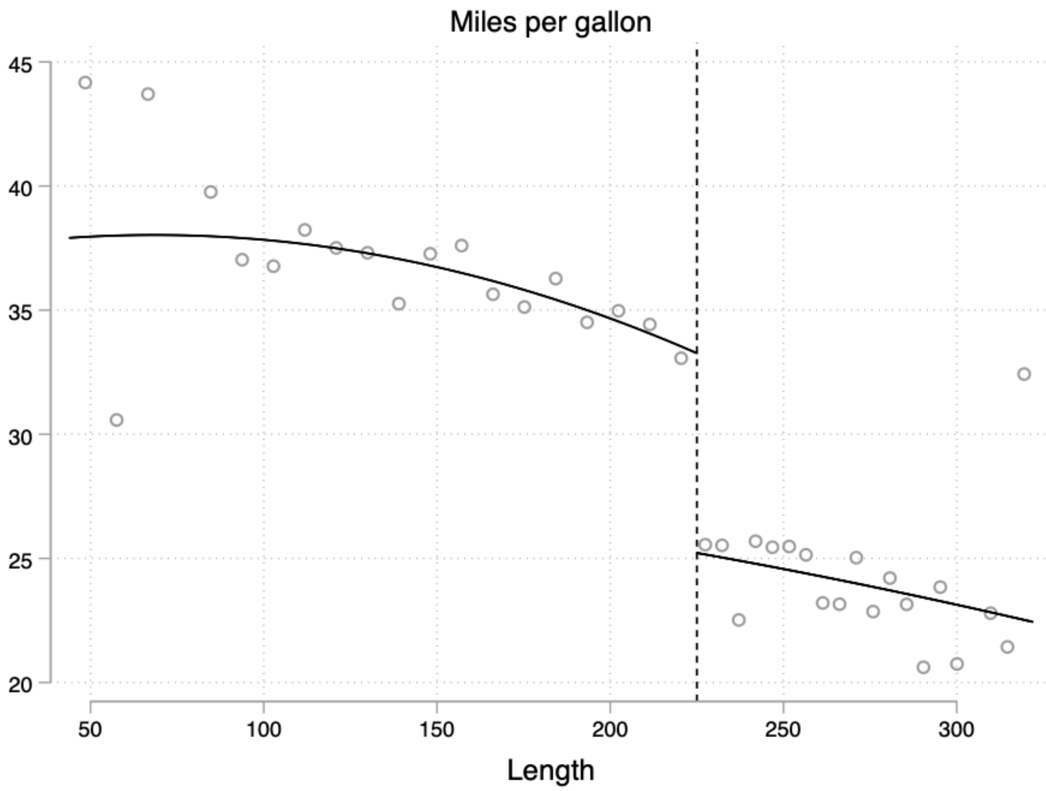

Figure 5: Scatter plot of impact of the policy on fuel efficiency and fitted second polynomial

2. Yes. I think it is a valid instrument.