Economics 3250 Dr. Lozada
Spring 2018 Final Exam

This exam has 50 points. There are ten questions on the exam, each worth 5 points.

Put your answers to the exam in a blue book or on blank sheets of paper.

You have 2 hours to take this test.

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.*

Answer all of the following ten questions.

1. **[5 points]** Students in more advanced classes can be given the following problem:

   > Find the net-present-value-maximizing time path of extraction for a competitive mining industry which: faces a demand curve of $p_t = 10 - q_t$ where p_t is the price of the resource at date t in dollars per ton and q_t is the quantity of the resource extracted at date t measured in tons; has a constant average and marginal cost of \$1/ton; begins with 36.8 tons of the resource; and uses a discount rate of approximately 18.4141% per period.

   The answer to this problem is obtained by calculating that

   $$\begin{aligned} \text{total revenue} &= pq = (10 - q)\, q = 10q - q^2 \\ \text{total cost} &= 1q \\ \text{profit} &= TR - TC = 10q - q^2 - q = 9q - q^2 \\ \text{marginal profit} &= 9 - 2q \end{aligned}$$

   and from there that Table 1 holds, where Π is profit, $M\Pi$ is marginal profit, and "cum. extr." stands for "cumulative extraction," namely the sum so far of the q column. (For example, cumulative extraction at date 3 is 11.7 because $11.7 = 4.0 + 3.9 + 3.8$.)

   (a) If each date represents one decade then this resource would be exhausted in how many decades? (Don't overthink this question: it is easy.)

   (b) Using Table 1, illustrate in Figure profit how profit changes over time by marking each time period's position on Figure profit with its date, for example, "1," "2," "3," etc. Also try to illustrate how marginal profit changes over time in Figure profit.

   (c) In Figure mpi, illustrate how marginal profit changes with time in Table 1.

   (d) In Figure demand, illustrate how quantity and price change with time in Table 1 by marking each time period's position on Figure demand with its date, for example, "1," "2," "3," etc.

date t	q_t	p_t	Π_t	$M\Pi_t$	cum. extr.
1	4.0	6.0	20.0	1.0	4.0
2	3.9	6.1	19.9	1.2	7.9
3	3.8	6.2	19.8	1.4	11.7
4	3.7	6.3	19.6	1.7	15.4
5	3.5	6.5	19.3	2.0	18.9
6	3.3	6.7	18.9	2.3	22.2
7	3.1	6.9	18.3	2.8	25.4
8	2.9	7.1	17.6	3.3	28.2
9	2.6	7.4	16.5	3.9	30.8
10	2.2	7.8	15.0	4.6	33.0
11	1.8	8.2	12.9	5.4	34.8
12	1.3	8.7	10.0	6.4	36.1
13	0.7	9.3	5.8	7.6	36.8
14	0.0	10.0	0.0	9.0	36.8

Table 1. Approximate solution to the exhaustible resource competitive intertemporal equilibrium problem given in Question 1.

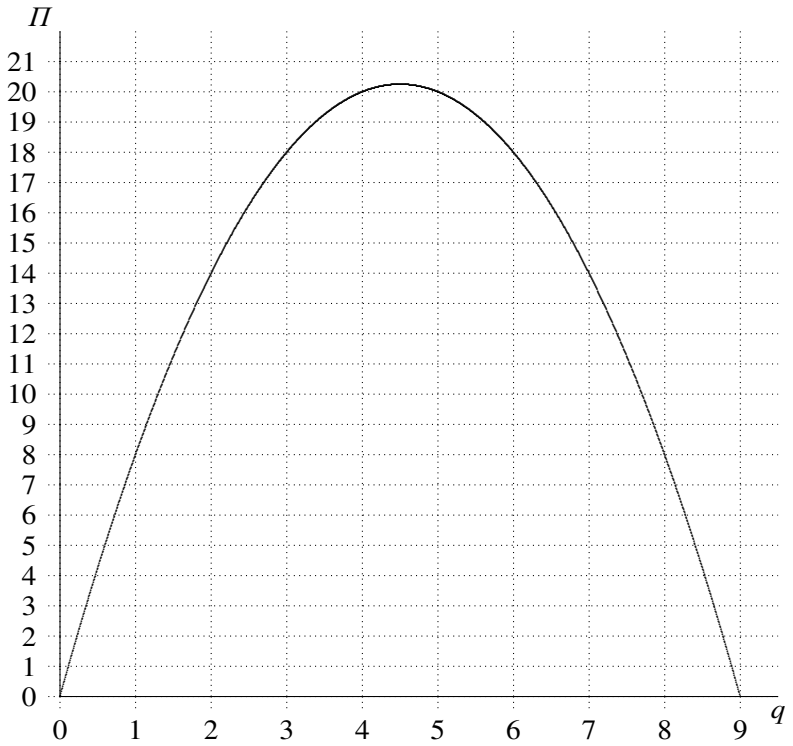

Figure profit. Profit versus quantity extracted. Region of negative profit not illustrated.

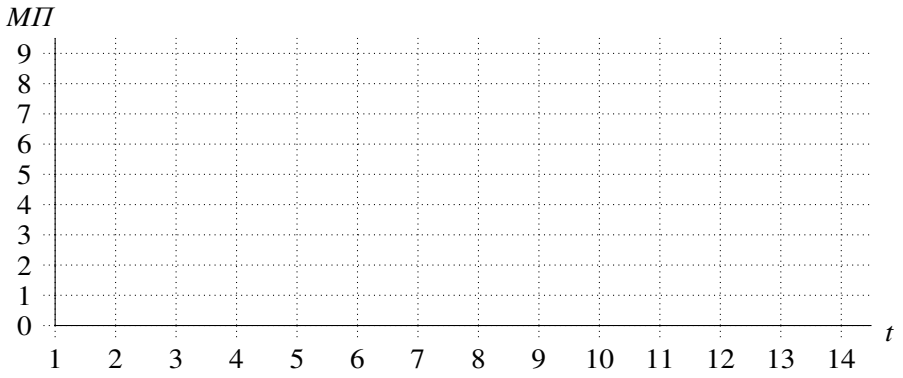

Figure mpi. Marginal profit versus time.

Figure demand. The demand curve $p = 10 - q$.

(e) Which column of the table represents the Hotelling Rule most directly? Why? (There is no need to use a calculator to answer this; just make a plausible numerical case.)

2. **[5 points]** Define "tipping point" and illustrate it with the example of methane trapped in permafrost.

3. **[5 points]** Speculate about why the Montreal Protocol was such a success.

4. **[5 points]** In a passage concerning the US "Homestead Act of 1862," one finds in Wikipedia:

> The "yeoman farmer" ideal of Jeffersonian democracy was still a powerful influence in American politics during the 1840–1850s, with many politicians believing a homestead act would help increase the number of "virtuous yeomen." [...] Southern Democrats had continually fought (and defeated) previous homestead law proposals, as they feared free land would attract European immigrants and poor Southern whites to the west. After the South seceded and their delegates left Congress in 1861, the Republicans and other supporters from the upper South passed a homestead act. [...]
>
> The homestead was an area of public land in the West (usually 160 acres or 65 hectares) granted to any US citizen willing to settle on and farm the land for at least five years. The law (and those following it) required a three-step procedure: file an application, improve the land, and file for deed of title. Any citizen who had never taken up arms against the U.S. government (including freed slaves after the fourteenth amendment) and was at least 21 years old or the head of a household, could file an application to claim a federal land grant. The occupant had to reside on the land for five years, and show evidence of having made improvements. —`https://en.wikipedia.org/wiki/Homestead_Acts`

Discuss this passage in the context of biodiversity.

5. **[5 points]** John Roemer is the Elizabeth S. and A. Varick Professor of Political Science and of Economics at Yale University, and he is

a Fellow of the Econometric Society, of the American Academy of Arts and Sciences, as well as a Corresponding Member of the British Academy. The abstract of a recent article of his ("The Ethics of Intertemporal Distribution in a Warming Planet," *Environmental and Resource Economics* March 2011, Volume 48, Issue 3, pp 363–390) says in part:

> This paper evaluates, from the ethical viewpoint, current work by economists on intergenerational resource allocation in the presence of global warming. We begin by attempting to elucidate the debate that has recently occurred on the appropriate choice of the discount rate. [...] We argue that the justification for discounting, inherent in the approaches taken by many economists, is that of 'the present generation of hegemon,' which is unacceptable. [...] As an alternative to discounted utilitarianism, we propose a principle of sustainability; we describe optimal paths that have been calculated for the sustainabilitiarian (Rawlsian) objective function, and paths that will sustain growth in welfare, at a positive rate. [...] —`https://link.springer.com/article/10.1007\%2Fs10640-010-9414-1`

Why do you think Roemer treats the words "sustainabilitarian" and "Rawlsian" as synonyms?

6. **[5 points]** In your personal opinion, should "disaster aversion" influence the way policy makers make decisions under uncertainty? Why or why not? (You should define "disaster aversion" in your answer.)

7. **[5 points]** Sketch a graph of "marginal net private benefit" and "marginal external cost" for which the socially-optimal amount of output of the product in question is zero. Explain why your graph answers the question, and briefly describe what these curves mean.

8. **[5 points]** Use Figure tariff and the following table to argue that, in this simple context, tariffs are inefficient. You do not need to explain the table. (If I had wanted to make this question harder, I could have asked you to explain the table, or I could have left the table blank and asked you to fill it out.)

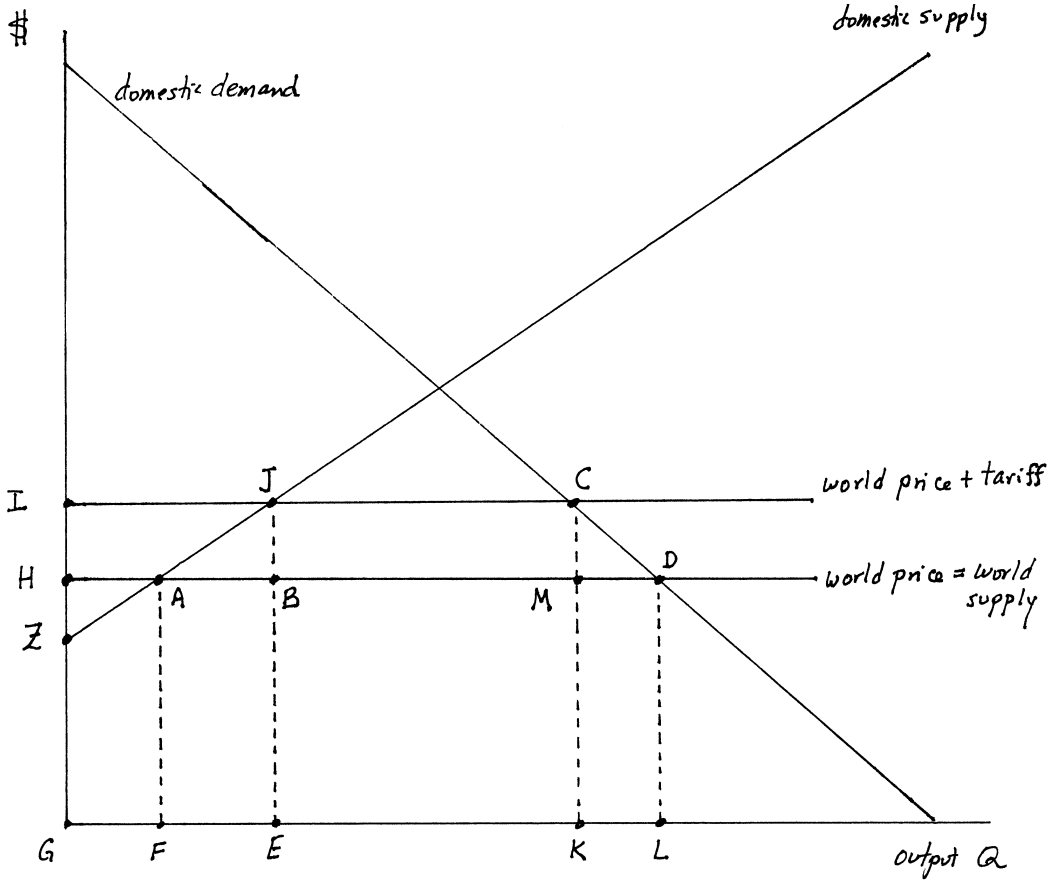

Figure tariff

Ignoring $Q > E$:	Tariff	No Tariff
consumers pay	IJEG	HBEG
consumers pay to domestic firms	IJEG	HAFG
domestic firm costs = area under the domestic supply curve	ZJEG	ZAFG
domestic firm profit	IJZ	HAZ

9. **[5 points]** Give a historical example of an open-access fishery which was bad in at least one way. Would introduction of an "individual transferable quota" system have helped this fishery? Why or why not?

10. **[5 points]** In class I said that "bequest value" could be a bequest of use value or of non-use value. Define "bequest value" and explain the statement I made.

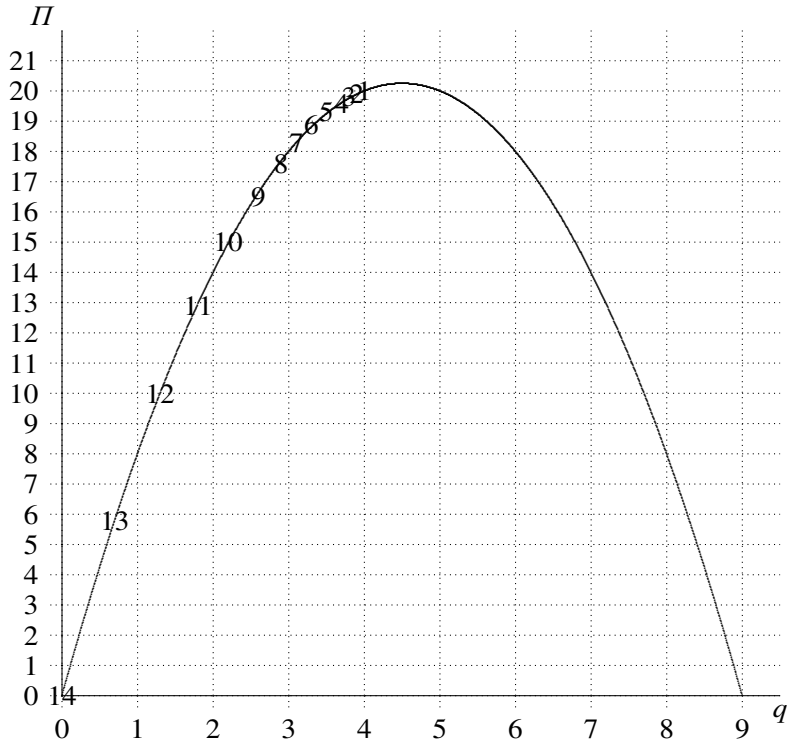

Figure profitanswer1. Profit versus quantity extracted. Region of negative profit not illustrated.

Answers to Final Exam Econ. 3250, Spring 2018

1. (a) From Table 1, in 14 decades, or 140 years, all 36.8 tons of the resource will have been mined.

   (b) The numbers '1,' '2,' ..., '14' in Figure profitanswer1 represent the q_t and Π_t columns of Table 1. Figure profitanswer2 shows the same points as Figure profitanswer1 together with the tangent lines representing marginal profit; the slope of each line is the $M\Pi$ column of Table 1 (which is easy to verify for the fourteenth point, which goes from the origin to (1, 9)).

   (c) The numbers '1,' '2,' ..., '14' in Figure mpianswer represent the t and $M\Pi$ columns of Table 1. For example, at $t = 14$, $M\Pi = 9$.

   (d) The numbers '1,' '2,' ..., '14' in Figure demandanswer represent the q_t and p_t columns of Table 1. For example, $q_{14} = 0$ and $p_{14} = 10$.

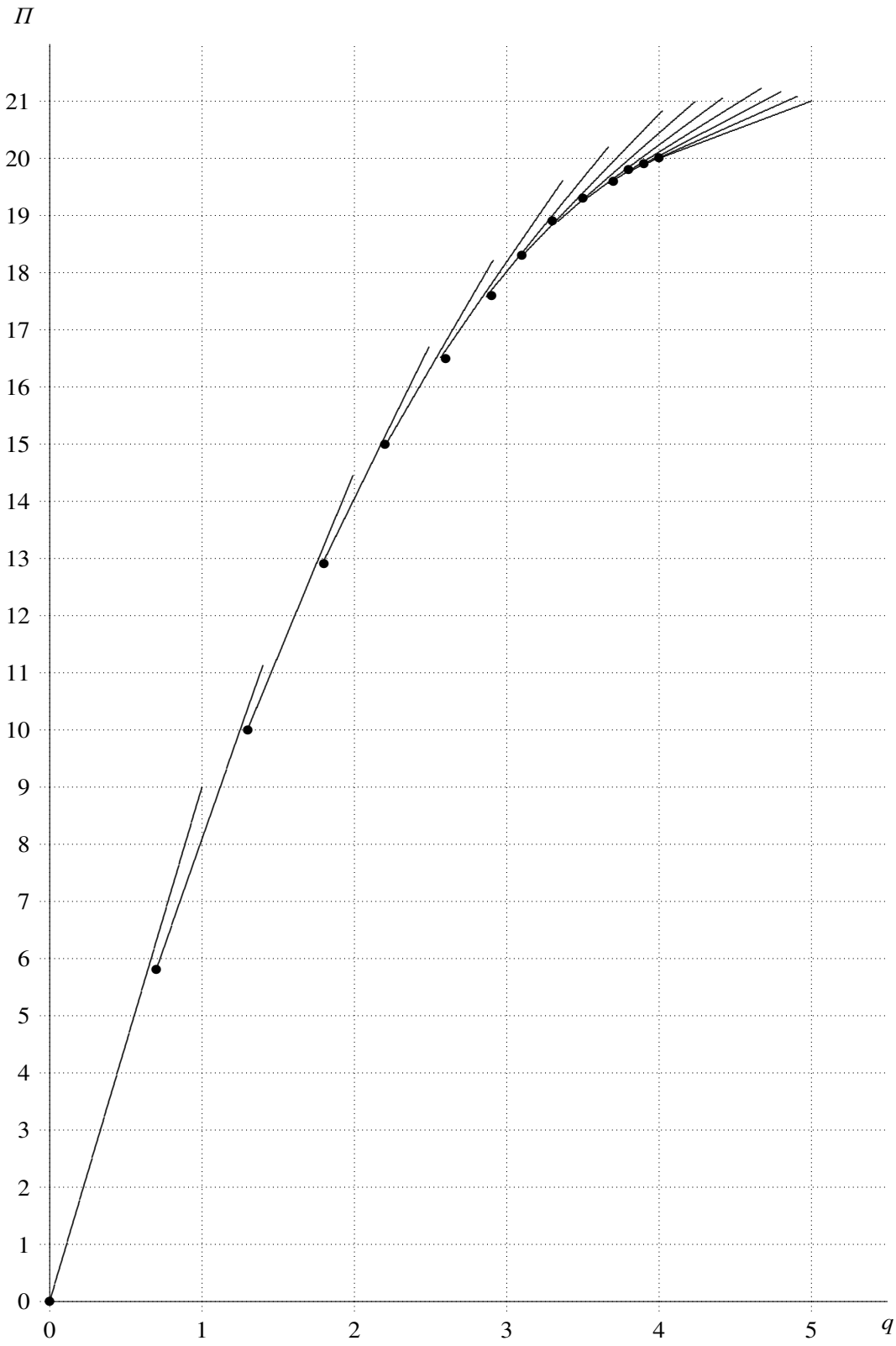

Figure profitanswer2. The left half of Figure profitanswer1 showing tangent lines going to the right but not showing the graph of Π versus q itself.

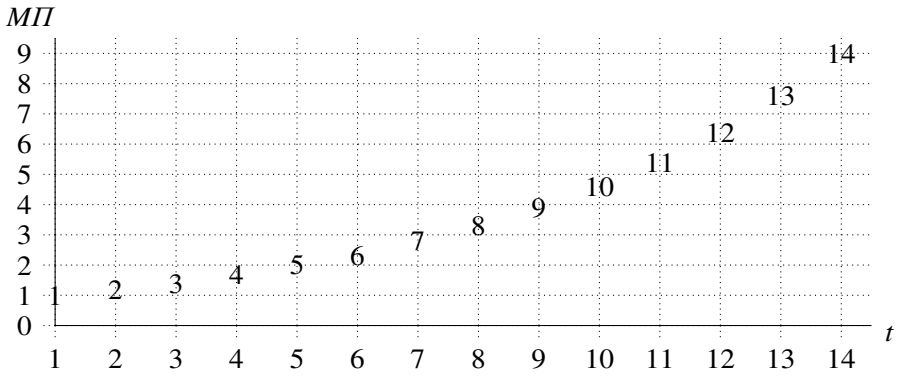

Figure mpianswer. Marginal profit versus time.

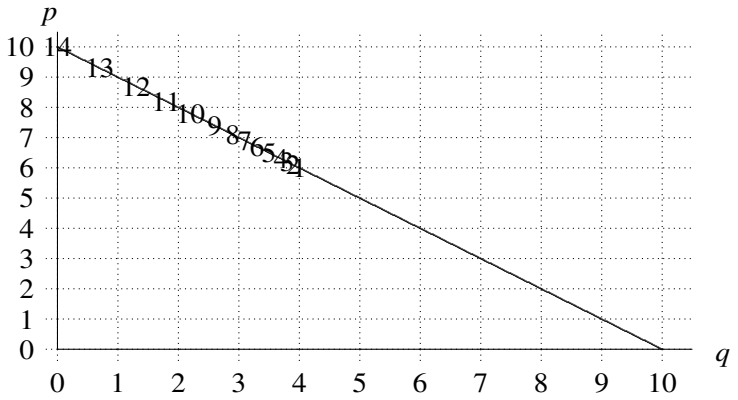

Figure demandanswer. The demand curve $p = 10 - q$.

(e) The $M\Pi$ column of Table 1 should show marginal profit rising at the rate of interest. The rate of interest is $18.4141 \approx 20$ percent, so each number should be approximately 20% larger than the previous entry in that column. Twenty percent of one is 0.2, and the first and second jump in the $M\Pi$ column are indeed 0.2. The next few jumps are 0.3: as marginal profit gets larger, 20% of marginal profit has become bigger than 0.2. The jumps in the $M\Pi$ column keep getting larger, which makes sense because it is supposed to be growing exponentially at approximately 20%.

2. A "tipping point" is a situation beyond which a change becomes self-reinforcing: the change cannot be stopped (or becomes very much harder to stop). For example:

   - A warming climate melts some Arctic permafrost;
   - organic matter in the newly-melted permafrost starts to decompose;
   - which releases methane, a greenhouse gas;
   - which leads to a repeat of this cycle.

   If the climate gets warm enough, this cycle perpetuates itself and the Earth will warm even if all human emissions of greenhouse gases cease.

3. The main reason it was such a success is because alternatives to ozone-depleting chemicals were relatively easy to develop and were not very much more expensive than the older chemicals. (This contrasts to global warming, which has currently-much-more expensive solutions.)

4. The term "improvements" and "improve" in this passage refers to destroying the natural ecosystem and putting the land to agricultural use. This reduces the biodiversity of the land. The Homestead Act ended up destroying almost all the native grasslands of the Great Plains, which is a large portion of the United States.

5. Rawls speculated that under a "veil of ignorance," a society's constitution would provide lots of help for the least-well-off members of the society. Rawls did not discuss intergenerational problems, but extending his idea to an intergenerational context, a just society undergoing climate change, as we are, would take strong steps to protect the generations which are most victimized by climate change: future

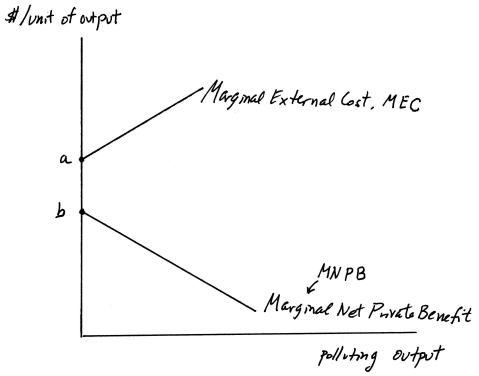

Figure MNPBMEC

generations. This would lead to adopting policies aiding sustainability.

6. Econ. 3250 Fall 2003 Exam 1 question 6.

7. Refer to Figure MNPBMEC. The MEC curve shows the marginal willingness and ability of pollution victims to pay to reduce production of the polluting output. The MNPB curve shows the marginal benefit (that is, profit) accruing to firms by producing the polluting output. Since MEC is always greater than MNPB, even at an output of zero (since $a > b$ in the figure), it is socially optimal to allow none of this output to be produced, because it social cost (MEC) is always larger than its social benefit (MNPB).

8. Econ. 3250 Spring 2016 Exam 1 question 2.

9. Examples of over-exploited fisheries include the halibut fishery off the southern coast of Alaska; the North Atlantic cod fishery (especially near Canada); whale hunting; the New England lobster fishery; and tuna in the eastern North Atlantic Ocean. "Individual transferable quotas" ("ITQs") would have helped by establishing a quota beyond which the fishery could not be exploited. Also, since ITQs are freely tradeable, firms which would like to make trades with other firms can do so; this limits inefficiencies that other regulatory schemes can cause.

10. "Bequest value" is the value someone—call them "Person A"—puts on something (such as a component of nature) not because Person A values that part of nature for himself or herself, but because Person A

cares about the happiness of some other person, "Person B," and Person B cares about that part of nature. Person B could value that part of nature in order to "use" it (for example, to cut down a tree to use its wood), or Person B could value that part of nature for a "nonuse" value (such as valuing the continued existence of polar bears).