EC313-Winter 2014

Midterm
2:10-3:10pm, February 27, 2014
Matt Turner

You will have 50 minutes to complete this exam. Anyone still working on their exam after this time expires is subject to an automatic penalty of not less than 5 points. No notes or books are allowed, but you may use a calculator. Cell phones and any device with a wireless connection must be off.

When you write up your answers, your goal should be to (1) be correct, and (2) convince your reader that your answer is correct. Answers which do not achieve these goals will not be awarded full credit. To accomplish the second objective, it is helpful if your work is legible and if all steps are presented, possibly with a line of explanation. Total points =100/Share of total grade =35% .

1. (40) Let $t = 0,1,2,...$ index years. Suppose that one ton of CO_2 emissions today causes 0$ of damage for $t < 100$ and 50$ of damage for $t \geq 100$. Let M denote the amount spent on mitigation at $t = 0$. If the interest rate is r how much will a planner who maximizes the discount present value of consumption be willing to spend on abatement to reduce future damage to zero.

2. (20) This exercise asks you to figure out how dummy variables work in a regression.

   Suppose that your data set consists of three observations of (y,x) : $(2,1)$,$(5,2)$,$(3,3)$. Define a dummy variable D which is equal to 1 for $x > 3/2$ and zero otherwise.

   We would like to estimate the following regression equation,

$$y = A_0 + A_1 D + \epsilon$$

   (a) Calculate A_0 and A_1 using OLS.
   (b) Plot the three data points and your regression line.
   (c) Explain, in one or two sentences, what the coefficient of the dummy variable measures.

3. (20) This question asks you to think about the estimation of the cost of climate change conducted in Nordhaus and Mendelsohn (1995) that we discussed in class.

   (a) Using the notation from lecture, suppose that

$$R = A_0 + A_1 T + A_2 T^2 + A_3 S + \epsilon$$

   where R is unit land rent, T is a scalar mean annual temperature, A_1 and A_2 are the parameters we care about, S is the farmer's skill, and ϵ is unobserved determinants of land rent.

   Suppose that skillful farmers choose places with the best climate, but that we don't observe the skill of a farmer. We do know, however, that skill depends on climate according to $S = B_0 - B_1 T$ for $B_0 > 0$, $B_1 > 0$ and $A_3 > 0$.

Suppose we estimate the model

$$R = \hat{A}_0 + \hat{A}_1 T + \hat{A}_2 T^2 + \epsilon.$$

Will our estimated coefficients of $\hat{A}_1$ and $\hat{A}_2$ measure what we want them too? Explain briefly.

(b) Does this approach overestimate or underestimate the effects of climate on agricultural land rents?

4. (20) Generating electricity from coal causes about 2100lbs of CO2 emissions per 1000kwh of electricity. Generating 1000kwh of electricity from methane, the primary product of 'fracking', requires about 500lbs of methane and produces about 1200lbs of CO2. Methane is a gas at room temperature, and typically, some of it leaks into the atmosphere while it is being extracted from the ground. One ton of methane has the same warming potential as 23 tons of CO2. Currently, we are uncertain about the amount of leakage. Suppose that leakage rates of 4% and 6% are equally likely. Should we expect that fracking will reduce CO2e emissions if the primary use of natural gas is in power generation?

1. THE DISCOUNT P.V. OF DAMAGE IS

$$D = \sum_{t=100}^{\infty} \delta^t 50$$

$$= \delta^{100} \sum_{t=0}^{\infty} \delta^t 50$$

$$= \frac{50\,\delta^{100}}{1-\delta}$$

BUT $\delta = \frac{1}{1+r}$, SO

$$D = 50\left(\frac{1}{1+r}\right)^{100}\left[\frac{1}{1-\left(\frac{1}{1+r}\right)}\right]$$

$$= 50\left(\frac{1}{1+r}\right)^{100}\left(\frac{1+r}{r}\right)$$

THUS, THE PLANNER WILL SPEND ANY AMOUNT

$$M \le 50\left(\frac{1}{1+r}\right)^{100}\left(\frac{1+r}{r}\right)$$ TO REDUCE

FUTURE DAMAGES TO ZERO

2.
(a) $(y, x, D) = \{(2,1,0), (5,2,1), (3,3,1)\}$

So

$$\varepsilon_1 = 2 - A_0$$

$$\varepsilon_2 = 5 - A_0 - A_1$$

$$\varepsilon_3 = 3 - A_0 - A_1$$

CHOOSE A_0 AND A_1 TO SOLVE

$$\text{Min } \varepsilon_1^2 + \varepsilon_2^2 + \varepsilon_3^2$$

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

F.O.C

$$\frac{d(\cdot)}{dA_0} = 2(2 - A_0)(-1) + 2(5 - A_0 - A_1)(-1) + 2(3 - A_0 - A_1)(-1) = 0$$

$$\Rightarrow (2 - A_0) + (5 - A_0 - A_1) + (3 - A_0 - A_1) = 0$$

$$\Rightarrow 10 - 3A_0 - 2A_1 = 0 \qquad (1)$$

$$\frac{d(\cdot)}{dA_1} = 2(5 - A_0 - A_1)(-1) + 2(3 - A_0 - A_1)(-1) = 0$$

$$\Rightarrow 8 - 2A_0 - 2A_1 = 0$$

$$\Rightarrow 4 - A_0 - A_1 = 0 \Rightarrow A_1 = 4 - A_0 \qquad (2)$$

$(2) \to (1) \Rightarrow$

$$10 - 3A_0 - 2(4 - A_0) = 0$$

$$10 - 3A_0 - 8 + 2A_0 = 0$$

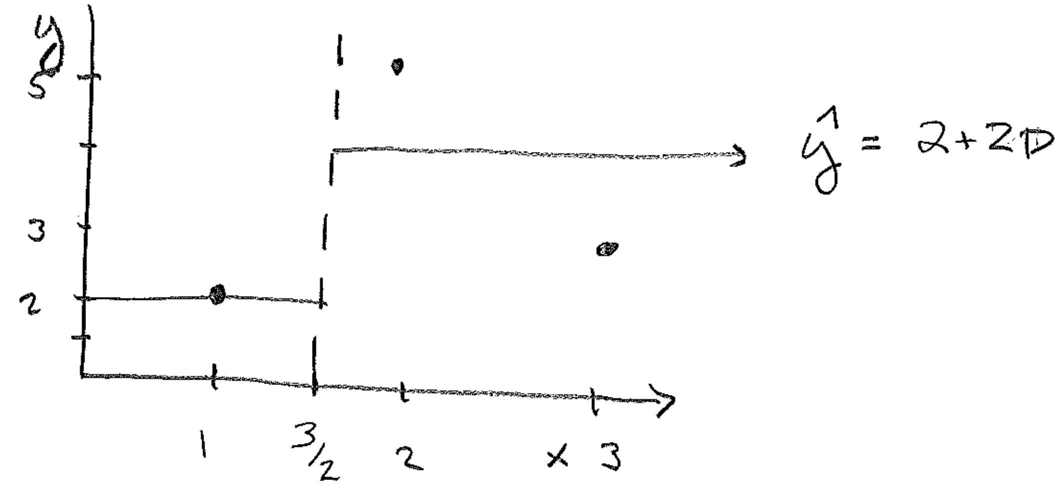
$$2 - A_0 = 0 \Rightarrow A_0^* = 2 \qquad (3)$$

$(3) \to (2)$

$$\Rightarrow A_1^* = 2$$

$\rightarrow$

(b)



(c) THE DUMMY VARIABLE MEASURES THE AVERAGE DIFFERENCE BETWEEN OBSERVATIONS WITH $D=1$ AND THOSE WITH $D=0$.

3. (a) RENT EQUATION IS

$$R = A_0 + A_1 T + A_2 T^2 + A_3 S + \varepsilon \qquad (1)$$

SKILL EQUATION IS

$$S = B_0 - B_1 T \qquad (2)$$

$(2) \to (1) \Rightarrow$

$$R = A_0 + A_1 T + A_2 T^2 + A_3 (B_0 - B_1 T) + \varepsilon$$

$$= (A_0 + A_3 B_0) + (A_1 - A_3 B_1) T + A_2 T^2 + \varepsilon$$

IF WE ESTIMATE

$$\hat{R} = \hat{A}_0 + \hat{A}_1 T + \hat{A}_2 T^2 + \hat{\varepsilon}$$ WHEN (1) AND (2)

ARE TRUE, WE'LL GET

$$\hat{A}_0 = A_0 + A_3 B_0$$

$$\hat{A}_1 = (A_1 - A_3 B_1)$$

$$\hat{A}_2 = A_2$$

$\rightarrow$

SO, $\hat{A}_2$ IS RIGHT, BUT $\hat{A}_1$ IS NOT

(b) WITH $B_0 > 0$, $B_1 > 0$, $A_3 > 0$

WE KNOW THAT $A_3 B_1 > 0$.

IT FOLLOWS THAT $\hat{A}_1 = A_1 - A_3 B_1 < A_1$

SO WE UNDERESTIMATE THE EFFECT OF CLIMATE ON AGRICULTURAL PRODUCTIVITY.

4.

w_1 = POUNDS OF METHANE BURNED / 1000 KWH $= 500$

w_0 = POUNDS OF METHANE EXTRACTED / 1000 KWH

LEAKAGE IS RANDOM

$$\eta = \left(\frac{4}{100}, \frac{6}{100}, \tfrac{1}{2}, \tfrac{1}{2} \right)$$

SO $w_0 = (1+\eta) w_1$ AND LEAKAGE IS ηw_1

EXPECTED LEAKAGE IS $E(\eta) w_1 = \frac{5}{100} \cdot w_1$

CO_2e OF $\frac{5}{100} w_1 = 23 \cdot \frac{5}{100} w_1 = 1.15 w_1$

SO TOTAL CO_2e FROM BURNING METHANE TO GENERATE 1000 KWH IS LESS THAT FROM COAL IF

$$1200 + 1.15 w_1 < 2100$$

$$\Rightarrow \quad 1.15 w_1 < 900$$

$$\Rightarrow \quad w_1 < 782.$$

BUT w_1 IS 500, SO USING METHANE REDUCES CO_2e FROM ELECTRICITY GENERATION, THOUGH AFTER WE ACCOUNT FOR LEAKAGE, THE EFFECT IS SMALL.