Economics 3250 Dr. Lozada
Spring 2017 Exam 1

This exam has 25 points. There are six questions on the exam. Most of the questions are worth 4 points, but one is worth 5 points.

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

You have the entire class period (80 minutes) 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 six questions.

1. **[4 points]**

   (a) In the top part of Figure 1 (which appears on a following page), a firm's total cost curve as a function of output "Q" is shown. Assuming the firm is perfectly competitive, draw in the total revenue curve and find the profit-maximizing output for the firm, which we called Q^{π}.

   (b) In the bottom part of Figure 1, sketch the marginal cost and marginal revenue curves of the same firm, and show where Q^{π} is.

   (c) Now suppose production of Q generates external costs. Draw in a possible total external cost curve on the top graph (or draw in a possible "total external cost plus total cost" curve, which is more useful); draw in its corresponding marginal external cost curve (or "marginal external cost plus marginal cost" curve, which is more useful) on the bottom graph; and show in both graphs where the socially-optimal production of Q, which we called Q^{*}, is.

   Explain and/or defend your answer to each one of the parts of this question thoroughly, just as you should do for every answer you give on this entire exam. Do not merely state the right answer.

2. **[4 points]** In class, we discussed the following ideas, which are connected to the "Arrow Impossibility Theorem."

   - Complete: either $A \succeq_s B$ or $A \preceq_s B$.
   - Responsive to Individual Preferences: if $A \succ_s B$, then some individuals' ranking of A goes up and no one's ranking of A goes down, then it is still the case that $A \succ_s B$.
   - Nonimposition: if $A \succ B$ is true for someone and $A \prec B$ is true for no one, then $A \succ_s B$.
   - Nondictatorship: it is not true that "$A \succ_s B$ if and only if $A \succ_i B$ for individual i."
   - Independence of Irrelevant Alternatives: if $A \succ_s B$ when the choices are A, B and C, then $A \succ_s B$ when the choices are A and B alone.

... *Question 2 continues* →

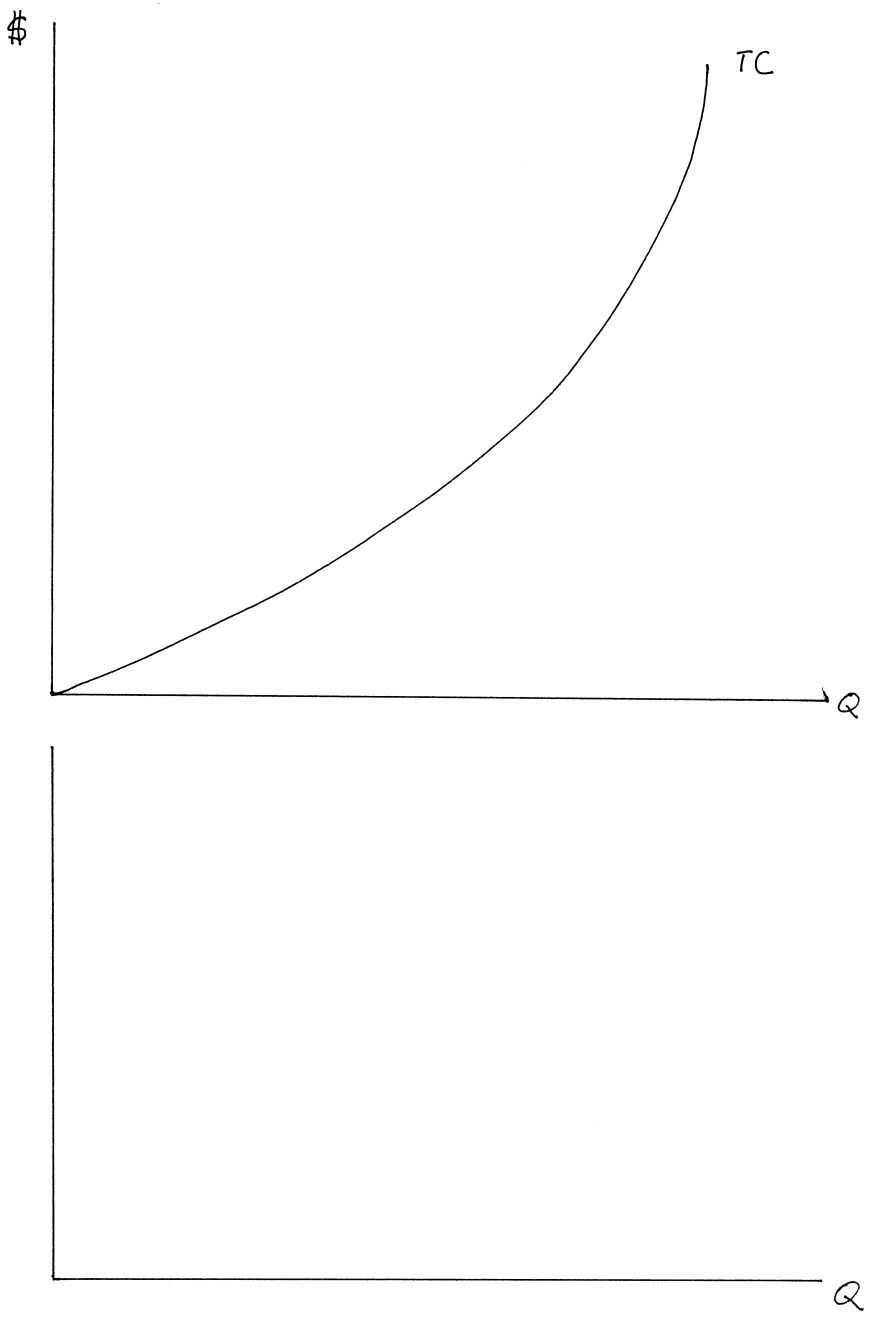

Figure 1.

What do the mathematical symbols in these sentences mean? What is the Arrow Impossibility Theorem and what is its relevance to this course?

3. **[4 points]** Distinguish between "revealed preference" approaches to valuation and "expressed preference" approaches to valuation. Give (and, of course, explain or defend) an example of each. What does the word "valuation" mean in this context?

4. **[5 points]** Suppose one plays a lottery in which a fair coin is tossed, and one's payoff increases with the number of times "heads" ("H") comes up before the first "tail" ("T") is tossed, at which point the game ends. Use Table 1 to argue that most people do not use "expected value" to value a lottery, but they might use "expected utility" to value a lottery.

#H before first T	Prob.	payoff	Prob. * payoff	$\sqrt{\text{payoff}}$	Prob. * $\sqrt{\text{payoff}}$
0	1/2	2	1	1.41	0.71
1	1/4	4	1	2.00	0.50
2	1/8	8	1	2.83	0.35
3	1/16	16	1	4.00	0.25
4	1/32	32	1	5.66	0.18
5	1/64	64	1	8.00	0.13
⋮	⋮	⋮	⋮	⋮	⋮
column's sum					$1 + \sqrt{2} \approx 2.41$

Table 1.

5. **[4 points]** Using a graph, explain exactly why some economists contend that if a nation's constitution gives everyone the right to completely clear air and water, there might still be air and water pollution—assuming *no one ever violates the constitution* (and assuming no pollution comes from other countries).

   Is the amount of pollution observed in this nation bad or good, and in what sense is it "bad" or "good"?

   Give at least the last name of the economist whose work inspired this line of reasoning.

6. **[4 points]** We discussed the following policies which generate "indirect alterations of prices or costs":

   (a) government direct subsidies;

   (b) soft loans; and

   (c) tax incentives.

   Define each of these; *state* in what part of the world each one often used; and *give* an example of each one in the context of environmental policy. What *effect* does each example have? Your examples may be hypothetical.

Answers to Exam 1, Econ. 3250, Spring 2017

1. (a) Total revenue TR equals price P times quantity of output Q. A (perfectly) competitive firm takes price as given, so the right-hand side of $TR = P \cdot Q$ becomes a constant (namely P) times Q, which means that TR is a linear function of Q with a zero intercept. See the graph following. Profit "π" is TR minus total cost "TC." It is maximized at the position indicated by "π" (and by Q^{π}) in the figure. (Note that profit is not maximized where TR equals TC: that is a point where profit $\pi = TR - TC$ is zero, because there $TR = TC$.)

   At Q^{π}, TR and TC are parallel (so marginal revenue "MR" and marginal cost "MC" are equal).

   (b) MR is the slope of TR, and since TR is a straight line, MR is a constant. MC is rising because TC is convex (tangent lines to TC get ever-steeper as one goes from left to right). At Q^{π}, $MR = MC$.

   (c) Total External Cost "TEC" adds to TC, as indicated on the upper graph. Similarly, Marginal External Cost "MEC"adds to MC, as on the lower graph. Society want to maximize $TR - TC - TEC$. In other words, in the top graph, society wants to maximizes the gap between TR and "$TC + TEC$." This maximum occurs where $Q = Q^*$ and accordingly where $MC + MEC = MR$.

   Note: No "marginal" curve can be drawn in the top graph because the units of the top graph are "dollars" whereas the units for all the marginal curves are "dollars per unit of output."

2. The expression "$A \succeq_s B$" means that society weakly prefers A to B. ("Weakly prefers" means that either society prefers A to B or society is indifferent between A and B.) The expression $A \succeq_i B$ means that individual "i" weakly prefers A to B. The expression "$A \preceq_s B$" means that society weakly prefers B to A.

   All of the bulleted points are desirable properties for a social decision rule to have. The Arrow Impossibility Theorem states that this set of desirable properties is internally inconsistent. Therefore, no "perfect" way of making social decisions exists, if the word "perfect" is understood to mean satisfying these criteria. In this class, we mostly use cost-benefit analysis to make social decisions. This is not a perfect way of making social decisions, but the Arrow Impossibility Theorem shows that there is no perfect alternative: all alternatives have

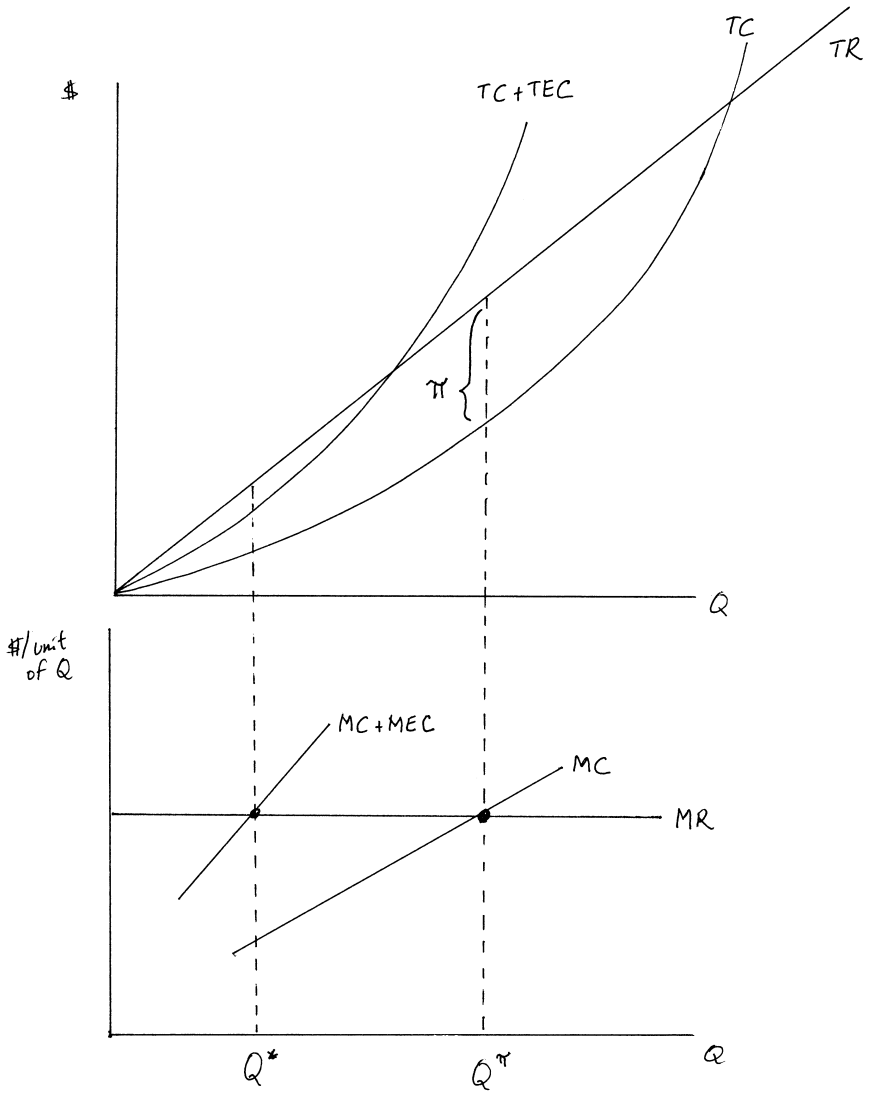

Figure 2.

flaws, just like cost-benefit analysis has flaws, although the flaws will usually be different.

3. "Revealed preference" approaches use observations of prior behavior. In other words, they use data of what consumers actually did. "Expressed preference" approaches use consumers' answers to hypothetical questions about what the consumers *would* do or *say* they *would* do.

   Examples of "revealed preference" approaches are the Travel Cost Method and Hedonic Pricing. An example of an "expressed preference" approach is Contingent Valuation.

   "Valuation" here means putting a dollar value on something which has no market price—for example, the value of clean air. (For something which has a market price, its value is just taken to be its market price.)

4. The table below shows that this "lottery" has an "expected value" ("EV"), which is the sum of the fourth column, of infinity. However, introspection shows that people are not willing to pay anywhere close to an infinite amount of money for the privilege of being able to participate in this lottery. (It would be difficult to conduct an experiment

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⋮	⋮	⋮	⋮	⋮	⋮
column's sum			EV $= \infty$		EU $= 1 + \sqrt{2} \approx 2.41$

Table 2.

   to test this out because typically such an experiment would allow the subjects to play this lottery if they paid the amount they claimed it was worth to them, but playing this experiment even once could bankrupt the experimenter.)

A solution to this "St. Petersberg Paradox" is that people do not value a lottery according to the lottery's expected value, but rather according to its "expected utility" ("EU"), which is the sum of each outcome's "probability times the utility of the payoff," where "the utility of the payoff" is given by u(payoff) where u is a "utility function" (defined over an amount of money which is certain not uncertain). The table shows an example where

$$u(\text{payoff}) = \sqrt{\text{payoff}}\,.$$

In this example, EU $< \infty$ (you are not expected to know how to calculate that EU ≈ 2.41).[1] This solves the "paradox" because it says people think this lottery is worth a finite amount of money.

By the way, Wikipedia's article on this topic, `https://en.wikipedia.org/wiki/St._Petersburg_paradox`, points out that in 1738, Daniel Bernoulli suggested considering u(payoff) = ln(payoff). The article points out that a few modern commentators do not believe that switching from EV to EU constitutes a solution to the fundamental problem because even with a concave utility function, if the utility function is nevertheless unbounded, and if in addition the payoffs are changed so that they rise sufficiently quickly (faster than the above table's 2^i), then even expected *utility* will be infinite.

5. Suppose the marginal net private benefit curve and the marginal external cost curve are as shown in Figure 3. Because of the constitution described in the question, one can assume that at the start of the analysis, $Q = 0$. However, firms have a willingness and ability to pay potential pollution victims for the right to pollution. Firms' willingness and ability is shown by their MNPB curve. Pollution victims' willingness to accept payment in return for pollution is shown by their MEC curve.

[1] Here is one example of how to calculate it. Call the sum of the infinite series "S." Then $S = \sum_{i=1}^{\infty}(1/2^i)\sqrt{2^i} = \sum_{i=1}^{\infty}(2^i)^{-1/2}$. So

$$\begin{aligned} S &= 2^{-1/2} + 2^{-1} + 2^{-3/2} + \cdots && \text{and therefore} \\ 2^{-1/2}S &= \qquad 2^{-1} + 2^{-3/2} + \cdots && \text{and subtracting,} \\ S - 2^{-1/2}S &= 2^{-1/2}\,. \end{aligned}$$

Then

$$S = \frac{2^{-1/2}}{1-2^{-1/2}} = \frac{1}{\sqrt{2}-1} = \frac{1}{\sqrt{2}-1}\cdot\frac{\sqrt{2}+1}{\sqrt{2}+1} = \frac{\sqrt{2}+1}{2-1} = \sqrt{2}+1\,.$$

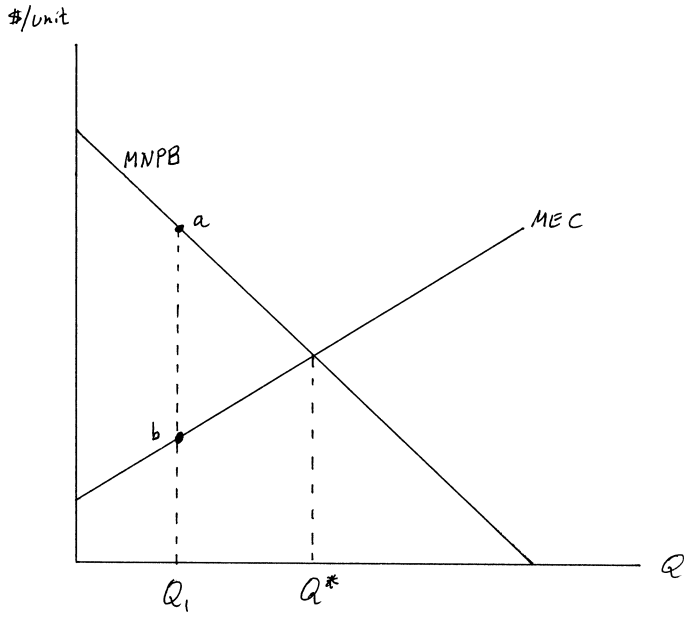

Figure 3.

It follows that, for example, to get the right to produce the Q_1 unit of output, firms would be willing and able to pay any price less than a, and pollution victims would be willing to accept any price greater than b. Since $a > b$, a mutually-beneficial agreement is possible.

This reasoning extends all the way to Q^*, which is the socially-optimal level of output. So the "Coase Theorem" predicts that output will finally be Q^*.

6. (a) "Government direct subsidies" are payments given by governments to firms. For example, in Europe, governments sometimes give firms money to help the firms buy pollution-control equipment, which improves environmental quality.

   (b) "Soft loans" are loans given by governments to firms at better-than-market terms (which usually means below-market-interest-rates, but sometimes means extended maturity dates or granting a payback guarantee). For example, the US government gave the former solar panel manufacturer Solyndra a loan guarantee before Solyndra went bankrupt (see `https://en.wikipedia.org/`

wiki/Solyndra). Soft loans given to renewable-energy producers can reduce greenhouse-gas emissions.

(c) "Tax incentives" are tax reductions given to firms or to consumers who do something the government wishes to encourage, such as purchase energy-saving equipment. Tax incentives are the main way the US federal and state governments try to change the economic behavior of people in the country. An example would be tax credits for purchasing a "hybrid" automobile, a policy which increased the number of such automobiles purchased, and thus decreased gasoline consumption and helped auto makers gain experience in manufacturing such cars.