EC1340 - Fall 2016

Midterm solutions
October 19, 2016
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1. Hansen proposes a complete ban on all burning of coal. See p 174.

2. We have three data points; $(y,x) = \{(1,1),(4,2),(2,3)\}$. Our dummy variable D is 1 for $x > 3/2$ and 0 otherwise.

   (a) We want to perform the regression, $y = A_0 + A_1 D + \epsilon$ using OLS.

   Our errors are,

$$\begin{aligned}
\epsilon_1 &= (2 - A_0) \\
\epsilon_2 &= (5 - A_0 - A_1) \\
\epsilon_3 &= (3 - A_0 - A_1)
\end{aligned}$$

   To find OLS coefficient, solve

$$\min_{A_0,A_1} (2 - A_0)^2 + (5 - A_0 - A_1)^2 + (3 - A_0 - A_1)^2$$

   To solve, differentiate with respect to each of A_0 and A_1.

   Our first first order condition is

$$\begin{aligned}
0 &= \frac{\partial(.)}{\partial A_0} \\
&= 2(2 - A_0)(-1) + 2(5 - A_0 - A_1)(-1) + 2(3 - A_0 - A_1)(-1) \\
&= (2 - A_0) + (5 - A_0 - A_1) + (3 - A_0 - A_1) \\
&= 10 - 3A_0 - 2A_1
\end{aligned}$$

   Our second first order condition is

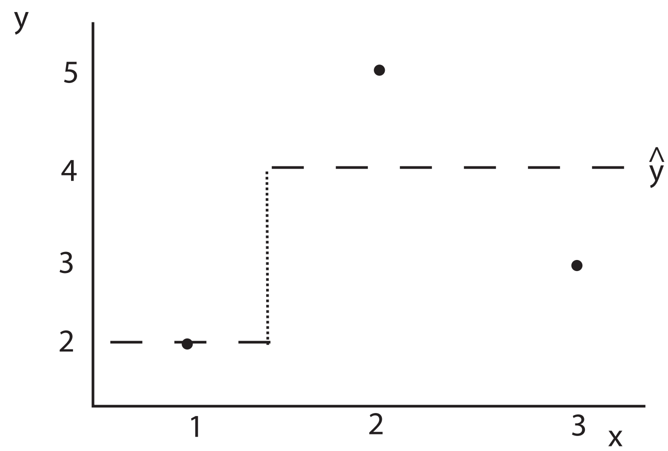
$$\begin{aligned}
0 &= \frac{\partial(.)}{\partial A_1} \\
&= 2(5 - A_0 - A_1)(-1) + 2(3 - A_0 - A_1)(-1) \\
&= (5 - A_0 - A_1) + (3 - A_0 - A_1) \\
&\implies A_1 = 4 - A_0
\end{aligned}$$

   Substituting the expression for A_1 into the first FOC, we get

$$\begin{aligned}
0 &= 10 - 3A_0 - 2(4 - A_0) \\
&\implies A_0 = 2
\end{aligned}$$

   Substituting into $A_1 = 4 - A_0$, we get $A_1 = 2$. Solving these two equations for A_0 and A_1 we get $A_0 = 2$ and $A_1 = 2$.

   (b) Your graph should look about like this:



(c) A dummy variable gives the mean difference in the outcome variable between the treated and untreated groups.

3. 20b kWh for 40 years is 800b kWh over the lifetime of the plant. Each kWh generates about 0.95kg Co2, so the plant generates 76b kg or 0.76 Gt of CO2 emissions over its lifetime. Converting this to C by multiplying by 12/44 gives 0.2 Gt of C emissions. About 0.55 of each unit of emissions stays in the atmosphere so we have 0.11 Gt of atmospheric carbon over the lifetime of the plant. Converting to concentration by dividing by 2.12 GtC/ppm this is 0.052ppm increase in concentration.

   From the Nordhaus rule, a 280ppm increase in concentration causes 3 degrees Celsius of warming by 2100, so each unit of concentration causes about 3/280 degrees of warming. It follows that over the course of its lifetime, the Nanticoke plant will generate enough emissions to cause about $0.052 \times 3/280 = 0.0006$ degrees of warming by 2100.

   There are well over 1000 coal fired power plants in North America, however, the Nanticoke plant is quite large and accounts for between one half and one percent of all coal fired power in North America. Scaling our calculation above, suggests that replacing all coal fired plants with nuclear plants would reduce warming by 0.05 to 0.1 degrees in 100 years.

4. (a) Under the first climate model land rent is a lottery, $R_1 = (1383{,}1783{,}\frac{1}{2}{,}\frac{1}{2})$. Under the second climate model, we have $R_2 = (1251{,}1651{,}\frac{1}{2}{,}\frac{1}{2})$.
   The expected values of these lotteries are:

$$\begin{aligned} E(R_1) &= \frac{1}{2}(1383) + \frac{1}{2}(1783) \\ &= 1583 \\ E(R_2) &= \frac{1}{2}(1251) + \frac{1}{2}(1651) \\ &= 1451 \end{aligned}$$

The standard deviations of these lotteries are:

$$\begin{aligned} sd(R_1) &= [\frac{1}{2}(1383-1583)^2 + \frac{1}{2}(1783-1583)^2]^{\frac{1}{2}} \\ &= 200 \\ sd(R_2) &= [\frac{1}{2}(1251-1451)^2 + \frac{1}{2}(1651-1451)^2]^{\frac{1}{2}} \\ &= 200 \end{aligned}$$

(b) If we think each climate model is equally likely then land rent is described by the compound lottery $R_3 = (R_1, R_2, \frac{1}{2}, \frac{1}{2}) = (1383, 1783, 1251, 1651, \frac{1}{4}, \frac{1}{4}, \frac{1}{4}, \frac{1}{4})$. Calculating mean and standard deviation in the usual way, we have $E(R_3) = 1517$ and $SD(R_3) = 210.6$.

(c) Since model uncertainty increases the standard deviation of our prediction, it increases our uncertainty.