National Taiwan University Mar, 2022
Economics Assignment 2
Group member name(s): 魏珈民、羅啟帆、李嘉芸、黃耀霆、林雋哲
Group member UID(s): b07303025, b07902047, b07303087, b08902136, b08901064

ECON5107: Industrial Organization Assignment #2

1 Bundling of Office Suites

Answer to Q1

Observe that it is not optimal to charge a price p between two different WTP , say $p_1 > p_2$ in the table because the revenue of charging p_1 must be greater that p. So we only have to consider the WTPs shown in the table. One can obtain that Microsoft Word should charge a price of 300 for MS Word and also 300 for MS Excel in order to maximize the revenue.

Answer to

For the optimal price for the bundle, we add the WTPs of MS Word and WTPs of MS Excel in the two tables for each separate group. Similarly, the optimal price must be one of the WTPs. One can obtain 500 is the optimal price in order to maximize the revenue.

Answer to Q3

Let P_1 be the random variable of WTP for MS Word.

Let P_2 be the random variable of WTP for MS Excel.

Both P_1 and P_2 is uniformly distributed on $[0, 400]$. We seek to maximize $p_1(1 - F_{P_1}(p_1))$ and $p_2(1 - F_{P_2}(p_2))$.

$$R_1 = p_1(1 - F_{P_1}(p_1)) = p - \frac{p^2}{400}$$

By the first order condition,

$$\frac{dR_1}{dp_1} = 1 - \frac{p_1}{200} = 0 \iff p_1 = 200$$
$$\max R_1 = 100 \ (\times \text{ 10 million})$$

So $p_1 = 200$ is the optimal price for MS Word. Similarly, one can obtain that $p_2 = 200$ is the optimal price for MS Excel and the maximum revenue is 1000 million.

Answer to Q4

Let $P = P_1 + P_2$ be the random variable of WTP for a bundle that contains MS Word and MS Excel. We interpret the "non-correlated" in the text as P_1 and P_2 being independent (or else there's not much we can do). P follows the Irwin-Hall Distribution ($n = 2$):

$$f_P(p) = \begin{cases} \frac{p}{400^2} & 0 \le p \le 400 \\ \frac{1}{200} - \frac{p}{400^2} & 400 \le p \le 800 \end{cases}$$
$$F_P(p) = \begin{cases} \frac{1}{2}\frac{p^2}{400^2} & 0 \le p \le 400 \\ 1 - \frac{1}{2}(800 - p)(\frac{1}{200} - \frac{p}{400^2}) & 400 \le p \le 800 \end{cases}$$

For $p \leq 400$,

$$R = p(1 - \frac{p^2}{400^2}\frac{1}{2}) = p - \frac{p^3}{400^2}\frac{1}{2}$$
$$\frac{dR}{dp} = 1 - \frac{p^2}{400^2}\frac{3}{2} = 0 \iff p = 400\sqrt{\frac{2}{3}} \approx 327$$
$$\max R = 217 \ (\times \text{ 10 million})$$

For $800 \geq p \geq 400$,

$$R = p\left(\frac{1}{2}(800 - p)(\frac{1}{200} - \frac{p}{400^2})\right)$$
$$\frac{dR}{dp} = \frac{(p - 800)(3p - 800)}{32000} < 0 \Rightarrow \text{ optimal } p = 400$$
$$\max R = 200 \ (\times \text{ 10 million})$$

Hence, Microsoft should charge a price of 327. The revenue of selling MS Word and Excel separately is $\max R_1 + \max R_2 = 2000$ (million). The revenue of selling MS Word and Excel as a bundle is $\max R = 2170$ (million). Microsoft earns greater profits if it sells the two products as a bundle.

Answer to Q5

Consider two different cases.

1. Customers with WTP greater than 200 has already bought MS Word.

   In this case, WordPerfect is left with a market of 5 million people with WTP uniformly distributed on $[0, 200]$. Following the steps identical to Q3, one can calculate that the optimal price is 100 and the maxmimum revenue is 250 million. It is not profitable to enter the market.

2. MS Word is not on the market currently. But for some reason WordPerfect knows the price that MS Word chooses.

   In this case, WordPerfect can charge a price slightly smaller than 200 and its revenue can be very close to 1000 million. It is profitable to enter the market.

Answer to Q6

Consider two different cases:

1. Customers with "WTP for the bundle" greater than 327 has already bought the bundle.

   Observe that the market size left for WordPerfect is

   $$F_P(327) = \frac{327^2}{2 * 400^2} \approx 33\%$$

   It is hard to know that customers with what "WTP for MS Word" have bought the bundle, and thus it is hard to calculate the maximum revenue for WordPerfect. But one can first consider the scenario that the market left is the highest 33 percent. In this scenario, the customers left are 3.3 million, with "WTP for MS Word" uniformly distributed on $[268, 400]$. The maximum revenue in this scenario, denote $\max R_U$, can be used as an upper bound for the real maximum revenue, denote R_{WP}.

   $$\max R_{WP} \leq \max R_U = 275.55(\text{ million })$$

$\max R_U$ can be calculated using the steps in Q3. We thus conclude that it is not profitable to enter the market.

2. The bundle is not on the market currently. But for some reason WordPerfect knows the price that Microsoft chooses for the bundle.

   Let p_{WP} be the price with which WordPerfect chooses to sell its product. A customer chooses to buy WordPerfect's product if and only if

   - He gains a higher payoff buying this product instead of buying the bundle provided by Microsoft, namely,

   $$P_1 - p_{WP} \geq P_1 + P_2 - 327 \iff P_2 \leq 327 - p_{WP}$$

   - His willingness to pay for the product is greater than p_{WP}

   $$P_1 \geq p_{WP}$$

   The percentage of people that will buy the product:

   $$\mathbb{P}\{P_1 \geq p_{WP} \text{ and } P_2 \leq 327 - p_{WP}\} = (1 - \frac{p_{WP}}{400})\frac{327 - p_{WP}}{400}$$

   The above equation holds since we assumed that P_1 and P_2 are independent. The revenue gained:

   $$\begin{aligned} R_{WP} &= p_{WP}(1 - \frac{p_{WP}}{400})\frac{327 - p_{WP}}{400} \\ \frac{dR_{WP}}{dp_{WP}} &= \frac{3p_{WP}^2 - 1454p_{WP} + 130800}{160000} \Rightarrow p_{WP} \approx 120 \\ \max R_{WP} &= 43.47 \ (\times \ 10 \text{ million}) \end{aligned}$$

   The maximum revenue is smaller than the fixed cost. It is not profitable to enter the market.

We see that in both cases, it is not profitable to enter the market.

Answer to Q7

If MS Word is already on the market (or they enter the market first), then their pricing strategy should not be influenced by the possibility of entry, assuming that Word and Excel are durable goods i.e. a customer will only purchase them once.

If MS Word is not on the market currently, but for some reason WordPerfect knows the price that MS Word chooses, MS should sell at a price so that total profit = 500M, which is the fixed costs for development.

If sell separately,

$$\begin{aligned} & 2P(1 - \frac{P}{400})10M = 500M \\ & P^2 - 400P + 10000 = 0 \\ & P = 26.795, Rev = 500M \qquad \text{(another solution 373.025 is not feasible)} \end{aligned}$$

If sell as a bundle, according to the analysis in Q6, MS can deter entry by setting price equals to 327 (which is the price that maximize the revenue).

2 Location Choice as a Means to Deter Entry

Answer to Q1

LC Burger should open two stores at $\frac{1}{4}$ and $\frac{3}{4}$. This setting allows them to obtain the entire market, and each store serves half of the market. Any more stores will not raise the market size but will increase the cost. The resulting profit is

$$\frac{1000 \times (4-1)}{0.1\%} - 600000 \times 2 = 1800000$$

Answer to Q2

CS Burger should open four stores, located at the immediate left and right of LC Burger's store $(\frac{1}{4} \pm \epsilon, \frac{3}{4} \pm \epsilon)$. This setting allows them to obtain the whole market with profit

$$\frac{1000 \times (4-1)}{0.1\%} - 600000 \times 4 = 600000$$

If CS Burger only open three stores $(\frac{1}{4} - \epsilon, \frac{1}{2}, \frac{1}{4} + \epsilon,$, they will only make profit

$$\frac{750 \times (4-1)}{0.1\%} - 600000 \times 3 = 450000$$

which is less than the previous one. One can calculate that only opening two stores or one stores obtain even less profit.

Answer to Q3

Observe that for a store to be profitable, it should have at least 200 customers, which corresponds to 0.2 miles:

$$\frac{1000x \times (4-1)}{0.1\%} \geq 600000 \Rightarrow x \geq 0.2$$

This implies that when the distance between two stores is less than 0.4 miles (or less than 0.2 miles between a store and an edge), the incomer will not open a new store. With this observation, LC Burger can set three stores at $\frac{1}{6}, \frac{1}{2}, \frac{5}{6}$ and make profit

$$\frac{1000 \times (4-1)}{0.1\%} - 600000 \times 3 = 1200000$$

CS Burger will not enter at all since no place is profitable.

Answer to Q4

Yes. Our analysis in Q2 will be different since this situation becomes a Bertrand competition (setting price only) and the resulting profit will be zero.

Answer to Q5

Considering the example above, it is clear that there exist a first-mover advantage: the first-mover earn all the market and makes positive profit, and the second-mover makes zero profit. However, if there exist resource constraint and each firm can not open unlimited number of stores, the result might be different. For example, if each firm can only open one store, than the second firm can earn at least the profit as large as the first firm.

Answer to Q6

Application 1: 7-11 and Family Mart

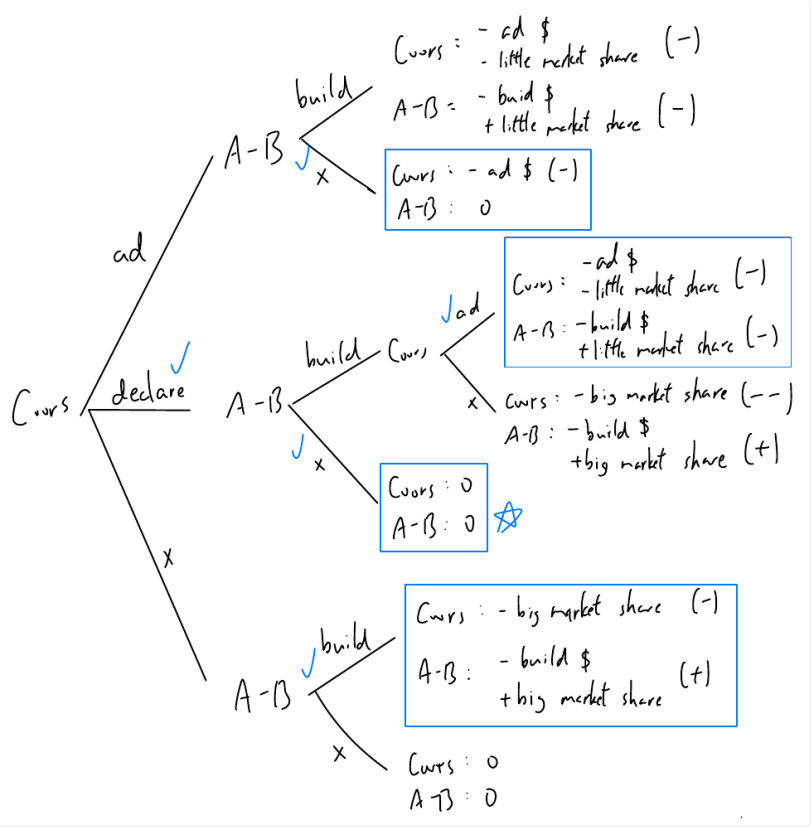
Application 2: vending machines

For the first application, once 7-11 first opens the store, Family Mart is unlikely to enter the same region. For the second application, once the first vending machine opens, other vending machines selling similar products(drinks or food) does not open at the same region.

3 Coors in the 1970s

Answer to problem

1. If Coors conducts a marketing campaign preemptively,
   (a) If A-B still builds the plant regardless, Coors would lose the money spent on ads and some market share, while A-B would lose the construction cost but gain some market share. A-B would get zero or negative ROI in this case.
   (b) If A-B decides not to enter, Coors would lose the money spent on ads while A-B ending up as the same as before.
2. If Coors declares that if A-B or Miller comes, they'll conduct a marketing campaign,
   (a) If A-B still builds the plant regardless,
      i. If Coors does conduct a marketing campaign in response, Coors would lose the money spent on ads and some market share, while A-B would lose the construction money but gaining some market share.
      ii. If Coors doesn't conduct a marketing campaign as it said, Coors would lose big market share, while A-B would lose the construction money but gain big market share. A-B would get positive ROI in this case.
   (b) If A-B decides not to enter, both Coors and A-B would end up as the same as before.
3. If Coors does nothing,
   (a) If A-B decides to build the plant, Coors would lose big market share while A-B would lose the construction money but gain big market share and end up in positive ROI.
   (b) If A-B does nothing as well, both Coors and A-B would end up as the same as before.



Using backward induction, the subgame perfect equilibrium is that Coors uses strategy 2: declares that if A-B or Miller comes, they'll conduct a marketing campaign. After that, A-B wouldn't commit in building the plant, and both Coors and A-B would end up as the same as before.