Homework 1, Solutions
Managerial Economics: Eco 685

Question 1

a. True. Economic profits are always lower than accounting profits because economic profits includes as a cost the value of the next best option. The economic profits at the restaurant include as a cost the value of Mr. Kovaceski's time. This cost is not included in an accounting statement, so economic profits are lower at the restaurant than accounting profits.

b. False. From the quote, Mr. Kovaceski could hire an executive chef and a general manager which would cause labor costs to rise from 20% to 33.3%. Since he chose not to hire a chef and a manager, the value of his time must be less than or equal to $33.3 - 20 = 13.3\%$ of his labor costs.

c. False. The value of Mr. Kovaceski's time is not included in the restaurant's accounting statement.

d. True. Labor costs are an accounting cost, but opportunity costs include accounting costs.

Question 2

a. We have for the TV strategy (notice that the units are in thousands of dollars):

$$pv = -\$100 + \frac{2.2 \cdot (\$300 - \$200)}{1 + 0.1}, \qquad pv = \$100 \tag{1}$$

Notice that we have at the end of the year revenues of $2.2 \cdot \$300$ and accounting costs of $2.2 \cdot \$200$. We use the market return to discount this cash flow back to the present. We also have the cost of the campaign which is incurred immediately.

For the grass roots strategy, we have:

$$pv = -\$100 + \frac{2.75 \cdot (\$300 - \$200)}{1 + 0.1}, \qquad pv = \$150 \tag{2}$$

If the money is invested, we have:

$$pv = \frac{1.0 \cdot (\$300 - \$200) + 0.1 \cdot \$100}{1 + 0.1}, \qquad pv = \$100 \tag{3}$$

b. To calculate the economic profit, we must figure out the next best option. From part (a), the next best option to TV is the grass roots strategy, since grass roots earns a higher profit than investing, and will earn a higher profit even including the value of the marketing department's time. So for TV we have:

$$\begin{aligned} \text{Econ Profit} &= \text{Accounting Profit} - (\text{ Value Next Best Option }) \\ &= 2.2 \cdot (\$300 - \$200) - (2.75 \cdot (\$300 - \$200) - \$22) \\ \text{Econ Profit} &= -\$33. \end{aligned} \tag{4}$$

Note that both strategies have the same initial cost, so the initial cost does not affect the decision. The The opportunity cost of the marketing department's time for the grass roots strategy reduces the value of the next best option. The economic profit is negative, so TV advertising is not the best option.

For the grass roots strategy, both the TV and investment options yield an accounting profit of \$100, so either can be used as the next best option. Using TV as the next best option results in:

$$\begin{aligned} \text{Econ Profit} &= \text{Accounting Profit} - (\text{ Value Next Best Option }) \\ &= 2.75 \cdot (\$300 - \$200) - (22 + 2.2 \cdot (\$300 - \$200)) \\ \text{Econ Profit} &= \$33. \end{aligned} \tag{5}$$

The value of the marketing department's time shows up as an opportunity cost of the grass roots option. Again, the up front cost is paid with either option, and so doesn't matter. The economic profit of grass roots is overall positive. Now these are the end of the year profits.

For investing, the next best option must be grassroots, since we have already decided that grassroots is better than TV. We have:

$$\begin{aligned} \text{Econ Profit} &= \text{Accounting Profit} - (\text{ Value Next Best Option }) \\ &= 1.0 \cdot (\$300 - \$200) + 0.1 \cdot \$100 - (2.75 \cdot (\$300 - \$200) - 22) \\ \text{Econ Profit} &= -\$143. \end{aligned} \tag{6}$$

Here these are just the end of the year revenues and opportunity costs. We will add in the up front cost of the next best option in part (c).

c. To get the present value, we discount the end of the year economic profits and add in the upfront costs:

$$\text{pv of Econ Profit (TV)} = -\$33/(1 + 0.1) = -\$30. \tag{7}$$

$$\text{pv of Econ Profit (Grass Roots)} = \$33/(1+0.1) = \$30. \quad (8)$$

$$\text{pv of Econ Profit (Invest)} = \$100 - \$143/(1+0.1) = -\$30. \quad (9)$$

In the present value of the economic profits of investing, we must included that the next best option has an up front cost of $100. This shows up as a positive for investing. Notice that the two best options have economic profits of equal magnitude, but opposite signs.

d. The grass roots strategy is best. It costs the same as TV, but generates more revenue. In fact it generates enough extra revenue to cover the cost of the campaign, the cost of time, and the time value of money, making it a better choice than investing.

Question 3

a. Economic profits approach zero in the long run. If economic profits at a firm are positive, that firm is earning higher profits than the market average. Such high margins will attract low price competitors such as Amazon. The increase in competition will lower prices, reducing the economic profits to zero, where the firm earns the market average return.

b. Examples are monopolies for which competitors such as Amazon cannot enter. Government monopolies include Amtrak and the US Post Office. Patents also create monopolies which prevents entry.

Question 4

a. The firm **provides products and services that consumers want** (as evidenced by their willingness to pay for the products, and thus add to firm profits).

b. The firm **minimizes the use of costly resources**. Other firms are then free to use these resources to produce other goods that society values.

c. The firm stays in business, thus **providing income to workers and stockholders.**

Question 5

a. For the number of pages read with 4 paralegals, we can use the formula:

$$MP = \frac{\Delta Q}{\Delta L}. \quad (10)$$

Therefore:

$$MP = 15 = \frac{Q(4) - 90}{4 - 3}. \tag{11}$$

$$15 = Q(4) - 90. \quad \rightarrow \quad Q(4) = 105. \tag{12}$$

Put differently, with 3 workers we could read 90. The fourth worker read 15 more ($MP = 15$). Therefore, the four workers read a total of 105.

The marginal product of the fifth worker can now be calculated using:

$$MP = \frac{\Delta Q}{\Delta L} = \frac{130 - 105}{5 - 4} = 25. \tag{13}$$

Four workers produced 105 and five workers produced 130 so the fifth worker produced 25.

For the marginal revenue product of the fifth worker, we can see that the fourth worker produced 15 and brought in revenue of 150. Hence:

$$MRP = MR \cdot MP, \tag{14}$$

$$150 = MR \cdot 15, \quad \rightarrow \quad MR = \$10. \tag{15}$$

The marginal revenue must be \$10. Therefore, the fifth worker brings in:

$$MRP = MR \cdot MP = \$10 \cdot 25 = \$250. \tag{16}$$

Here is the rest of the table:

Input (L)	100s of Pages read (Q)	Marginal product	Marginal Revenue Product
3	90	NA	NA
4	105	15	150
5	130	25	250
6	140	10	100
7	145	5	50

Table 1: Document reading production.

b. For profit maximization, we set marginal revenue product equal to marginal expenditure. Here the marginal expenditure is \$100 per hour, so we should have the paralegals work 6 hours.

Question 6

a. The marketing executive has no incentive to increase firm profits once sales exceed $40 million. Also, the marketing executive has an incentive to promote low margin items that sell well, which adds to sales but does not maximize profits.

b. The physician has an incentive to order tests that add to total billings, but are low margin. In addition, ordering expensive tests may reduce patient satisfaction, reducing repeat business and long run profits.

c. The incentive is to sign up a lot of accounts with very little money in them. Wells Fargo incurs the cost of maintaining these accounts but gets little revenues from investing the account dollars.

d. The incentive is to rush patients through the system, lowering the profits that could be obtained from longer visits and/or more tests.

e. Incentive is to bill too many hours, leading to a loss of repeat business and lower long run profits.

f. Too much time will be spent searching, even if the odds of finding anything are very low.

Question 7

a. We maximize profits which are total revenues less total costs:

$$\pi = \max_L TR - TC = \max_T P \cdot Q - TC, \tag{17}$$

$$\pi = \max_L \$60 \cdot \left(50L - \frac{3}{2}L^2\right) - \$120L, \tag{18}$$

$$= \max_L \$3000L - \$90L^2 - \$120L \tag{19}$$

$$= \max_L \$2880L - \$90L^2 \tag{20}$$

The maximum is where the slope or derivative equals zero:

$$\frac{d\pi}{dL} = \$2880 - \$90 \cdot 2L = 0, \quad \rightarrow \quad L = 16. \tag{21}$$

Further, 16 hours corresponds to 2 team members.

Note that we can also use our formula:

$$MRP = MR \cdot MP = ME. \tag{22}$$

The marginal revenue is the price of a web page, \$60, and the marginal expenditure is the cost of a worker/hour, \$120. The marginal product is the slope of the production function:

$$Q = 50L - \frac{3}{2}L^2, \tag{23}$$

$$\frac{dQ}{dL} = MP = 50 - 3L. \tag{24}$$

So we have:

$$\$60\,(50 - 3L) = \$120, \tag{25}$$

which when solved gives $L = 16$.

b. We maximize profits with 16 hours worked. To compute the maximum profit, we plug 16 into the profit equation (20).

$$\pi\,(16) = \$2880 \cdot 16 - \$90\left(16^2\right) = \$23{,}040 \tag{26}$$

c. Using the formula:

$$MRP = MR \cdot MP. \tag{27}$$

Now the formula for marginal product is the derivative of the production function (the extra production from one more worker).

$$Q = 50L - \frac{3}{2}L^2, \tag{28}$$

$$MP = \frac{dQ}{dL} = 50 - 3L \tag{29}$$

Next we have $MR = \$60$ since each page may be sold for \$60. Substituting this and

(29) into (27) gives:

$$MRP = MR \cdot MP = \$60\,(50 - 3L) \tag{30}$$

Notice that we do not set $MRP = 0$. We are not interested in finding a worker which brings in no revenue. Instead, we are interested in the revenue brought in by the 15th worker/hour. So we plug in 15 for L:

$$MRP\,(15) = \$60\,(50 - 3 \cdot 15) = \$300. \tag{31}$$

So the 15th worker hour brings in \$300, which is more than the marginal expenditure of \$120. Hiring the 15th worker generates $\$300 - \$120 = \$180$ of marginal profit. Thus we want to hire this worker.

d. We maximize production:

$$\max_L Q = 50L - \frac{3}{2}L^2 \tag{32}$$

$$\frac{dQ}{dL} = 50 - 3L = 0 \quad \rightarrow \quad L = \frac{50}{3} = 16.67. \tag{33}$$

So although workers 16-16.67 cost more than they bring in in terms of revenue, they still produce something. Only when we increase above 16.67 worker/hours do we see workers get so tired that production actually start to decline.

Question 8

Some answers refer to the Production function table:

	Fuel (F)					
Labor (L)	128	128.5	129	129.5	130	131.5
12.25	845.03	846.64	848.25	849.84	851.44	856.17
12.50	853.75	855.40	857.04	858.67	860.29	865.13
12.75	862.31	863.99	865.66	867.32	868.98	873.92
13.00	870.70	872.41	874.11	875.81	877.50	882.53
13.25	878.93	880.67	882.40	884.13	885.86	890.99
13.50	887.00	888.77	890.54	892.30	894.06	899.28
13.75	894.92	896.72	898.52	900.32	902.10	907.42
14.00	902.69	904.53	906.36	908.18	910.00	915.41
14.25	910.31	912.18	914.05	915.90	917.75	923.26
14.50	917.80	919.70	921.60	923.48	925.36	930.96
14.75	925.15	927.09	929.01	930.93	932.84	938.53

Table 2: Production (Q), which is millions of miles traveled.

a. For the marginal product of labor, we hold the fuel column fixed and compare production across rows. We are interested in the extra production from adding a worker, and so we don't want to also add fuel, which would prevent us from isolating the effect of an extra worker. For example, at 12.5M labor and 122M fuel, from the production function table 2,

$$MP_L = \frac{\Delta Q}{\Delta L} = \frac{853.75 - 845.03}{12.5 - 12.25} = 34.88. \tag{34}$$

Add an extra worker/hour adds about 35 miles traveled. One would think this number is higher (e.g. 55 miles per extra hour). However, recall that we are keeping fuel constant. To travel further while keeping fuel constant, all the drivers must slow down slightly (all drivers go the same speed). This causes a decrease in miles traveled, partially offsetting the increase in miles traveled from the extra worker.T he rest of the numbers are:

	Fuel (F)				
Labor (L)	128	128.5	129	129.5	130
12.25	NA	NA	NA	NA	NA
12.50	34.88	35.04	35.16	35.32	35.40
12.75	34.24	34.36	34.48	34.60	34.76
13.00	33.56	33.68	33.80	33.96	34.08
13.25	32.92	33.04	33.16	33.28	33.44
13.50	32.28	32.40	32.56	32.68	32.80
13.75	31.68	31.80	31.92	32.08	32.16
14.00	31.08	31.24	31.36	31.44	31.60
14.25	30.48	30.60	30.76	30.88	31.00
14.50	29.96	30.08	30.20	30.32	30.44
14.75	29.40	29.56	29.64	29.80	29.92

Table 3: Marginal product of labor.

Now for marginal product of fuel, we hold labor fixed and compare across columns. For 128.5M gallons of fuel and 12.25M labor, we have:

$$MP_F = \frac{\Delta Q}{\Delta F} = \frac{846.64 - 845.03}{128.5 - 128} = 3.22. \tag{35}$$

An extra gallon of fuel results in 3.22 extra miles traveled. Again, since the fuel efficiency is about 6 miles per gallon, one might think we should get 6 here. However, we are keeping labor fixed. Therefore, to get more miles traveled, all drivers must speed up slightly. This reduces the fuel economy of the entire fleet, offsetting the gain of a gallon of fuel somewhat. The rest of the numbers are:

	Fuel (F)				
Labor (L)	128	128.5	129	129.5	130
12.25	NA	3.22	3.22	3.18	3.20
12.50	NA	3.30	3.28	3.26	3.24
12.75	NA	3.36	3.34	3.32	3.32
13.00	NA	3.42	3.40	3.40	3.38
13.25	NA	3.48	3.46	3.46	3.46
13.50	NA	3.54	3.54	3.52	3.52
13.75	NA	3.60	3.60	3.60	3.56
14.00	NA	3.68	3.66	3.64	3.64
14.25	NA	3.74	3.74	3.70	3.70
14.50	NA	3.80	3.80	3.76	3.76
14.75	NA	3.88	3.84	3.84	3.82

Table 4: Marginal product of fuel.

Finally, to compute the MRTS, we divide the marginal products. For example, at 12.5M labor and 128.5 fuel:

$$MRTS = \frac{MP_L}{MP_F} = \frac{35.04}{3.22} = 10.62. \tag{36}$$

An extra hour of labor is 10.6 times more productive as an extra gallon of fuel. This makes sense, as one can travel 65 miles per hour, while fuel economy is about 6 miles per gallon. Of course, truckers cost far more per hour than a gallon of fuel, so we will have to account for both when computing how much of each to use in part (e). Here are the rest of the numbers.

	Fuel (F)				
Labor (L)	128	128.5	129	129.5	130
12.25	NA	NA	NA	NA	NA
12.50	NA	10.62	10.72	10.83	10.93
12.75	NA	10.23	10.32	10.42	10.47
13.00	NA	9.85	9.94	9.99	10.08
13.25	NA	9.49	9.58	9.62	9.66
13.50	NA	9.15	9.20	9.28	9.32
13.75	NA	8.83	8.87	8.91	9.03
14.00	NA	8.49	8.57	8.64	8.68
14.25	NA	8.18	8.22	8.35	8.38
14.50	NA	7.92	7.95	8.06	8.10
14.75	NA	7.62	7.72	7.76	7.83

Table 5: Marginal rate of technical substitution.

b. From table 2, at 13.5 million hours, we get to 900 million miles at about 131.5 million gallons.

c. From table 3, going down each column, we see that the marginal product of labor does indeed decrease as L increases. For example, when using 128 million gallons of fuel, the marginal product of labor falls from 34.88 miles per hour when labor is 12.5 million hours to 29.40 miles per hour when 14.75 million hours are worked. What is happening here: suppose we are traveling at 60 mph. One would think adding an extra hour generates 60 miles of production. However, it generates less. Fuel is constant, so the driver must slow down to be able to travel farther with the same amount of fuel, especially at higher values of L. The more the driver slows, the lower the marginal product becomes.

d. Yes. For example, from table 4, at 12.25 million hours, the marginal product decreases from 3.22 miles per gallon at 128 million gallons to 3.20 miles per gallon at 130 million gallons. Because of rounding, the marginal product appears constant at some points, but is in reality decreasing.

e. We can calculate the price ratio using:

$$\frac{P_L}{P_F} = \frac{\$34.38}{\$3.86} = 8.91. \tag{37}$$

Labor is more productive, but also much more expensive than fuel. Here labor is about 9 times as costly as fuel. From table 5, we see that at 13.75 million hours and 129.5 million gallons of fuel, the $MRTS$ is 8.91. So this combination is closest to optimal. Walmart moves from 131.5 million gallons to 129.5 million gallons of fuel, saving 2 million gallons of fuel.

f. We have from table 2:

$$\text{mph} \ = \frac{\text{miles}}{\text{hours}} = \frac{900.32}{13.75} = 65.49 \text{ mph} \ . \tag{38}$$

g. We have from table 2:

$$\text{mpg} \ = \frac{\text{miles}}{\text{gallons}} = \frac{900.38}{129.5} = 6.95 \text{ mpg} \ . \tag{39}$$