

Economics 5250
Fall 2005

Dr. Lozada
Final Exam

This exam has 67 points. There are eight questions on the exam; you should work all of them. Most of the questions are worth 8 points each, but Question 4 is worth 10 points, and Question 5 is worth 9 points.

Put your answers to the exam in the blue books you have brought (if you remembered to bring blue books).

Answer the questions using as much precision and detail as the time allows. Correct answers which are unsupported by explanations will not be awarded points. Therefore, even if you think something is "obvious," do not omit it. If you omit anything, you will not get credit for it. You get credit for nothing which does not explicitly appear in your answer. If you have questions about the adequacy of an explanation of yours during the exam, ask me.

You have two hours to finish this test.

Answer all of the following eight questions.

1. [8 points]
 - (a) Explain the Coase Theorem. Use a graph with quantity of output on the horizontal axis in your explanation.
 - (b) Suppose polluters have the (property) right to pollute. Using your graph from part (a), what is the minimum amount of money that will be paid to the polluters? What is the maximum amount of money that will be paid to the polluters?
2. [8 points] Suppose something bad may happen to you, such as an increase in the level of a pollutant which you suffer from.
 - (a) Define the “compensating variation” and the “equivalent variation” in this context.
 - (b) Define “willingness to pay” and “willingness to accept” in this context.
3. [8 points] I recommend you read both parts of this question before answering it.
 - (a) Defend the proposition that, for the purposes of deciding what to do about environmental problems, the appropriate social rate of discount is zero.
 - (b) Defend the proposition that, for the purposes of deciding what to do about environmental problems, the appropriate social rate of discount is strictly greater than zero.
4. [10 points] This question concerns a fishery.
 - (a) In an open-access fishery, we showed that a graph of steady-state harvest versus effort typically has an “inverted-U” shape. How did we show that?
 - (b) In a private-property fishery, we encountered the equation

$$r = \frac{-C_{x8}}{MII_7} + F_8' \frac{MII_8}{MII_7} + \frac{MII_8 - MII_7}{MII_7}.$$

What does this tell us about the steady state of a schooling fishery?

5. [9 points] In a simple Hotelling model of the extractive firm, contrast two price paths, the second in a world with higher discount rates than in the first. Also, briefly explain why such price paths are not flat.
6. [8 points] In what ways might loss of forests have different effects in rich countries compared to in poor countries?
7. [8 points] Tell me everything you know about the ideas of *only one* of the three authors listed below:
 - (a) Nicholas Georgescu-Roegen
 - (b) Herman Daly
 - (c) Kenneth Boulding.
8. [8 points] Comment on the two documents which appear below. The first explains the Administration's position on the Kyoto Protocol. The second is an editorial from this past weekend's *Salt Lake Tribune*. If either piece makes factual errors, point them out. Otherwise, comment on the strengths and/or weaknesses of the two arguments. What does the term "economy" mean in part (a), and what are the scopes of the terms "noxious" and "poisonous" in part (b)?

- (a) Text of a Letter from the President to Senators Hagel, Helms, Craig, and Roberts

March 13, 2001

Thank you for your letter of March 6, 2001, asking for the Administration's views on global climate change, in particular the Kyoto Protocol and efforts to regulate carbon dioxide under the Clean Air Act. My Administration takes the issue of global climate change very seriously.

As you know, I oppose the Kyoto Protocol because it exempts 80 percent of the world, including major population centers such as China and India, from compliance, and would cause serious harm to the U.S. economy. The Senate's vote, 95-0, shows that there is a clear consensus that the Kyoto Protocol is an unfair and ineffective means of addressing global climate change concerns.

As you also know, I support a comprehensive and balanced national energy policy that takes into account the importance of

improving air quality. Consistent with this balanced approach, I intend to work with the Congress on a multipollutant strategy to require power plants to reduce emissions of sulfur dioxide, nitrogen oxides, and mercury. Any such strategy would include phasing in reductions over a reasonable period of time, providing regulatory certainty, and offering market-based incentives to help industry meet the targets. I do not believe, however, that the government should impose on power plants mandatory emissions reductions for carbon dioxide, which is not a "pollutant" under the Clean Air Act.

A recently released Department of Energy Report, "Analysis of Strategies for Reducing Multiple Emissions from Power Plants," concluded that including caps on carbon dioxide emissions as part of a multiple emissions strategy would lead to an even more dramatic shift from coal to natural gas for electric power generation and significantly higher electricity prices compared to scenarios in which only sulfur dioxide and nitrogen oxides were reduced.

This is important new information that warrants a reevaluation, especially at a time of rising energy prices and a serious energy shortage. Coal generates more than half of America's electricity supply. At a time when California has already experienced energy shortages, and other Western states are worried about price and availability of energy this summer, we must be very careful not to take actions that could harm consumers. This is especially true given the incomplete state of scientific knowledge of the causes of, and solutions to, global climate change and the lack of commercially available technologies for removing and storing carbon dioxide.

Consistent with these concerns, we will continue to fully examine global climate change issues—including the science, technologies, market-based systems, and innovative options for addressing concentrations of greenhouse gases in the atmosphere. I am very optimistic that, with the proper focus and working with our friends and allies, we will be able to develop technologies, market incentives, and other creative ways to address global climate change.

I look forward to working with you and others to address global climate change issues in the context of a national energy policy that protects our environment, consumers, and economy.

Sincerely,

GEORGE W. BUSH

- (b) Get tough on toxins: COAL-GENERATED POWER:
IPP plant should use cleanest technology—now
Salt Lake Tribune
12/10/2005

We could apply Nevada's famous marketing slogan, "What happens here, stays here," to the noxious air pollution created by power plants in Utah and other Western states: The junk that's spewed into the air here stays here—even though much of the electricity goes west to power-hungry California.

Traditional coal-fired power plants, including the Intermountain Power Project in Utah's Millard County, generate pollution that pretty much stays within our borders, fouling the air with sulfur dioxide, mercury, carbon dioxide and nitrogen oxides. In 2003, the amount of such emissions from IPP, and from plants in New Mexico, Nevada and Arizona, equaled the pollution from 11 million cars.

That information comes from a new report by the Center for Energy Efficiency and Renewable Technologies, Environmental Defense and Western Resource Advocates. It is based on data from federal agencies and from the California Energy Commission.

Because coal is a relatively cheap fuel, more than 20 new coal-fired plants are proposed in seven Western states. IPP wants to increase its capacity by building a third 900-megawatt unit, approved long ago to meet environmental standards that now are 25 years old.

Existing state pollution standards might allow it, but good sense tells us it is foolhardy and dangerous to proceed. Air pollution from the IPP complex already contributes to the health problems of Utahns and their neighbors.

In 2003, the annual carbon dioxide emissions from the existing IPP plant equaled the annual emissions from 2.6 million cars. That

same year, there were 1.7 million cars, trucks and motorcycles registered in Utah.

In contrast, California keeps its coastal air relatively clean by requiring power plants there to use modern technology that nearly eliminates the most poisonous pollutants emitted by coal-burning plants. Until recently, California was happy to buy power from polluting plants outside the state, including IPP. This year, it revised its rules aimed at requiring these out-of-state power generators to abide by California's environmental standards.

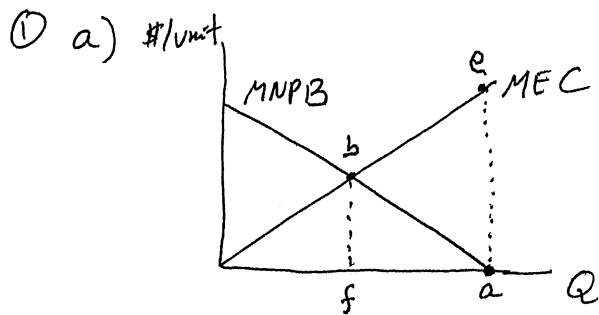
But IPP's contract to provide power to Southern California doesn't expire until 2027, so it is not immediately subject to California's evolving standard for out-of-state power. IPP also supplies electricity to 23 Utah cities and towns. The time has come for the state to impose stricter pollution standards on new coal-fired plants. Failure to do so means IPP will be spewing dangerous pollutants in even greater amounts if another generation unit with inadequate controls is added.

With the health of Utah residents and the visibility that enhances enjoyment of the state's natural splendors so dangerously in jeopardy, Utah lawmakers should require the best and cleanest technology now, instead of waiting for California to set the sensible standard.

There are alternatives to existing coal-fired plants as well. Coal gasification plants that eliminate pollutants and capture carbon dioxide are looking economically viable, as are renewable energy sources such as wind, solar and geothermal.

All that is needed is the political will to embrace them.

Answers to Econ 5250 Final Exam, Fall 2005



MNPB: marginal net private benefit
 MEC: marginal external cost
 Q: output

If firm owners have the right to pollute, $Q = a$, and pollution sufferers are willing & able to pay MEC in exchange for a reduction in pollution. So pollution will be reduced as long as $MEC > MNPB$ via this private bargaining. To the left of "b", $MEC < MNPB$, so no further reductions of Q are beneficial to both parties.

If pollution sufferers have the right to clean air, $Q = 0$, but firms' willingness to pay and ability to pay for increases in output is MNPB, which exceeds MEC. As long as $MNPB > MEC$, in exchange for some payment between MEC and MNPB, pollution sufferers will let the firm raise output, and the firm would willingly pay. This cannot proceed beyond "b" however, since then $MNPB < MEC$.

This assumes costless bargaining.

So in both cases, private contracting leads to the ^{socially} optimal level of Q .

b) minimum payment acceptable to firms in compensation for $\downarrow Q$ is abf .

maximum payment which pollution sufferers are willing & able to pay for

$\downarrow Q$ is $beaf$. ← area below the MEC curve

↗ area below the MNPB curve

② a) **compensating variation**: If we do this what would you have to be paid to make you as happy as if we hadn't done this?

equivalent variation: If we don't do this, what would you have to pay to make you as happy as if we had done this?

b) CV is willingness to accept because the money would be paid to you;
EV is willingness to pay " " " " " paid by you.

③ a) future generations' welfare is as important as our own;
impatience is irresponsible;
societies are immortal so the "mortality justifies discounting" position doesn't apply

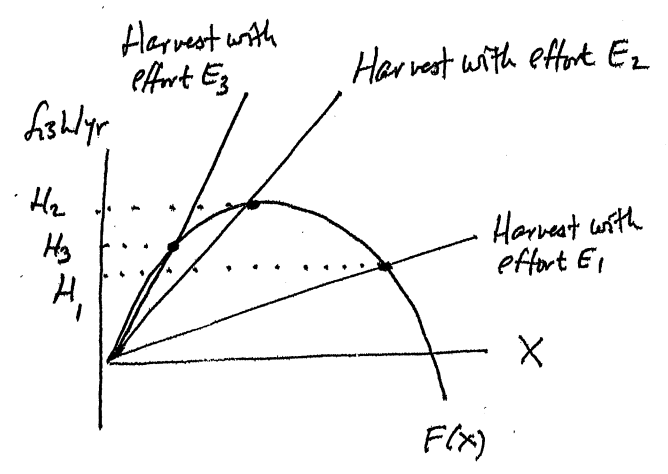
b) the economy grows, so discounting is needed to prevent future generations from being much richer than we are;

Societies may die, so discounting limits the waste of resources never used by a society which dies "too early";

our welfare is more important than future generations' (a particular personal preference some people may have).

(4)

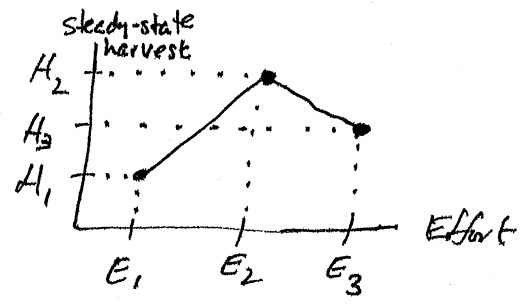
a)



X : stock size
 $F(x)$: excess of births over natural deaths
 $E_1 < E_2 < E_3$

Steady-state harvest : $F(x) = H$

Hence we have :



b) steady-state \Rightarrow all years are the same \Rightarrow time subscripts can be

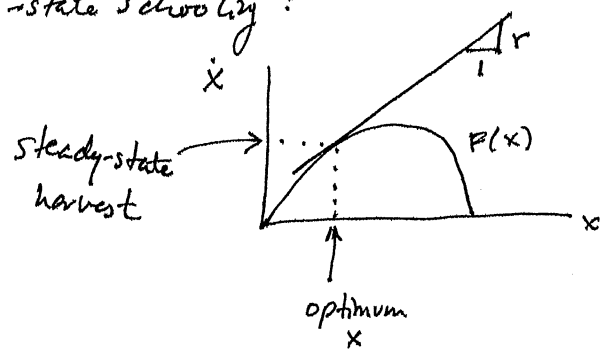
dropped $\Rightarrow r = \frac{-C_x}{\Delta\pi} + F' \frac{\Delta\pi}{\Delta\pi} + \frac{\Delta\pi - \Delta\pi}{\Delta\pi}$

$$= \frac{-C_x}{\Delta\pi} + F' + 0$$

Schooling $\Rightarrow C_x = 0$ ($\downarrow X$ has no effect on costs) \Rightarrow

$$r = F'$$

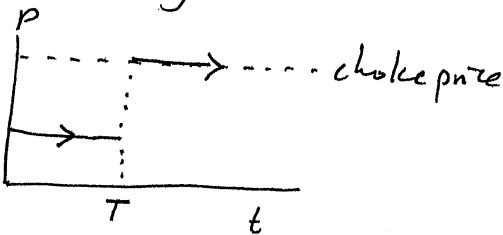
for steady-state schooling :



⑤

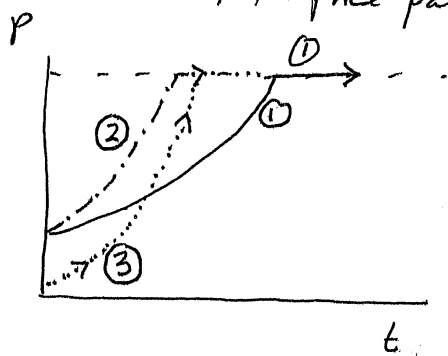
Price paths cannot be flat because a flat price path would imply a constant quantity, and quantity cannot be constant forever (and > 0) because the resource would eventually run out.

A price path like this



is not an equilibrium because firms, taking it as given, would save some resource to sell after "T" when the price jumps. This is inconsistent with the price after "T" being the choke price, which by definition corresponds to zero quantity for sale.

With zero costs, the Hotelling Rule gives $P_{t+1} = (1+r)P_t$; price rises at the rate of interest. With $r \uparrow$, the price path becomes steeper.



①: original

②: steeper but with same initial price

③: correct new path

But path ② has a higher price than ① everywhere, so from the demand curve, ②'s quantity is $<$ ①'s at all dates, so not enough resource is extracted. To make the new, steeper price path's ultimate extraction the same as ①'s, initial price has to fall, as in ③. (③ has to cross ①.)

⑥

↓ forests ⇒ ↓ supply of wood for fuel for cooking & heating

{ ⇒ ↑ time needed to gather wood for the household
 ⇒ reduced cooking ⇒ poorer nutrition, more water-borne diseases
 ⇒ diversion of dung to cooking ⇒ ↓ soil fertility

↓ forests ⇒ increased run off ⇒ dirtier drinking water

These effects are unlikely to be seen in rich countries because: ① wood isn't an important household fuel there; and ② effective methods of making water potable exist.

⑦ a) he connected the 2nd Law of Thermodynamics (the "Entropy Law") to economics

he authored the "Minimal Bideconomic Program" ((1) stop production of armaments, (2) help poor countries, (3) practice sustainable agriculture (no fossil fuel use), (4) stop energy waste, (5) eliminate "extravagant gadgetry," (6) eliminate fashion, (7) make products more repairable, (8) curb the zealous pursuit of ultimately pointless goals)

he coined the term "linear thinking" to describe predicting the future by merely extrapolating from the past

he was deeply influenced by Schrödinger's conception of living beings as being dependent on "low entropy matter/energy" [a flawed conception] ; he applied this to the economy

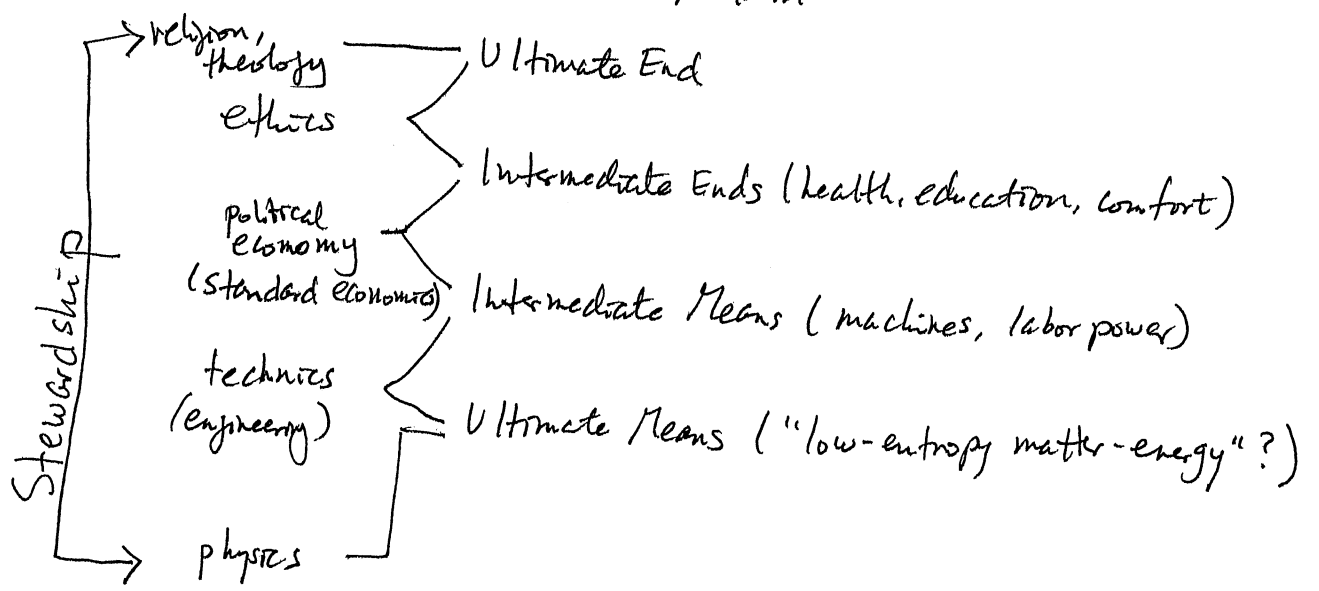
he correctly attacked the "H-theorem" of Statistical Mechanics -i.e., Newtonian Mechanics cannot give rise to Time's Arrow

he correctly attacked any linking of entropy and "information"
thermodynamic

he correctly pointed out that because of the 2nd Law, the amount of unavailable energy in a closed system is ↑ (or, rarely, constant)

he postulated that complete recycling of matter is impossible (his "4th Law of Thermodynamics," a controversial proposition)

b) he suggested the "Ends - Means Spectrum"



8

For Daly, "stewardship" is "humanity's ultimate economic problem"

he recommended a "steady-state economy"

c) he conceived of economics as occurring on "Spaceship Earth," a finite place with no inputs or outputs except for solar radiation and re-radiation - & hence with more limited prospects for "growth" than commonly assumed

he suggested a Birth license scheme to control population size while allowing diversity in family sizes

- Ⓟ a) • China and India are exempt because they're responsible for very little of the current stock of greenhouse gasses in the atmosphere
- The Kyoto Protocol is more effective than Bush's alternatives, which are just research projects
 - Bush is right that CO_2 is not a pollutant in the sense of causing adverse human health effects at anywhere near current concentrations
 - He is right that energy costs would \uparrow if greenhouse gas controls went into effect
 - He is right that current technologies for CO_2 removal & storage are uneconomical in energy production, but they are close to being economical, and might be already economical

if CO₂ externalities were correctly taxed

- His appeal to "the incomplete state of scientific knowledge" ignores the majority opinion of climate scientists that global climate change is occurring due to human emission of greenhouse gases.

b) This editorial incorrectly lumps CO₂ with SO₂, mercury (Hg), and NO_x. CO₂ only causes climate change (currently), not human health effects, while Hg and NO_x damage human health and SO₂ damages forests, buildings, aquatic life, and perhaps people.

Furthermore, the number of people whose health is damaged by the IPP plants in central Utah is likely to be low because not many people live nearby.

Otherwise, there seem to be no errors in the editorial, and it correctly points out the external costs of coal-fired power plants. Those ^{many of} external costs should be considered before approving construction of a new plant.