POLS0012 Causal Analysis: Tutorial 7 Exercises

Leah Stokes (2016)[1] examines whether governments are punished electorally for building wind farms, a policy that mitigates climate change but may impose costs on the communities where turbines are sited. She looks at Ontario in Canada, where from 2009 the provincial government removed local communities' rights to make planning decisions on the building of wind turbines. Instead, decision-making was centralised and turbines were imposed by the government. It chose to build turbines in places where their construction was most feasible and they would generate the most electricity. In particular, they were more likely to be sited in places with higher prevailing wind speeds. Whilst certain broad areas are in general better suited for turbines (more rural and more elevated places, and areas closer to the windy great lakes), she argues that within these broad areas wind speed varies at random at the local level. This means that local communities could not select out of (or into) receiving a wind farm based on their levels of support for the policy or for the government. This is therefore a natural experiment where wind speed is an instrument that randomly encouraged the government to site turbines in particular places.

Her outcome of interest is change in support for the incumbent government from 2007 (before the wind farm policy) to 2011 (after it began) at a highly localised level known as "precincts" in Canada, which typically contain around 300 voters. Using GIS software, she geo-located all wind turbines that were built or proposed in the period and matched them to precincts, where she collected voting data, localised prevailing wind speeds, and background covariates. The dataset for this question is contained in the file Stokes.Rda and contains the following variables:

- *chng_lib* - outcome: pp change in support for the incumbent government, 2007-11
- *prop_3km* - treatment: =1 if a wind turbine was built or proposed within 3km, 0 otherwise
- *avg_pwr_log* - instrument: prevailing wind speed in the precinct, logged
- *longitude* - of the precinct
- *longitude* - of the precinct
- *ed_id* - the broader district within which the precinct is located
- *mindistlake* - distance to the great lakes in km
- *mindistlake_sq* - distance to the great lakes in km, squared

[1] Leah Stokes (2016). "Electoral Backlash against Climate Policy: A Natural Experiment on Retrospective Voting and Local Resistance to Public Policy." *American Journal of Political Science* 60 (4): 958-974

a) Assess whether wind speed can be considered to be as-if randomly assigned geographically, by regressing *avg_pwr_log* on all of the geographical covariates. What do you conclude?
Code Hint: Remember to use `factor()` for the *ed_id* variable

Code:

```
summary(lm(avg_pwr_log ~ factor(ed_id) + longitude + latitude + mindistlake +
mindistlake_sq,data=s))
```

Answer:
There is a lot of imbalance in terms of geographical covariates. There are statistically significant relationships between *avg_pwr_log* and *longitude*, *mindistlake*, *mindistlak_sq* as well as many of the districts. Distance to the Great Lakes is negatively related to wind speed: areas closer to the Lakes are windier. Longitude is positively related to wind speed: more westerly areas are windier. This is not particularly surprising. It is bound to be the case that different areas of Ontario are naturally windier than others.

b) Estimate the first-stage relationship between *prop_3km* and *avg_pwr_log* using a regression with no added covariates. Interpret the result precisely.

Code:

```
summary(lm(prop_3km ~ avg_pwr_log, data=s))
```

Answer:
There appears to be a fairly strong relationship between the instrument and the treatment. A 1% increase in wind speed is estimated to lead to a 0.01-point increase in the probability of a turbine being proposed, an effect which is highly significant at all conventional levels. [It's important to note that the dependent variable is binary and the independent variable is logged. Remember that when an independent variable in a regression is logged and its coefficient is β, a 1% increase in the variable leads to a change of $\frac{\beta}{100}$ in the dependent variable]

c) Stokes actually estimates the first and second stages with a full set of geographic controls included. Why do you think she does this?

Instrumental variables analysis relies on different values of the instrument being randomly assigned based on potential outcomes. In this case, wind speed varies systematically across geographical areas. For example, places closer to the Great Lakes are windier. Those places may have different potential outcomes to places further from the Great Lakes - perhaps, for example, communities nearer the Lakes are more opposed to the government. However, within the smaller geographic areas defined by district, latitude, longitude and so on, it seems likely that windspeed is randomly assigned. Thus she controls for the geographic covariates because it ensures that the assumptions behind IV estimation are more likely to hold.

d) Estimate the first-stage relationship between *prop_3km* and *avg_pwr_log* using a regression, this time with a full set of geographic controls. Interpret the result, and explain why it does or does not differ from part (b)

Code:

```
summary(lm(prop_3km ~ avg_pwr_log + factor(ed_id) + longitude + latitude +
mindistlake + mindistlake_sq , data=s))
```

Answer:
The relationship remains strong, with a 1% increase in wind speed estimated to lead to a 0.0076-point increase in the probability of a turbine being proposed. This is slightly weaker than the first-stage effect estimated without controls, because controlling for the geographic covariates means that we are focusing only on variation in wind speed within small geographic areas. Some of the estimated effect of wind speed on turbine construction in (b) merely reflected the fact that high-wind areas may also be more amenable in general to wind-farm construction, such as being more rural, etc.

e) Conduct an F test for the strength of the *avg_pwr_log* instrument. Using this test and your answer to (d), do you think that the instrument can be considered to be relevant?
Code Hints: Use the function `waldtest()` in the `lmtest` library. Your code should take the form `waldtest(model1,model2)`, where `model1` and `model2` are the names of estimated regression models with and without the instrument

Code:

```
library(lmtest)
mod1 <- lm(prop_3km ~ longitude + latitude + mindistlake + mindistlake_sq +
factor(ed_id), data=s)
mod2 <- lm(prop_3km ~ avg_pwr_log + longitude + latitude + mindistlake +
mindistlake_sq + factor(ed_id), data=s)
waldtest(mod2, mod1)
```

Answer:
The F test produces an F-Statistic of 70.1. This is much larger than the benchmark value of 10 below which an instrument is considered to be unacceptably weak. This result, combined with the first-stage regression in (d), suggests that the relevance assumption is clearly met here.

f) Estimate the Local Average Treatment Effect of *prop_3km* on *chng_lib* using two-stage least squares with *avg_pwr_log* as the instrument and the full set of geographic controls. Interpret the coefficient on *prop_3km* and its statistical significance precisely.
Code Hints: Remember to use `ivreg()` in the `AER` library. Your code should take the form:

```
ivreg(outcome ~ treatment + covariates | instrument + covariates)
```

Code:

```
library(AER)
summary(ivreg(chng_lib ~ prop_3km + mindistlake + mindistlake_sq + longitude +
latitude + as.factor(ed_id) | avg_pwr_log + mindistlake + mindistlake_sq +
longitude + latitude + as.factor(ed_id), data = s))
```

Answer:
The estimated Local Average Treatment Effect of turbine construction on voting is that proposing to build a turbine in a precinct led to a 7.4 percentage-point fall in the incumbent party's vote share in that precinct. The p-value for this effect is 0.037, meaning that it is statistically significant at the 5% level.

g) Now find the same Local Average Treatment Effect of *prop_3km* on *chng_lib*, but this time using two-stage least squares manually in two separate stages with covariates. Does your result differ from part (f)?
Code Hints: Extract fitted values from the first stage using `fitted.values()` and add them to the dataset as a variable. In the second stage, include them as an explanatory variable

Code:

```
first.stage <- lm(prop_3km ~ avg_pwr_log + factor(ed_id) + longitude + latitude +
mindistlake + mindistlake_sq , data=s)
s$fitted.first <- fitted.values(first.stage)

summary(lm(chng_lib ~ fitted.first + factor(ed_id) + longitude + latitude +
mindistlake + mindistlake_sq , data=s))
```

Answer:
The estimated coefficient is identical to (f), as we would expect. The standard error is slightly different, however. The standard error from doing 2SLS manually, as in (g), is slightly biased. The `ivreg()` function should always be used in practice because it corrects for this bias: see Angrist and Pischke, p. 144

h) Outline one way in which the randomisation assumption could be violated, here. How serious do you think this violation is likely to be for the internal validity of the results?

Randomisation could be violated by residential sorting based on wind speed. For instance, if people with different potential outcomes (perhaps people who are already predisposed to dislike the government) live in windier areas, then the instrument would not be randomly assigned. However, this seems very unlikely to be a serious threat to internal validity. Because the paper focuses on very small geographic areas, it seems implausible that there would be systematic differences between people in low- or high-wind places.

i) What does the 'exclusion restriction' mean in this study? Do you think it is likely to be violated?

   The exclusion restriction means that the only way wind speed matters for voting is through its impact on the probability of a turbine being built. This seems highly plausible. it is unlikely that living in a high-wind place would, on its own, turn people against the government.

j) Briefly, assess the external validity of this study. To what extent do you think the results can be generalised to other settings, times, treatments, etc.?