Question 1: You are thinking of entering the business of producing and selling extremely fancy cast-iron pots. A factory costs $9 million to create. In addition to the factory costs, overhead plus variable costs are given by $1,000,000 + \frac{q^2}{1,000}$.

(a) Suppose that cast-iron pots are indistinguishable from each other and that the market price for cast-iron pots is $100. Should you enter the industry? Why?

Answer: Produce up to the point that \( p = MC \):

\[
\frac{q}{500} = 100 \Rightarrow q = 50,000.
\]

Revenue is $5,000,000. Profits are therefore negative.

(b) Suppose that the demand for cast iron pots is given by \( Q_D = 1,000,000 - 1,000p \), where \( p \) is the price per pot. What are long-run equilibrium price, quantity and number of firms?

Answer: Minimum efficient scale is

\[
\frac{10,000,000}{q} + \frac{q}{1,000} = \frac{q}{500} ; \quad MC
\]

hence,

\[
\frac{q^2}{1,000} = 10,000,000 \Rightarrow Q = 100,000 .
\]

\( MC(100,000) = 200 \). Demand is \( D(MC(100,000)) = 800,000 \). There are 8 firms.

(c) Suppose now that the cast-iron pots that you produce are different and unique from other cast iron pots. Demand for your specific cast-iron pots is given by \( D(p) = 600,000 - 500p \). In this case, would you find it profitable to open the factory? Why?

Answer: Now if you produce,

\[
MR = 1,200 - \frac{q}{250} = MC = \frac{q}{500}
\]

\[
1200 = \frac{3q}{500} .
\]
Hence, \( q = 200,000 \). Hence, \( p = $800 \). Revenues are $160,000,000. Costs are $9 million plus
\[
1,000,000 + \frac{200,000^2}{1000} = 41,000,000
\]
dollars. Positive profits so enter.

**Question 2:** You are building a shopping center and are trying to figure out how many stores to build. Because of zoning restrictions, you can build only 300,000 square feet worth of store space (a square foot is .09 square meters). You are committed to building the shopping center and the difference in your costs from different divisions of the space is negligible.

More stores in your shopping center means more traffic, which raises each store’s demand. However, because more stores means less square footage for each store, the amount stores can sell decreases the more stores there are. Consequently, the number of units, \( u \), of merchandise sold by a store annually as a function of the number of stores, \( n \), is
\[
u = \begin{cases} 
1000n, & \text{if } 1 \leq n < 100 \\
1200n - n^2 - 10,000, & \text{if } n \geq 100 
\end{cases}
\]
Assume that each store earns a $10 margin (i.e., difference between price and marginal cost) on each unit of merchandise sold. Each store has overhead costs (exclusive of rent) of $20,000 year. Assume that you, as the real estate developer, are in a monopoly position with respect to setting rents.

(a) As a function of \( u \), what is the annual rent you should charge a store?

**Answer:** A store’s gross annual profit is \( 10u - 20,000 \). Because you are in a monopoly position, you can capture all that gross profit. So your rent is \( 10u - 20,000 \).

(b) Suppose you have 50 tenant stores. What rent would you charge each store? Suppose you have 100 tenant stores. What rent would you charge each store? What explains this difference?

**Answer:** \( 10 \times 50 \times 1000 - 20,000 = 480,000 \), so the annual rent is $480,000 if there are 50 stores. \( 10 \times 100 \times 1000 - 20,000 = 980,000 \), so the annual rent is $980,000 if there are 100 stores. The difference is explained by the network effect—the more stores “on the network” (in the shopping center), the more valuable having a store there is. You, as the landlord, capture this increase in value.

(c) Assume that tenants will just flock to your shopping center. How would you go about finding the optimal number of stores? [You do not need to solve the actual problem—although you can—but it should be clear what steps you would follow.]
**Answer:** We can think of your business as one of selling store space. Your profit from $n$ stores is $n(10u(n) - 20,000)$, what you get in rent. Writing this out,

$$
\pi = \begin{cases} 
  n \times (10,000n - 20,000), & \text{if } 1 \leq n < 100 \\
  n \times (12,000n - 10n^2 - 120,000), & \text{if } 100 \leq n
\end{cases}
$$

The top line tells us that we would never have fewer than 100 tenants. At 100 tenants, total rent is $98,000,000. We can think of the second line as revenue, $12,000n^2$, less cost, $10n^3 + 120,000n$. Equating marginal revenue to marginal cost:

$$
24,000n = 30n^2 + 120,000.
$$

The solution is $20(20 + \sqrt{390}) \approx 795$. At 395 tenants, total profit is $2,464,301,250$. Clearly, 795 tenants is profit maximizing.

(d) Suppose, instead, that tenants don’t flock to your shopping center and you need to build up the number of tenants. What are some of the strategies that you might employ? How do these strategies change, if they change, with the sophistication of your tenants?

**Answer:** You need to employ the strategies of building up a network. These include

- **Penetration pricing:** Low or subsidized rent for those who rent first. Depending on the expectations of the tenants, you might even have to pay the first few tenants to join. Later renters pay more. The trick is to raise rents on all tenants once the network reaches the appropriate size. Sophisticated tenants will attempt to get long-term leases at the low rent. This may require you to offer an upgrade in services to induce larger rents from them.

- **Generate forward expectations:** Market the advantages of a full shopping center. Hint that other tenants are about to sign up. If tenants are forward looking, then they will start flocking to you. Here, having sophisticated tenants would help.

- **Lobby the local government:** If the local government believes that more stores will help the local economy, it might be willing to subsidize early renters. Sophistication of tenants matters to the degree that they are forward looking.

- **Note:** Because the stores are identical, there are no obvious early adopters to go after.
Question 3: One of your professors was recently emailed by a company in Ohio for advice about its pricing. The person contacting him wrote, “Our company has traditionally priced its (sic) products from average total cost plus a ‘desired’ gross margin.” Upon further discussion, “desired” gross margin was revealed to be 10% of average total cost.

(a) If this firm prices in this way, is it making a profit? (Assume it is calculating average total cost correctly.) How do you know?

**Answer:** It is making a profit because \( AR \), which is price, is above \( AC \).

(b) Because of a shock to the market of one of its inputs, average cost recently increased 1%. The company’s subsequent price increase let to a 0.5% decline in its sales. What does this tell you about the firm’s pricing?

**Answer:** It is on the inelastic portion of its demand curve \( \epsilon_D \approx -0.5 \). It should therefore raise its price.

(c) In the original email, it was reported that the company currently sold 60,000 units annually and charged approximately $2000 per unit. Subsequent discussion suggested that the firm’s marginal cost was likely constant. The percentage of costs at 60,000 units that were variable (i.e., non-overhead) was taken to be 68.75% (it might interest you to know that \(.6875 = 11/16\)). Assuming a linear demand curve is a good approximation to this company’s demand, what is the best estimate of how much it should produce and the price it should charge?

**Answer:** We need to obtain an estimate of \( MC \) and \( MR \). Recall that

\[
2000 = p = 1.1AC(60,000) = 1.1 \frac{C}{60,000}
\]

Hence, total cost is

\[
C = \frac{10}{11} \times 120,000,000.
\]

Of this, 11/16th is variable:

\[
VC = \frac{11}{16} \times \frac{10}{11} \times 120,000,000 = 75,000,000.
\]

Because marginal cost is constant,

\[
MC = \frac{VC}{60,000} = \frac{75,000,000}{60,000} = 1250.
\]

To estimate \( MR \), we need demand. Because demand is linear, we know

\[
D(p) = A - Bp,
\]

where \( A \) and \( B \) are the numbers we need to determine. We know

\[
60,000 = A - 2000B.
\]
We also know that the elasticity is 

\[-0.5 = \epsilon_D = \frac{P}{D} \times \text{slope of demand} = \frac{2000}{60,000} \times (-B) .\]

Hence, \( B = 15 \). Plugging into (1), we have \( A = 90,000 \). From demand, we need inverse demand:

\[ q = 90,000 - 15P(q) \Rightarrow P(q) = 6000 - \frac{q}{15} .\]

Marginal revenue is, therefore,

\[ MR(q) = 6000 - \frac{q}{15} - \frac{1}{15}q = 6000 - \frac{2q}{15} .\]

Equating \( MR \) and \( MC \):

\[ 6000 - \frac{2q}{15} = 1250 \Rightarrow q^* = 35,625 .\]

The profit-maximizing price is, therefore, \( P(35,625) = 3625 \) dollars.

(d) This company sells its product through a network of independent dealerships. Each dealership has an exclusive area. The markups vary from dealership to dealership, but the company estimates that, on average, a dealership makes approximately $500 in profit per unit sold. What problem does this represent for the company?

**Answer:** Double marginalization.

(e) Due to state franchising laws and other restrictions, it is not possible for the company to acquire its dealerships or setup company-owned dealerships to compete. The company does, however, know that the marginal cost to a dealership of selling the company’s product is the price it pays the company for the product. The company knows the price each dealership is currently charging and the number of units it is selling. If the company knew (i) that each dealer was maximizing profits and (ii) that each dealership’s demand curve was linear, then set forth how the company should go about setting its optimal pricing strategy to the dealerships. **Note:** No calculations are required, you just have to say what calculations should be done.

**Answer:** Observe that if the company can get an accurate enough estimate of each dealership’s demand, it can engage in first-degree (perfect) price discrimination via a two-part tariff (the entry fee would be the “dealership fee” and the per-unit charge would be the wholesale price). As in the answer to part (c), if we know elasticity, price, and quantity, then we can calculate what the demand curve is for each dealership under the
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assumption that the demand is linear. Hence, we wish to employ the following steps (here \( p_d \) is the price charged by the dealership, $2000 is the dealership’s marginal cost, \( q_d \) is the quantity purchased by the dealership at a price of $2000, and \( \epsilon_d \) is the dealership’s elasticity):

- We know

\[
q_d = a_d - 2000b_d, \tag{2}
\]

where \( a_d \) and \( b_d \) are the intercept and slope, respectively, of the dealership’s demand.

- If the dealership is maximizing profits, then its price and marginal cost satisfy the Lerner markup rule

\[
\frac{p_d - 2000}{p_d} = -\frac{1}{\epsilon_d}.
\]

Because \( p_d \) is known, this equation can be solved for \( \epsilon_d \); that is, we know \( \epsilon_d \).

- We also know

\[
\frac{p_d}{q_d} \times (-b_d) = \epsilon_d.
\]

Solve this equation for \( b_d \). Plug that value of \( b_d \) into equation (2) to obtain \( a_d \).

- In a two-part tariff, the per-unit charge should be marginal cost, which is $1250 (see above). The entry fee is the area under the demand curve from that price to the point at which demand goes to zero (i.e., \( \bar{p} = a_d/b_d \)). Because demand is linear, this is the area of a triangle with a height of \( (\bar{p} - 1250) \) and a base of \( a_d - 1250b_d \). The entry fee is, thus, base \times height/2.

**Question 4:** You are considering going into the business of making a certain chemical compound. The compound is well known, so it can’t be patented. What may be protected by intellectual property laws are the processes for producing the chemical. Your company has discovered two processes, Process X and Process Y, for producing the compound. Both are far superior to the existing technology, so you would have a monopoly in the production of this compound provided no one can copy these processes. Under Process X, costs are given by

\[
C_X(q) = \begin{cases} 
0, & \text{if } q = 0 \\
3,000,000 + 3q^2, & \text{if } q > 0
\end{cases}; \text{ and}
\]

under Process Y, costs are given by

\[
C_Y(q) = \begin{cases} 
0, & \text{if } q = 0 \\
6,000,000 + 2q^2, & \text{if } q > 0
\end{cases},
\]

where \( q \) denotes metric tonnes produced annually. The number of metric tonnes of the compound demanded annually is given by

\[D(p) = 24,000 - p.\]

Assume that you can produce using only one of the two processes.
(a) Suppose you know that courts will uphold your exclusive rights to both processes (i.e., you know no other firm can use either of these processes). Which process would you adopt (the other will remain unused)? And why?

**Answer:** Calculate the profit-maximizing quantity under each process. Observe that inverse demand is \( P(q) = 24,000 - q \); hence,

\[
MR(q) = 24,000 - q + (-1)q = 24,000 - 2q.
\]

We have

\[
24,000 - 2q = MC_X(q) = 6q;
\]

implying,

\[
q^*_X = 3000.
\]

Similarly,

\[
24,000 - 2q = MC_Y(q) = 4q;
\]

implying,

\[
q^*_Y = 4000.
\]

Observe that \( AC_X(q) < AC_Y(q) \) at both candidate levels, then we prefer Process X. Conversely, if \( AC_X(q) > AC_Y(q) \) at both candidate levels, then we prefer Process Y.

\[ AC_X(q) = \frac{3,000,000}{q} + 3q, \]

which implies

\[
AC_X(3000) = 1000 + 9000 = 10,000 \quad \text{and} \quad AC_X(4000) = 750 + 12,000 = 12,750.
\]

Similarly,

\[ AC_Y(q) = \frac{6,000,000}{q} + 2q, \]
which implies

\[ AC_Y(3000) = 2000 + 6000 = 8000 \quad \text{and} \quad AC_Y(4000) = 1500 + 8000 = 9500. \]

We see that \( AC_Y(q) < AC_X(q) \) at both candidate levels; therefore, we should adopt Process Y.

(b) Suppose you knew that the courts would allow you to keep one process proprietary, but force you to give up the other one to encourage competition. You choose which process you wish to give up. The process that you give up can be used by any firm that wants to use it. Any existing chemical plant (of which there are thousands) can be adapted at negligible cost to produce the compound using either of the two processes. Which process do you keep for your firm and which do you give up? Why?

**Answer:** Because there will be free entry into this business, the equilibrium will be that of perfect competition. In the long run, that means that price will equal the minimum of the average cost of the marginal technology. Hence, if your firm is to make a profit, it will need to have the process with the lower minimum average cost. Recall that minimum of average cost occurs where average cost and marginal cost coincide:

\[ AC_X(q) = MC_X(q) \]

\[ \frac{3,000,000}{q} + 3q = 6q. \]

Hence,

\[ MES_X = 1000. \]

Likewise,

\[ AC_Y(q) = MC_Y(q) \]

\[ \frac{6,000,000}{q} + 2q = 4q. \]

Hence,

\[ MES_Y = 1000\sqrt{3} \approx 1732. \]

Observe

\[ AC_X(MES_X) = 6000 \quad \text{and} \quad AC_Y(MES_Y) = 4000\sqrt{3} \approx 6928. \]

Because Process X has the lower minimum average cost, your company wants to use it and let the other firms use Process Y.
(c) Suppose you are dealt a couple of regulatory and judicial setbacks. The Environmental Protection Agency (EPA) bans the use of Process Y because it releases more toxic waste into the air than is acceptable under the current law. In addition, it is determined that Process X is “prior art” and, therefore, ineligible for patent protection. Consequently, competitors are free to enter, employing Process X. Note all firms, yours included, can use only Process X. After the market reaches long-run equilibrium at the demand given above, there is a shock to demand such that demand becomes $28,000 - p$. What is the short-run equilibrium price following that shock?

**Answer:** The industry consists of identical firms because all firms will use Process X. That means in long-run equilibrium firms operate at $\text{MES}_X$, which we found was 1000 for Process X. The price will be $AC_X(\text{MES}_X)$, which we found was $6000/\text{unit}$. At that price, 18,000 metric tonnes are demanded. There are, therefore, 18 firms in the industry in long-run equilibrium. In the short run, the number of firms remains fixed. Each firm’s supply curve is 0 for price below minimum of average cost and, thereafter, tracks the marginal cost curve:

$$s(p) = \begin{cases} 0, & \text{if } p < 6000 \\ p/6, & \text{if } p \geq 6000 \end{cases}$$

Short-run aggregate supply is $18s(p)$:

$$S(p) = \begin{cases} 0, & \text{if } p < 6000 \\ 3p, & \text{if } p \geq 6000 \end{cases}$$

Equating $S(p)$ to $28,000 - p$, we have

$$3p = 28,000 - p \Rightarrow p = 7000.$$  

So the short-run equilibrium price will be $7000.$

**Question 5:** Danish Modern American Network, better known by its acronym **dman**, is another fashionable Scandinavian furniture manufacturer. **dman** makes two lines of beds, ekøpptås and gøldøpptås. **dman**’s accounting is given in Table 1.

(a) From your examination of Table 1, what problems do you see with the accounting numbers with regard to making good business decisions?

**Answer:** All of the following.

- It has treated the capital cost of the equipment as a variable cost, when it is truly a line-specific overhead cost.
- Factory and company overhead are shared overhead and should not be allocated to the product lines.
<table>
<thead>
<tr>
<th>Product</th>
<th>ekødöitplås</th>
<th>géldöitplås</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beds produced</td>
<td>40,000</td>
<td>20,000</td>
<td>60,000</td>
</tr>
<tr>
<td>Material cost/bed</td>
<td>$500</td>
<td>$675</td>
<td>N/A</td>
</tr>
<tr>
<td>Labor hours/bed</td>
<td>4</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>Hourly wage rate</td>
<td>$25</td>
<td>$25</td>
<td>N/A</td>
</tr>
<tr>
<td>Labor cost/bed</td>
<td>$100</td>
<td>$125</td>
<td>N/A</td>
</tr>
<tr>
<td>Capital cost/unit</td>
<td>$2</td>
<td>$2</td>
<td>N/A</td>
</tr>
<tr>
<td>Shipping cost/unit</td>
<td>$200</td>
<td>$200</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Total direct cost</strong></td>
<td><strong>$32,080,000</strong></td>
<td><strong>$20,040,000</strong></td>
<td><strong>$52,120,000</strong></td>
</tr>
<tr>
<td>Allocated factory &amp; company overhead</td>
<td>$8,000,000</td>
<td>$5,000,000</td>
<td>$13,000,000</td>
</tr>
<tr>
<td>Allocated marketing overhead</td>
<td>$2,000,000</td>
<td>$1,000,000</td>
<td>$3,000,000</td>
</tr>
<tr>
<td><strong>Total overhead</strong></td>
<td><strong>$10,000,000</strong></td>
<td><strong>$6,000,000</strong></td>
<td><strong>$16,000,000</strong></td>
</tr>
<tr>
<td><strong>Total cost</strong></td>
<td><strong>$42,080,000</strong></td>
<td><strong>$26,040,000</strong></td>
<td><strong>$68,120,000</strong></td>
</tr>
<tr>
<td>Price/bed</td>
<td>$875</td>
<td>$1600</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Total revenue</strong></td>
<td><strong>$35,000,000</strong></td>
<td><strong>$32,000,000</strong></td>
<td><strong>$67,000,000</strong></td>
</tr>
<tr>
<td><strong>Total Profit</strong></td>
<td><strong>($7,080,000)</strong></td>
<td><strong>$5,960,000</strong></td>
<td><strong>($1,120,000)</strong></td>
</tr>
</tbody>
</table>

\(^a\)Market value of equipment used in production times 25% (forgone interest plus rate of depreciation) divided by number of units. \(\text{dman}\) owns three bed-making machines. Each can produce 20,000 beds a year. There is no cost to switching a machine from making one line of bed to the other.

\(^b\)Allocated on the basis of total labor hours.

\(^c\)Allocated on the basis of beds. This consists of line-specific advertising (e.g., brochures illustrating various options, etc.); currently, each line has the same amount of such advertising. In addition, there is $1,000,000 of general \(\text{dman}\) advertising (i.e., not line specific).

**Table 1:** Accounting for \(\text{dman}\). Numbers in parentheses are losses.
$1,000,000 of advertising is shared overhead and should not be allocated to the product lines.

Each line is responsible for $1,000,000 in advertising, which should not be put in an overhead pool and reallocated according to units produced.

(b) The CEO of dman calls you and faxes you Table 1. She asks your advice about her plan to save the company by shutting the ekødöitplås line while keeping the géltdöitplås line open. Based on the information presented so far (in particular, assume the sales numbers are fixed), is this a good or bad strategy? Based on the information presented so far, what should dman do?

Answer: Ignoring shared or mis-allocated overhead, we should do the following: Subtract $1,000,000 in line-specific advertising and the $32,080,000 from ekødöitplås's total revenue, $35,000,000. This yields a positive contribution of $1,920,000 from the ekødöitplås line. Hence, there is no gain from shutting the ekødöitplås line—the CEO's proposed strategy is a bad one. Doing the same for the géltdöitplås line, we see it provides a positive contribution of $10,960,000. It should not be shut either. However, the contributions of both lines, $12,880,000 is less than dman's total shared overhead, $14,000,000, by $1,120,000. So based solely on the information available to this point, the best strategy is to shut dman entirely.

(c) Of course sales numbers are not fixed and you wonder if dman is pricing correctly. Hence, you ask the CEO for demand data. In response, she faxes you Table 2. Based on the information provided you in Tables 1 and 2, which lines do you recommend that dman keep? For each line kept, what price do you recommend that dman charge per bed?

Answer: From Table 1, the marginal cost of an ekødöitplås is $800 and the marginal cost of a géltdöitplås is $1000. Observe that both market segments' additional value for a géltdöitplås over an ekødöitplås is more than the increment in marginal cost, $200. Hence, if dman were to offer only one line, it would be the géltdöitplås line. There are two possible price points if dman sells only the géltdöitplås, namely $1200 and $1800. Table 3 shows the profits from those two possibilities. In addition, dman can engage in second-degree price discrimination via quality distortion. In that case the price of the ekødöitplås is set equal to the low type's willingness to pay (i.e., here, $900). If a high type were to buy an ekødöitplås at $900, he or she would enjoy a surplus of $100; that is the high type's information rent. So the price for the géltdöitplås is high type's value, $1800, less information rent, $100, which leaves $1700 as the géltdöitplås price. Table 3 shows the profits from 2nd-degree price discrimination. As shown, dman's profits are greatest if it engages in 2nd-degree price discrimination. Both lines should, therefore, be open and the prices should be $900 for ekødöitplås and $1700 for géltdöitplås.
**Table 2:** Demand data for dman beds ("K" denotes thousands).

<table>
<thead>
<tr>
<th>Population Segment</th>
<th>Annual number interested in a <strong>dman</strong> bed</th>
<th>Value for an <strong>ekødöitplås</strong> bed$^a$</th>
<th>Value for a <strong>gëltdöitplås</strong> bed$^b$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Households earning less than $100K</td>
<td>40,000</td>
<td>$900</td>
<td>$1200</td>
</tr>
<tr>
<td>Households earning $100K or more</td>
<td>20,000</td>
<td>$1000</td>
<td>$1800</td>
</tr>
</tbody>
</table>

$^a$All households within a segment have the same value for the **ekødöitplås**

$^b$All households within a segment have the same value for the **gëltdöitplås**

**Question 6:** You are managing the overseas operation of an American breakfast cereal manufacturer in a remote corner of the world. Specifically, you oversee sales to the neighboring countries of Florin and Guilder. Florintines are traditionally bigger breakfast eaters than Guilderians. The demand for cereal (measured in kilograms) of an individual Florintine is $d_f(p) = 11/10 - p/10$. The demand of individual Guilderian is $d_g(p) = 1 - p/10$. The marginal cost of cereal per kilogram is $1$. In solving this problem, you may find the following pieces of information useful.

- Individual inverse demand of a Florintine: $p_f(q) = 11 - 10q$.
- Individual inverse demand of a Guilderian: $p_g(q) = 10 - 10q$.
- Benefit an individual Florintine derives from $q$ kilograms is $b_f(q) = 11q - 5q^2$.
- Benefit an individual Guilderian derives from $q$ kilograms is $b_g(q) = 10q - 5q^2$.
- Observe that $b_f(q) - b_g(q) = q$.

At the moment relations between Florin and Guilder are very tense (something to do with a missing princess). As a consequence, it is impossible for anyone to cross the Florin-Guilder border.

(a) What size box do you sell in Florin? At what price?

**Answer:** Because you know individual demand and you can engage in third-degree price discrimination between Florintines and Guilderians, you
<table>
<thead>
<tr>
<th>Option</th>
<th>Sell  geköödıplass only at $1200 per bed</th>
<th>Sell  geköödıplass only at $1800 per bed</th>
<th>2nd-degree price discrimination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>eköödıplass</td>
<td>geköödıplass</td>
<td>Total</td>
</tr>
<tr>
<td>Beds sold</td>
<td>60,000</td>
<td>20,000</td>
<td>40,000</td>
</tr>
<tr>
<td>mat. cost/bed</td>
<td>$675</td>
<td>$675</td>
<td>$500</td>
</tr>
<tr>
<td>labor/bed</td>
<td>$125</td>
<td>$125</td>
<td>$100</td>
</tr>
<tr>
<td>shipping/bed</td>
<td>$200</td>
<td>$200</td>
<td>$200</td>
</tr>
<tr>
<td>Variable cost$^a$</td>
<td>$60,000,000</td>
<td>$20,000,000</td>
<td>$32,000,000</td>
</tr>
<tr>
<td>Machine cost$^b$</td>
<td>$120,000</td>
<td>$40,000</td>
<td>$80,000</td>
</tr>
<tr>
<td>Advertising$^c$</td>
<td>$2,000,000</td>
<td>$2,000,000</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>Factory &amp; Co. O/H</td>
<td>$13,000,000</td>
<td>$13,000,000</td>
<td>N/A</td>
</tr>
<tr>
<td>Total Cost$^d$</td>
<td>$75,120,000</td>
<td>$35,040,000</td>
<td>$33,080,000</td>
</tr>
<tr>
<td>Price</td>
<td>$1200</td>
<td>$1800</td>
<td>$900</td>
</tr>
<tr>
<td>Total Revenue$^e$</td>
<td>$72,000,000</td>
<td>$36,000,000</td>
<td>$36,000,000</td>
</tr>
<tr>
<td>Profit</td>
<td>($3,120,000)</td>
<td>$960,000</td>
<td>$2,920,000</td>
</tr>
</tbody>
</table>

$^a$Sum of the preceding three lines times number of beds sold.

$^b$Two dollars per bed times number of beds. This works because number of beds sold is always a multiple of 20,000.

$^c$Assuming that shutting one line saves only its direct advertising.

$^d$Sum of previous four lines.

$^e$Price times beds sold.

Table 3: Answer data for dman. Numbers in parentheses are negative amounts.
want to set the optimal two-part tariff for the Florintines. This means that boxes in Florin will have the number of kilograms that equates inverse demand with marginal cost; that is, 1 kilogram. The price is equal to a Florintine’s benefit from 1 kilogram, which is $6.

(b) What size box do you sell in Guilder? At what price?

**Answer:** Same reasoning as (a). Equating inverse demand with marginal cost, yields .9 kilograms (900 grams) per box. At .9 kilograms, a Guilde-rian’s benefit is 99/20 or $4.95.

As a consequence of diplomacy, there is a relaxation of tensions. Indeed, the border is opened up so that Florintines and Guilderians are free to cross the border at will. Both countries are very small, so there is negligible cost to travel to the border. Moreover, because land near the border was incredibly cheap, all grocery stores (supermarkets) are located right next to the border anyway. Finally, Florin and Guilder have populations of the same size.

(c) How big will your large (or only) box of cereal be?

**Answer:** The problem has now switched from 3rd-degree price discrimination to 2nd-degree discrimination via quantity discounts. We know there is no distortion at the top, so the large box continues to have 1 kg.

(d) Do you offer a small box and, if so, how many kilograms are in it?

**Answer:** We know that if the small box is offered, it will be intended for Guilderians and priced so as to extract all Guilderian surplus. This means the price of the small box will be $b_g(q_s)$. That means that a Florintine would enjoy a surplus (information rent) of

\[ I(q_s) = b_f(q_s) - b_g(q_s) = q_s \]

if he or she were to buy the small box. The price for a large box is thus $b_f(1) - I(q_s)$. Profit is

\[ \pi = N_f(b_f(1) - I(q_s)) + N_g b_g(q_s) - N_f - N_g q_s, \]

where $N_f$ are the number of Florintines and $N_g$ are the number of Guilderians. Recall, however, that $N_f = N_g$. Hence, in maximizing profit, we’re free to ignore population size. Recall that we can treat the revenue from $q_s$ as $b_g(q_s)$ and we can treat the cost of $q_s$ as $q_s + I(q_s) = 2q_s$. Setting marginal revenue equal to marginal cost, we have

\[ 10 - 10q_s = 2 \Rightarrow q_s^* = 8/10. \]

Because $q_s^* > 0$, we do want to offer the small box and it will have .8 kg. (800 grams) in it.
(e) What is the price of the large box? If sold, what is the price of the small box?

**Answer:** The price of the large box is $b_f(1) - I(q_s)$, which is $5.20. The price of the small box is $b_g(.8)$, which is $24/5$ or $4.80$. 
