

ECO 435
Environmental Economics
Spring 2017

SECOND EXAM: DUE FR, 21 April [100 points]

I. [44 points] Directions: Consult chapter 1 "Overshoot," in your text Limits to Growth by Meadows, Randers & Meadows (Meadows et al). Provide each definition/answer, using complete sentences.

1. (3) *Define "overshoot."*

2.

a. (3) *What are the three causes of overshoot?*

b. (3) *Consider the first cause of overshoot. What form might the change take?*

c. (3) *Consider the second cause: What might constitute limits?*

d. (6) *Consider the third cause: What things might cause the delay?*

4. (4) Meadows et al acknowledge that many instances of overshoot can be harmless, but that occasionally there is the potential for catastrophe: what Taleb might dub a "black swan:--an event with negligible probability of happening with dramatic consequences (good or bad).

What are the two different outcomes of overshoot?

5. (4) Overshoot comes from a combination of

- growth, acceleration, rapid change;
- some form of limit or barrier, beyond which the moving system may not safely go; and
- a delay or mistake in the perceptions and the responses that strive to keep the system with its limits.

Climate change can be construed as a paradigmatic example of overshoot.

Consider the three graphs (p. 6-7 in Limits to Growth).

Meadows et al identify TWO 'sources of exponential growth' that are evidently correlated (positively) but that they also argue are **causes** of growing pollution levels, and CO2 specifically.

What are these two fundamental drivers causing greater (exponential) global rates of change, also greater in the sense that they are the highest ever experienced during our species' term on earth?

6. (3) *What is throughput?*

7. (3) *What are sources according to the Meadows et al (reminiscent of Greer)?*

8. (3) What are sinks according to the Meadows et al?

9. (3) First, consider the Meadows' bad news—that the throughput flows presently generated by the human economy cannot be maintained at their current rates for much longer. ***Explain, specifically, how this argument—that current levels of throughput cannot be maintained—relates to LANDFILLS, the unique method recently innovated by humans to dispose of waste.***

10. Second, consider the Meadows' goods news—that current high rates of throughput are not necessary to support a decent standard of living for all the world's people.

a. (3) ***How, generically, can the ecological footprint be reduced?***

b. (3) In the specific context of LANDFILLS, **what can humans do** (assuming population growth and industrial growth both proceed largely unchecked) ***to reduce 'emissions'***—in this case, the solid waste stream headed for landfills, the leachate effluent headed for the water table, and the methane gas emitted?

II. [15 points] FRACK ATTACK—in reality

1. Watch the film **SPLIT ESTATE** (available for free at http://www.snagfilms.com/films/title/split_estate)
2. (7) Think about our diagram (the one you used to characterize coal in great detail for the First Exam-Take Home and that we also thought about with respect to *The Nuclear Option* after watching **PANDORA'S PROMISE**. Using what you learn from the film as well as from reading The Union of Concerned Scientists' executive summary entitled Toward an Evidence Based Fracking Debate.

Natural gas, like the other fossil fuel (coal) and uranium, is a primary product, extracted from Nature and conveyed to the economic realm. But other primary products are must be invoked to enable hydraulic fracking. The film refers to these other 'inputs' in the drilling process.

Briefly cite the other primary products that are used by oil and gas companies to do hydraulic fracturing (fracking). Some are obvious, and can be named; others are more opaque. Some ingredients are 'black box' or the equivalent of 'special sauce.'

***Proceed to visit the website **FracFocus**, and select **What Chemicals are Used**. Print this (probably TWO pages) of 'special sauce' and attach to this exam.

This list is not extremely helpful. Explain.

3. (8) And of course, since virtually no production of secondary products does not generate waste (emission, effluent, solid waste), you should be able to identify some of the ways in which fracking uses nature as a sink. Identify and explain the harm to humans and the environment of the waste generated by the fracking process. [Hint: *produced water* had better be one of them.]

III. [41 points] FRACK ATTACK IN REALITY

In the diagram on the next page, a citizen/rancher is initially in 'consumer equilibrium' at point A, enjoying a level of utility (satisfaction, pleasure) of U^0 enabled by income, I^0 , which enables access to secondary goods (Q_s on the vertical axis) which can be purchased at price $P_s^0 = 1$ and access to primary goods (Q_p on the horizontal axis)—environmental quality—which ostensibly 'money can't buy' but that we 'value' at P_p^0 .

Note: setting $P_s^0 = 1$ is equivalent to naming secondary goods as the numeraire good; this has the practical effect of making the vertical axis measure monetary income, since $I^0/P_s^0 = I^0$.

A. (21)

1. Consider fracking as a decrease in environmental quality, in effect an increase in the 'price' that reduces the quantity of environmental quality the rancher/consumer can obtain, all other variables constant. This causes the budget constraint to pivot _____ (inwards/outwards) as the price of environmental quality changes from P_p^0 to _____.
2. If fracking happens, the rancher/consumer will experience a reduction in utility from U^0 to _____.
3. An equivalent variation—a change in income that mimics the deterioration in environmental quality—is a(n) _____ (decrease/increase) in income.
4. A compensating variation—a change in income that 'undoes' the deterioration (compensating for if not reversing the damage) is a(n) _____ (decrease/increase) in income.
5. The EV and the CV are assessments, as if we can put a monetary value or 'price tag' on a reduction in environmental quality or an improvement in environmental quality. In this graph illustrating a potential reduction in environmental quality, the vertical distance on the vertical axis _____ is the EV, one measure of the damage done by fracking; the vertical distance on the vertical axis _____ is the CV.
6. With respect to EV, this amount of money is what the rancher/citizen is willing to _____ (accept/pay) to avoid the damage to the environment from fracking and what oil and gas companies are willing to _____ (accept/pay) to agree not to frack, not to damage the environment.

7. With respect to CV, this amount of money is what the oil and gas companies are willing to _____ (accept/pay) in order to be able to frack, to decrease environmental quality and what ranchers/citizens are willing to _____ (accept/pay) to permit environmental quality to be compromised.

8. If ranchers have the (full panoply) of property rights, and NOT FRACKING IS SOCIALLY OPTIMAL, no income redistribution applies. The outcome (originally A) will be _____ (A/R/S/Z).

9. If ranchers have the (full panoply) of property rights, and FRACKING IS SOCIAL OPTIMAL, then the outcome (original A) will be _____ (A/R/S/Z). **Explain the redistribution of income, using WTP (willingness to pay), WTA (willingness to accept), and either CV or EV vocabulary.**

10. If oil and gas companies have the rights, and FRACKING IS SOCIAL OPTIMAL, no income redistribution applies. The outcome (originally A) will be _____ (A/R/S/Z).

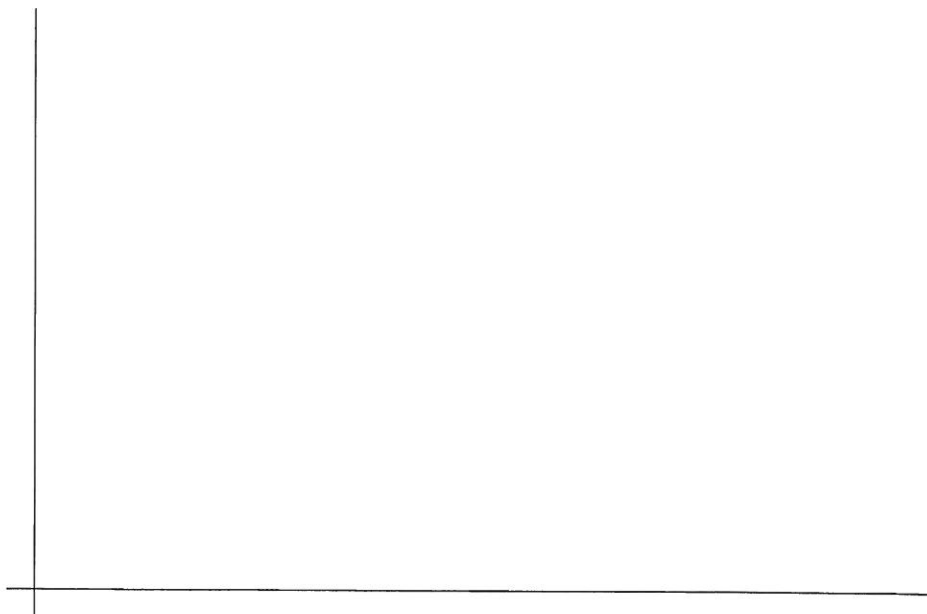
11. If oil and gas companies have the rights, and NOT FRACKING IS SOCIALLY OPTIMAL, then the outcome, originally A, will be _____ (A/R/S/Z). **Explain the redistribution of income, using WTP (willingness to pay), WTA (willingness to accept), and either CV or EV vocabulary.**

B. (5) Of course, the above assumes the conditions that inform the Coase Theorem: that property rights are clearly articulated and that the number of parties involved is small and negotiation costs negligible so that 'a conference call' —"my lawyers talking to your lawyers"—can resolve the dispute and result in a socially optimal outcome.

Let's assume that no third parties are involved, and that the number of oil and gas companies and ranchers are few so that negotiations are feasible. There remains a serious impediment to a market mediated solution: the odd nature of the property rights in place. **Explain what is meant by "split estate" and why this system of property rights prevents social optimality from being achieved through transfers (payments from one party to another).** [Hint: Recall Greer's point that sometimes economic power can purchase political power and in turn limit the economic choices available to others.]

C. But fracking involves spillover, sometimes literally. It is appropriate to speak of a 'negative externality' when a good is being produced (assume natural gas is a good, since it is a cleaner source of energy than 'the other fossil fuel' coal) but costs are imposed on 'third parties' (in this case citizens who are not ranchers or gas company owners/employees). The negative externality in the case of only a few 'victims' is non-rival but exclusive. (It is non-rival in the sense that one person's experience of the bad—noxious fumes or contaminated drinking water—does not diminish the ability of others to experience that bad. It is exclusive in the sense that the damage is apparently limited to those within a certain geographical area over a certain period of time—e.g. during drilling, or in the aftermath of an explosion, fire, or 'accidental leak, or during treatment (as of 'produced water') or transportation (leaking pipelines, train derailments, truck accidents).

a. (2) In the space below, provide a sketch of the market for natural gas, with sellers (oil and gas companies) on the supply side and buyers (ranchers and citizens) on the demand side.



b. (5) Referring to the diagram, consider one remedy: a Pigouvian 'extraordinary restraint,' that is, a tax.

You might imagine that a Pigouvian tax, with the statutory incidence on suppliers, could be used to 'internalize' this negative externality...but NOT!!! Just because oil and gas companies ante up tax revenues does not eradicate the damage to the environment! Explain how the actual remedy—also effecting a leftward shift in supply, could provide a 'fix'—by forcing, through regulation, the oil and gas companies to incorporate sufficient safeguards to prevent the deterioration of environmental quality.

In the process, reveal the difference in opportunity cost and producer surplus between the tax and regulation remedies. You can provide your own markings or colored OUTLINES. (Hint: don't shade, outline; more room to write on next page also!)

13. (8) In addition to the inarticulate nature of mineral rights, government is also failing in the face of frack attacks by not performing one of Adam Smith's 'duties of the sovereign' by failing to 'prevent coercion of citizens by other citizens.' ***What 'exemptions' does the fracking industry enjoy that ensure that third parties will suffer a decrease in environmental quality from fracking? (Both the film and the reading speak to these loopholes.)***

