Your Name: ____ UM ID Number ____________________

Ford School of Public Policy 555: Microeconomics A

Fall 2011

Exam 2 November 10, 2011

Professor Kevin Stange

This exam has 9 questions and spans the topics we have covered in the second part of the course. Please explain your answers when asked and **show your work**. It is in your best interest to show each of your steps clearly in order to receive partial credit and so that you are not penalized in later parts for math mistakes in earlier ones. You have 80 minutes to complete the exam. Each question indicates the points each question is worth – you should use this as a guide to the number of minutes you can spend on each question. The points sum to 90, so 10 points are optional. Good luck!

Short Answer [18]

1. [4] True or False. Suppose the market for airport taxi service between Ann Arbor and DTW is in a competitive equilibrium at a price of $50 per trip and a quantity of 1000 trips. The demand function is given by Qd = 2000 – 20P. True or False: "Imposing a strict quota that limited the number of trips to 800 would be worse for consumers and generate more deadweight loss than setting a price floor of $60 per trip." Explain briefly with a graph. [Note: You do not need to know the supply function to answer this question.]

2. [4] True or false. Suppose a typical auto manufacturing plant employs 1000 workers per year. True or False: "A policy that provides auto manufacturers a $100 subsidy for each worker it employs will cost the government more than $100,000 annually for each auto plant in the long run." Explain briefly.

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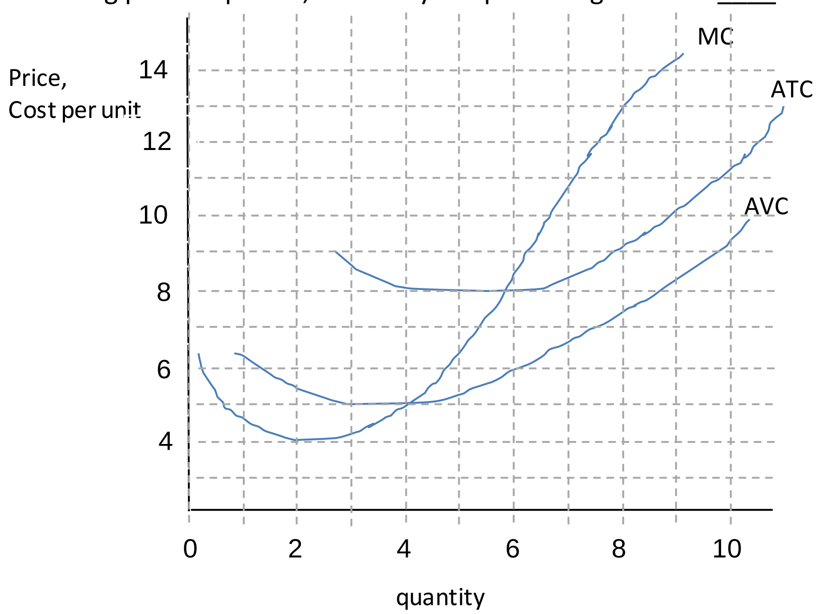
3. [4] True or false: “Since Greg and Mary do not get paid extra for holding additional review sessions, (they do it out of the kindness of their hearts), then these review sessions have no economic cost to the Ford School.” Explain briefly.

4. [3] The graph below plots the short-run average total cost (ATC), average variable cost (AVC), and marginal cost (MC) curves for a competitive firm. Fill in the blanks (with nearest whole number). No explanation needed.
    a. If the price is $11, the firm will produce ____ units.
    b. If the firm is going to produce, the minimum quantity that they will is ____.
    c. If the firm is making positive profits, then they are producing at least ____ units.



5. [3] Seth is risk averse and deciding how to invest the $1000 he won in a writing contest. He has three options: (1) a bond which returns $1100 for sure (gain of $100); and (2) real estate, which has a 50% chance of returning $2000 ($1000 gain) and a 50% chance of returning $0 ($1000 loss). Can you say which option he would prefer? Explain briefly.

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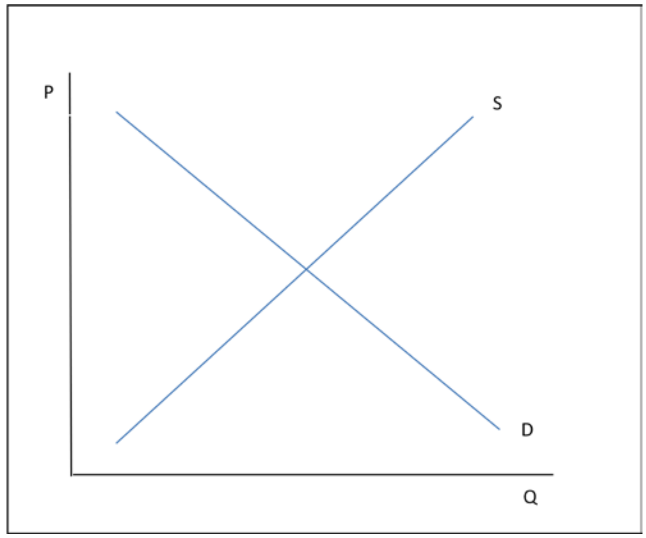
6. [19] Subsidies

The market for graduate-level engineering education has both a supply (i.e. colleges) and demand (i.e. students). Assume that this market is competitive, with demand function $Q_D = 130 - 2P$ and supply function $Q_S = 30+2P$. Q is the number of students attending and P is the price.

a. [3] Calculate the equilibrium quantity of graduate engineering students and the price they pay. Label these quantities P* and Q* on the graph below.



Complaining that there are not enough well-trained engineers, high tech employers successfully lobby the Obama Administration to provide subsidies for engineering graduate students. Assume that the government provides a $10 subsidy (in the form of a fellowship) to each student.

b. [4] Find the new price that students pay for their education and the price that colleges receive for each student, taking the subsidy into account.

c. [2] How many engineering graduate students are there now?

d. [3] Show the effect of the subsidy on the supply and demand curves above. Be sure to label the price received by colleges (P_P), price paid by consumers (P_C), the subsidy per unit, and new quantity (Q_{subidy}).

e. [3] Calculate the deadweight loss associated with the subsidy and label it on your graph.

f. [4] Is this deadweight loss more or less than what would result from a policy that shifted the demand curve outward by making it easier for foreign students to come study and work in the US? Explain.

7. **[15] Expected utility.** Mike has a utility function given by $U = (0.50)Y_{Mike}$ where Y_{Mike} is his total income from all sources. His job pays him $100,000.

a. [2] Is Mike risk averse, risk neutral, or risk-loving? (No explanation needed)

b. [2] Suppose there is a 10% chance that Mike will lose his job next year, what is the expected value of his income for next year?

c. [3] What is Mike's expected utility for next year?

Suppose that Mike's state is voting on a ballot measure that would create an unemployment insurance program that would cost all workers 15% of their income, but would pay workers their full salary if they lose their job. That is, net income would be 85% of original income regardless of whether one keeps the job.

d. [3] If Mike cared only about his own expected utility, would he vote for or against the program? Explain.

e. [5] Mike's wife Mindi has a utility function given by $U = (0.50)(Y_{Mindi})^a$ where *a* is a number less than one. Mindi also has a 10% chance of losing her job. Now suppose Mike cared only about his wife's expected utility. For which of the following values of *a* would he vote for the ballot measure?

a = 0.25
a = 0.50
a = 0.75

Note that you do not need to know Mindi's income to be able to solve this problem.

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8. **[16] Input choice.** You are the race director of the New York City Marathon, which is held every November. Suppose you can produce a marathon using two inputs: police barricades (K - capital) and volunteers (L -labor) according to a production function:

$$q = 100(K)(L)$$

where q is the number of runners. The price of police barricades is P_k = \$10 per barricade and the price of volunteers is P_L = \$1 per volunteer (you give each volunteer a shirt, so they are not entirely free).

   a. [3] Calculate expressions for the marginal products of barricades and of volunteers?

   b. [5] Suppose all inputs are variable so you are free to choose any combination of barricades and volunteers you see fit. What is the cost-minimizing ratio between barricades (K) and volunteers (L)?

   c. [5] If you want the marathon to have 16,000 runners, how many police barricades and how many volunteers will you need (spending the least amount of money)?

   d. [3] The race was so successful that you want to expand and double the size next year (to 32,000 runners) but you know that it will be difficult to find twice as many volunteers as you currently use. Is this a problem? Explain. DO NOT redo part c to answer this.

9. **[22] Profit maximization.** Again you are the race director of the New York City Marathon (NYCM), but now you are trying to decide how many runners (q) to let into the race so as to maximize the amount of money raised for charity (equal to the race's profits). Ignore everything from question 8 above. You can assume the marathon industry is competitive with a current price of $100. Suppose you have three types of costs:
   - Administrative costs and advertising: $900 (does not depend on number of runners)
   - Food, drink, and t-shirts for runners: $20 per runner
   - Security and medical costs: $1x(number of runners)^2

   a. [3] What is the NYCM's total cost function?

   b. [4] What is the marginal cost (MC) function, the average total cost (ATC) function, the average fixed cost (AFC) function, and the average variable cost (AVC) function?

   c. [5]What is the profit-maximizing number of runners it should let into the race?

   d. [5] How much profit (money for charity) is the race making (if any) at this price?

e. [5] You are concerned about how changes in costs will impact the optimal quantity in the short run. Should you care most about changes in administrative costs or changes in t-shirt costs? Explain.

Useful Formulas

The partial derivative of a function $F(X,Y) = aX^nY^m$ with respect to X is $\frac{\partial F(X,Y)}{\partial X} = anX^{n-1}Y^m$ where a, n, and m are numbers.

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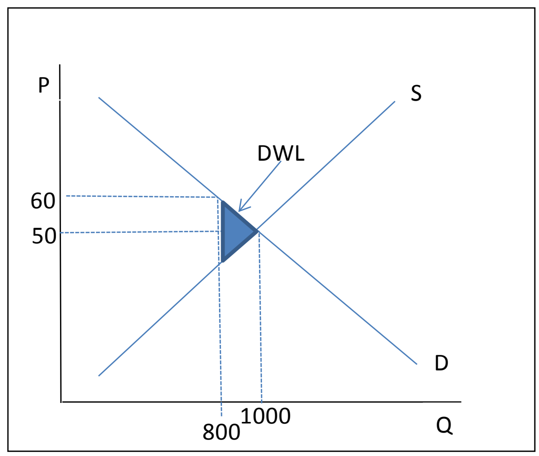
   False. The two policies result in the same price and quantity and the same amount of dead weight loss. To see this, note that a price floor of $60 will result in Qd = 2000 – 20(60) = 800 units. And a strict quota of 800 units will result in a price of $60.Compared to the competitive equilibrium of P = 50 and Q = 1000, both policies generate a dead weight loss given by the shaded triangle in the graph.



2. [4] True or false. Suppose a typical auto manufacturing plant employs 1000 workers per year. True or False: "A policy that provides auto manufacturers a $100 subsidy for each worker it employs will cost the government more than $100,000 annually for each auto plant in the long run." Explain briefly.

   True. If the number of workers employed stayed fixed at 1,000, then the subsidy would cost exactly ($100/worker)x(1000 workers) = $100,000. However, the number of workers may increase for two reasons in the long run. First, manufacturers will shift their production process to use relatively more workers and less capital for a given amount of output. Second, a decrease in labor costs will decrease marginal costs, which will increase the profit-maximizing level of output, further increasing firms' use of workers. For both reasons, the number of workers should increase so the total cost of the subsidy will be greater than $100,000.

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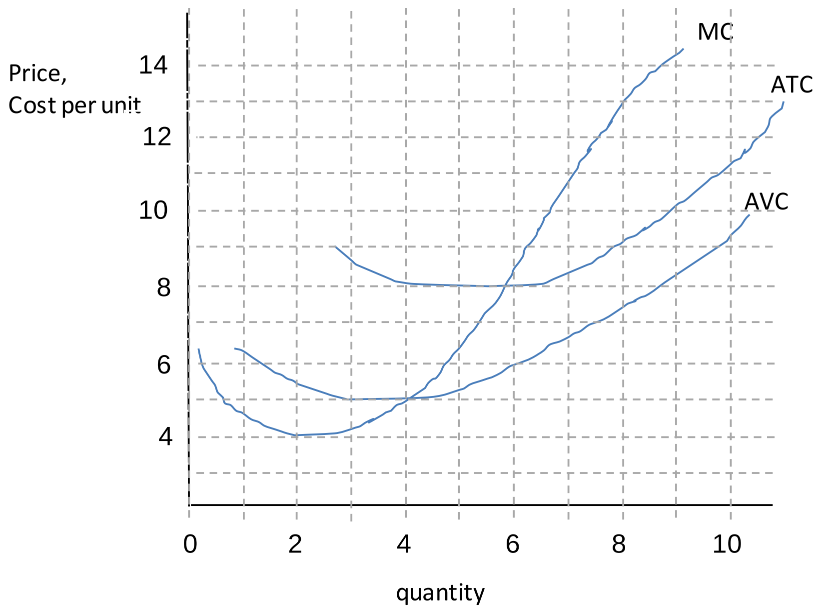
3. [4] True or false: "Since Greg and Mary do not get paid extra for holding additional review sessions, (they do it out of the kindness of their hearts), then these review sessions have no economic cost to the Ford School." Explain briefly.
False. These review sessions impose opportunity cost on the Ford School, since Mary and Greg's time is valuable and could be used elsewhere. Exactly how much opportunity cost these sessions create depends on what else Mary and Greg could do with their time and how the Ford School could monetize this. For instance, if they instead did more one-on-one tutoring or provided more feedback on the homework instead of holding review sessions, then this could save the school from having to hire tutors. Or if they instead used this time to consult for local governments on behalf of the Ford School, then the review sessions represents lost income for the school.

4. [3] The graph below plots the short-run average total cost (ATC), average variable cost (AVC), and marginal cost (MC) curves for a competitive firm. Fill in the blanks (with <u>nearest whole number</u>). No explanation needed.
   a. If the price is $11, the firm will produce _7__ units.
   b. If the firm is going to produce, the minimum quantity that they will is _4__.
   c. If the firm is making positive profits, then they are producing at least <u>6 (approx)</u> units.



5. [3] Seth is risk averse and deciding how to invest the $1000 he won in a writing contest. He has three options: (1) a bond which returns $1100 for sure (gain of $100); and (2) real estate, which has a 50% chance of returning $2000 ($1000 gain) and a 50% chance of returning $0 ($1000 loss). Can you say which option he would prefer? Explain briefly.
He would prefer the bond (option 1). The bond has both a higher expected value ($1100) and is less risky than the real estate (the bond has no risk, the real estate has some). Since he is risk averse, the less risky option would be more desirable if the two had the same expected value. In fact option 1 has a higher expected value and is less risky, so it is favored for both reasons.

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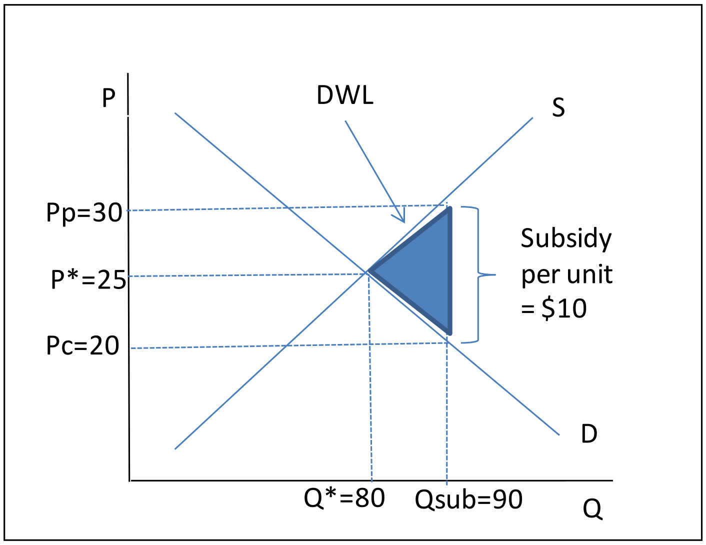
6. [19] Subsidies

The market for graduate-level engineering education has both a supply (i.e. colleges) and demand (i.e. students). Assume that this market is competitive, with demand function $Q_D = 130 - 2P$ and supply function $Q_S = 30+2P$. Q is the number of students attending and P is the price.

a. [3] Calculate the equilibrium quantity of graduate engineering students and the price they pay. Label these quantities P* and Q* on the graph below.

$$Qd = Qs$$
$$130 - 2P = 30 + 2P$$
$$100 = 4P$$
$$\boxed{P^* = 25}$$
$$Q = 30 + 2(25)$$
$$\boxed{Q^* = 80}$$



Complaining that there are not enough well-trained engineers, high tech employers successfully lobby the Obama Administration to provide subsidies for engineering graduate students. Assume that the government provides a $10 subsidy (in the form of a fellowship) to each student.

b. [4] Find the new price that students pay for their education and the price that colleges receive for each student, taking the subsidy into account.

$$Now: Pc = Pp - 10$$
$$Qd = Qs$$
$$130 - 2Pc = 30 + 2Pp$$
$$130 - 2(Pp - 10) = 30 + 2Pp$$
$$130 - 2Pp + 20 = 30 + 2Pp$$
$$120 = 4Pp$$
$$\boxed{Pp = 30}$$
$$Pc = Pp - 10$$
$$\boxed{Pc = 20}$$

c. [2] How many engineering graduate students are there now?

$$Qd = 130 - 2Pc$$
$$Q = 130 - 2(20)$$
$$\boxed{Qsubsidy = 90}$$

d. [3] Show the effect of the subsidy on the supply and demand curves above. Be sure to label the price received by colleges (P_P), price paid by consumers (P_C), the subsidy per unit, and new quantity (Q_{subidy}).

See above.

e. [3] Calculate the deadweight loss associated with the subsidy and label it on your graph.

$$DWL = 0.5 * (Subsidy) * (Qsubsidy - Q^*)$$
$$DWL = 0.5 * (10) * (90 - 80)$$
$$DWL = 0.5 * (10) * (10)$$
$$\boxed{DWL = 50}$$

f. [4] Is this deadweight loss more or less than what would result from a policy that shifted the demand curve outward by making it easier for foreign students to come study and work in the US? Explain.

More. A policy that just shifted the demand curve outward by, for instance, permitting more foreign students to come study and work in the U.S. (say by increasing the number of student and worker visas) would have no deadweight loss. This shift in the demand curve would result in a higher quantity and higher price, but no deadweight loss if the market moved to this new competitive equilibrium. Of course there could be distributional considerations – existing US engineering students would benefit more from the subsidy (which lowers their price) than the demand shift (which increases their price), but the subsidy costs the government more than students and colleges benefit from it, so it creates deadweight loss. The implication of this simple model is that increasing demand via immigration policy would be a more efficient way of increasing the number of engineering graduate students than simply subsidizing it.

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7. [15] Expected utility. Mike has a utility function given by $U = (0.50)Y_{Mike}$ where Y_{Mike} is his total income from all sources. His job pays him $100,000.

a. [2] Is Mike risk averse, risk neutral, or risk-loving? (No explanation needed)

   Risk neutral.

b. [2] Suppose there is a 10% chance that Mike will lose his job next year, what is the expected value of his income for next year?

   E[Y] = (0.9)(100,000) + (0.1)*(0) = $90,000*

c. [3] What is Mike's expected utility for next year?

   *E[U] = (0.9)*U(100,000) + (0.1)*U(0)*

   E[U] = (0.9)(0.5)(100,000) + (0.1)*(0.5)(0)*

   E[U] = 45,000

Suppose that Mike's state is voting on a ballot measure that would create an unemployment insurance program that would cost all workers 15% of their income, but would pay workers their full salary if they lose their job. That is, net income would be 85% of original income regardless of whether one keeps the job.

d. [3] If Mike cared only about his own expected utility, would he vote for or against the program? Explain.

   Against. He would compare his E[U] with the program to that without the program and vote for it if E[U] with the program is higher.
   Without: E[U] = 45,000 (from above)

   With: His income will be $85,000 with or without losing his job, so

   E[U] = (0.9)(0.5)(85,000) + (0.1)*(0.5)(85,000) = 42,500*

   Since the E[U] with the program (42,500)is lower than E[U] without the program (45,000), he will vote against the program.

e. [5] Mike's wife Mindi has a utility function given by $U = (0.50)(Y_{Mindi})^a$ where *a* is a number less than one. Mindi also has a 10% chance of losing her job. Now suppose Mike cared only about his wife's expected utility. For which of the following values of *a* would he vote for the ballot measure?

   a = 0.25
   a = 0.50
   a = 0.75

   Note that you do not need to know Mindi's income to be able to solve this problem.

   0.25 and 0.50, but not 0.75. Mike will support the program if Mindi's E[U] with the program is greater than her E[U] without the program. This comparison can be made even without knowing Mindi's income

$$E[U]_{with} > E[U]_{without}$$
$$(0.5)*(0.85*Y_{Mindi})^a > (0.9)*(0.5)*(Y_{Mindi})^a + (0.1)*(0.5)*(0)^a$$
$$(0.5)*(0.85*Y_{Mindi})^a > (0.9)*(0.5)*(Y_{Mindi})^a$$
$$(0.85*Y_{Mindi})^a > (0.9)*(Y_{Mindi})^a$$
$$(0.85)^a*(Y_{Mindi})^a > (0.9)*(Y_{Mindi})^a$$
$$(0.85)^a > (0.9)$$

Substituting the different values for a into the expression gives:

$$(0.85)^{0.25} = 0.96$$
$$(0.85)^{0.50} = 0.92$$
$$(0.85)^{0.75} = 0.89$$

So if Mindi is sufficiently risk averse (a is small), then her E[U] from participating in the program will be higher than it would be without the program, so Mike should support it.

8. **[16] Input choice.** You are the race director of the New York City Marathon, which is held every November. Suppose you can produce a marathon using two inputs: police barricades (K - capital) and volunteers (L -labor) according to a production function:

q = 100(K)(L)

where q is the number of runners. The price of police barricades is P_k = \$10 per barricade and the price of volunteers is P_L = \$1 per volunteer (you give each volunteer a shirt, so they are not entirely free).

a. [3] Calculate expressions for the marginal products of barricades and of volunteers?

$$MP_K = \partial q / \partial K = 100L \qquad MP_L = \partial q / \partial L = 100K$$

b. [5] Suppose all inputs are variable so you are free to choose any combination of barricades and volunteers you see fit. What is the cost-minimizing ratio between barricades (K) and volunteers (L)?

$$\frac{MP_K}{MP_L} = \frac{P_K}{P_L} \Rightarrow \frac{100L}{100K} = \frac{10}{1} \Rightarrow L = 10K \text{ or } \boxed{\frac{L}{K} = 10}$$

c. [5] If you want the marathon to have 16,000 runners, how many police barricades and how many volunteers will you need (spending the least amount of money)?

$$q = 100KL$$
$$16000 = 100K(10K)$$
$$16000 = 1000K^2$$
$$K^2 = 16$$
$$\boxed{K = 4, L = 40}$$

d. [3] The race was so successful that you want to expand and double the size next year (to 32,000 runners) but you know that it will be difficult to find twice as many volunteers as you currently use. Is this a problem? Explain. DO NOT redo part c to answer this.
No. Since the production function for marathons above exhibits increasing returns to scale, then doubling all inputs will more than double the output. A consequence is that you will need less than twice as many workers in order to double output, assuming you can also increase the number of police barricades (K).

9. **[22] Profit maximization.** Again you are the race director of the New York City Marathon (NYCM), but now you are trying to decide how many runners (q) to let into the race so as to maximize the amount of money raised for charity (equal to the race's profits). Ignore everything from question 8 above. You can assume the marathon industry is competitive with a current price of $100. Suppose you have three types of costs:
   - Administrative costs and advertising: $900 (does not depend on number of runners)
   - Food, drink, and t-shirts for runners: $20 per runner
   - Security and medical costs: $1x(number of runners)^2

   a. [3] What is the NYCM's total cost function?

   $$TC = 900 + 20q + q^2$$

   b. [4] What is the marginal cost (MC) function, the average total cost (ATC) function, the average fixed cost (AFC) function, and the average variable cost (AVC) function?

   $$MC = 20 + 2q$$
   $$ATC = \frac{900}{q} + 20 + q$$
   $$AFC = \frac{900}{q}$$
   $$AVC = 20 + q$$

   c. [5]What is the profit-maximizing number of runners it should let into the race?

   $$\textit{Set}\ \mathrm{P = MC}$$
   $$100 = 20 + 2q$$
   $$80 = 2q$$
   $$\boxed{q^* = 40}$$

   d. [5] How much profit (money for charity) is the race making (if any) at this price?

   $$\mathrm{Pr}\,ofit = \mathrm{Re}venue - TotalCost$$
   $$= Pq - TC$$
   $$= 100 * (40) - [900 + 20 * 40 + 40 * 40]$$
   $$= 4000 - 3300$$
   $$\boxed{\mathrm{Pr}\,ofit = \$700}$$

e. [5] You are concerned about how changes in costs will impact the optimal quantity in the short run. Should you care most about changes in administrative costs or changes in t-shirt costs? Explain.
You should care about the t-shirt costs (which are variable) rather than the administrative costs (which are fixed). The t-shirt costs directly influence marginal cost - each $1 increase in t-shirt costs increases marginal cost by $1 – so they directly impact the optimal quantity. If the t-shirt costs were so high that AVC exceeded price, then it would be optimal to shut down (not hold the race) in the short run. The fixed administrative costs have no bearing on short-run decisions. Rather, they influence short-run profits and entry/exit decisions only in the long run.

Useful Formulas

The partial derivative of a function $F(X,Y) = aX^nY^m$ with respect to X is $\frac{\partial F(X,Y)}{\partial X} = anX^{n-1}Y^m$ where a, n, and m are numbers.