ADVERTISING AND MARKET STRUCTURE

Advertising Behavior in Monopoly Market

We are considering the model of monopoly where the quantity sold also depends on the level of advertising, that is, the demand function is given by \( Q(P, A) \) where \( A \) is the level of advertising expenditure, \( Q \) represents the quantity demanded, and \( P \) is the price. We assume that only the quantity demanded is affected by advertising, but price is independent from it. Consequently, the total cost is \( TC = C[Q(P, A)] + A \). The monopolist seeks to maximize his profit given by

\[
\pi = PQ(P, A) - C[Q(P, A)] - A
\]

The monopolist must equate the marginal revenue from increase in advertising, \( \frac{dTR}{dA} \), to the marginal cost of the additional advertising, \( \frac{dTC}{dA} \). We see that

\[
TR = PQ(P, A), \quad TC = C[Q(P, A)] + A
\]

\[
MR = \frac{dTR}{dA} = P \frac{\partial Q}{\partial A}, \quad MC = \frac{dTC}{dA} = \frac{dC}{dQ} \frac{\partial Q}{\partial A} + 1
\]

\[
P \frac{\partial Q}{\partial A} = \frac{dC}{dQ} \frac{\partial Q}{\partial A} + 1
\]

\[
(P - \frac{dC}{dQ}) \frac{\partial Q}{\partial A} = 1
\]

\[
(P - MC) \frac{\partial Q}{\partial A} \frac{A}{PQ} = \frac{A}{PQ}
\]

\[
\left( \frac{P - MC}{P} \right) \frac{\partial Q}{\partial A} \frac{A}{PQ} = \frac{A}{PQ}
\]

Recall from the review chapter on monopoly that from the maximized profit condition, \( MR = MC \), we have the following.
\[
\frac{dP(Q)Q}{dQ} = MC
\]

\[
P(Q) + Q \frac{dP(Q)}{dQ} = MC, \text{ factoring } P(Q) \text{ out yields}
\]

\[
P(Q) \left[1 + \frac{dP(Q)}{dQ} \frac{Q}{P(Q)}\right] = MC, \text{ recalling that } \frac{dQ}{dP(Q)} \frac{P(Q)}{Q} = \varepsilon_d,
\]

\[
P(Q) \left[1 + \frac{1}{\varepsilon_d}\right] = MC,
\]

assuming normal goods we have \( \varepsilon_d < 0 \), so we have that \( \varepsilon_d \) and \(-|\varepsilon_d|\) must have the same sign. Then,

\[
P(Q) \left[1 - \frac{1}{|\varepsilon_d|}\right] = MC
\]

\[
P(Q) - \frac{P(Q)}{|\varepsilon_d|} = MC
\]

\[
P(Q) - MC = \frac{P(Q)}{|\varepsilon_d|}
\]

\[
\frac{P(Q) - MC}{P(Q)} = \frac{1}{|\varepsilon_d|}
\]

Also note that \( \frac{\partial Q}{\partial A} \frac{A}{Q} \) is the elasticity of advertising. Then, the above expression is

\[
\frac{A}{PQ} = \frac{\varepsilon_A}{|\varepsilon_d|} = \left(\frac{P - MC}{P}\right) \varepsilon_A
\]

This equation states that the advertising to sales ratio, \( \frac{A}{PQ} \) is directly related to the price cost margin, \( \frac{P - MC}{P} \), inversely related to the (absolute value of) price elasticity of demand, and directly related to the advertising elasticity of demand, \( \varepsilon_A \). Industry in which advertising expenditures has
a large impact on sales have high advertising elasticity of demand. Suppose the monopolist faces competition from substitute products, what do we know? We know that the price elasticity is large, resulting in low price cost margin. Then, the advertising sales ratio must be small. As the price elasticity decreases as there is less substitute products, the price cost margin increases, resulting in higher advertising sales ratio.

This basic model for monopoly suggests a link between market power and advertising. As the Lerner Index of market power inxcreases, so does the advertising to sales ratio. However, we must further examine the oligopoly behavior, not only just monopoly behavior.

**Advertising and Oligopoly Behavior**

Consider the simple duopoly market with two basically identical manufacturers denoted by $i = 1, 2$. Outputs are represented by $q_i$, and its advertising expenditures are represented by $A_i$. We denote the new component, market share, by $m_i = \frac{q_i}{Q}$, where $Q = q_1 + q_2$. We initially assume Cournot behavior with regard to advertising expenditures. Both firms assume their rival will maintain its current level of advertising. We will derive the relation between price cost margin, price elasticity, and advertising sales ratio as follows.

Consider the profit function of firm $i$ when there is an advertising expenditure. We assume that advertising has no effect on price.

$$\pi_i = Pq_i (P, A_i) - C [q_i (P, A_i)] - A_i$$

The firm maximize profit with respect to advertising expenditure by taking derivative with respect to $A_i$ and set it equal to zero.

$$\frac{d\pi}{dA_i} = P \frac{\partial q_i}{\partial A_i} - \frac{dC}{dq_i} \frac{\partial q_i}{\partial A_i} - 1 = (P - MC) \frac{\partial q_i}{\partial A_i} - 1 = 0$$

With some algebraic manipulation, we insert $q_i = \frac{q_i}{Q} = m_i Q$ to the above equation

$$\frac{d\pi}{dA_i} = (P - MC) \frac{\partial m_i Q}{\partial A_i} - 1 = 0$$
But \( \frac{\partial m_i Q}{\partial A_i} = m_i \frac{\partial Q}{\partial A_i} + Q \frac{\partial m_i}{\partial A_i} \), we get

\[
(P - MC) \left[ m_i \frac{\partial Q}{\partial A_i} + Q \frac{\partial m_i}{\partial A_i} \right] = 1
\]

Multiplying both sides by the advertising sales ratio, \( \frac{A_i}{P q_i} \)

\[
\frac{(P - MC)}{P} \left[ \frac{m_i A_i}{q_i} \frac{\partial Q}{\partial A_i} + \frac{Q A_i}{q_i} \frac{\partial m_i}{\partial A_i} \right] = \frac{A_i}{P q_i}
\]

\[
\frac{(P - MC)}{P} \left[ \frac{q_i A_i}{Q q_i} \frac{\partial Q}{\partial A_i} + \frac{A_i}{Q} \frac{\partial m_i}{\partial A_i} \right] = \frac{A_i}{P q_i}
\]

\[
\frac{(P - MC)}{P} \left[ \frac{A_i}{Q} \frac{\partial Q}{\partial A_i} + \frac{A_i}{m_i} \frac{\partial m_i}{\partial A_i} \right] = \frac{A_i}{P q_i}
\]

The two terms in the bracket represent the two effect of an increase in advertising. The first term, \( \frac{A_i}{Q} \frac{\partial Q}{\partial A_i} \), represent the industry output effect. Firm \( i \) increased advertising increases the demand for the generic industry product, not just its own brand. The second term represents the market share effect. Increased advertising expenditures make market share higher, provided that we still maintain our assumption of output maintainance.

We consider some simple example. If initially \( Q = 1,000 \), and \( q_i = 500 \), then \( m_i = 0.5 \). Suppose firm \( i \) increases its advertising by 1 percent, industry output increases by 1 percent, to \( Q' = 1,010 \), and firm \( i \)'s market share increases by 2 percent to \( m'_i = 0.51 \). Then we know that \( \frac{A_i}{Q} \frac{\partial Q}{\partial A_i} = 1 \) (why?) and \( \frac{A_i}{m_i} \frac{\partial m_i}{\partial A_i} = 2 \). We denote the term in the bracket as the elasticity of advertising. This equals 1+2=3. The new output is then given by \( q'_i = m'_i Q' = 0.51 \times 1,010 = 515 \). Then the output is changed by \( \frac{15}{500} \times 100 = 3 \) percent.

We compare this formular with the one derived from monopoly behavior.
This suggests that oligopolists have an additional incentive to advertise. Not only does advertising increase the industry demand for the product, $Q$, but it also increases its own market share, $m_i$.

This also suggests that for a given price cost margin, the advertising sales ratio will be larger in oligopoly market, because the elasticity of advertising is larger. Intuitively, an increase in advertising does not change the monopolists’s 100 percent market share so there is no incentive to advertise.

The firms in competitive environments that face highly elastic demand curves with low price-cost margins will advertise very little. This helps explain why individual farmers rarely advertise their agricultural products.

In duopoly market there is a possibility of excessive advertising explained by the prisoner’s dilemma. Consider the next table.

<table>
<thead>
<tr>
<th></th>
<th>high advertising</th>
<th>low advertising</th>
</tr>
</thead>
<tbody>
<tr>
<td>high advertising</td>
<td>100, 100</td>
<td>130, 80</td>
</tr>
<tr>
<td>low advertising</td>
<td>80, 130</td>
<td>120, 120</td>
</tr>
</tbody>
</table>

We can summarize the advertising concepts as follows.

1. Firms with little market power have low price-cost margins and should have low advertising to sales ratio.
2. As a firm’s price-cost margin increases, so should its advertising to sales ratio.
3. Holding other things constant, oligopolists will have larger advertising to sales ratios than monopolists or competitive firms.
4. Oligopolists may tend to engage in excessive advertising.

**The Product Differentiation Advantages of First Movers**

Consider the market for a newly introduced goods such as internet service. People who are uninformed do not know what the internet can do and hesitate to buy the service. We can see that the first firm who introduced internet service in the market will have what is called **first-mover advantage**. Here, we shall see where the first-mover advantage comes from.
Consider the demand for the internet service. If all consumers were fully informed about it, the inverse market demand would be

\[ P = 100 - Q \]

However, before the introduction of internet, people who are uninformed about it risk buying the engine and end up disliking it. Uninformed consumers will be willing to pay less for internet service than informed consumers so the demand for internet service before introduction is less than \( P = 100 - Q \). Assume that the demand for internet service if all consumers are uninformed is

\[ P = (100 - Q) (1 - \tau) \]

where \( \tau \) represents the risk-cost factor of trying internet service for the first time.

Suppose \( \tau = 0.5 \), then the introductory demand for internet service is

\[ P = 50 - \frac{1}{2}Q \]

Suppose that the first firm, say TRUE, introduce the low promotion price of \( P = 25 \). Then, we have that the quantity sold will be \( Q = 50 \). At this price, the service would be sold to the most eager 50 consumers, i.e., those on the left most side of the introductory demand curve. After the promotional period ends, TRUE can continue to serve only this informed 50 consumers by charging at \( P = 50 \).

Suppose that in the next period, the entering firm, TOT, would like to introduce the identical service to consumers. TOT faces a different demand from TRUE because consumers cannot be certain whether TOT’s service is actually identical to TRUE’s service. To derive TOT demand we need to separate consumers into informed and uninformed groups.

Informed consumers receive consumer surplus from using TRUE service. Since they are not sure whether TOT service are identical, the maximum price they will pay to TOT is
\[ P = (100 - Q)(1 - \tau) - CS \]

where CS represents the consumer surplus consumers get from TRUE service. For example, the 0th consumer has the reservation price at \( P = 100 - 0 = 100 \), but the price is actually just 50 so he receives \( CS = 50 \). If TOT wants him to try its service, it has to charge at the price of

\[ P = (100 - Q)(1 - \tau) - CS = (100 - 0)(1 - 0.5) - 50 = 50 - 50 = 0. \]

The 1st consumer has the reservation price at \( P = 100 - 1 = 99 \), but the actual price is just 50 so he has consumer surplus equal 99-50=49. If TOT wants him to try its service, it has to charge at the price of

\[ P = (100 - Q)(1 - \tau) - CS = (100 - 1)(1 - 0.5) - 49 = 49.5 - 49 = 0.5 \]

The 2nd consumer has the reservation price at \( P = 100 - 2 = 98 \), but the actual price is just 50 so he has consumer surplus equal 98-50=48. If TOT wants him to try its service, it has to charge at the price of

\[ P = (100 - Q)(1 - \tau) - CS = (100 - 2)(1 - 0.5) - 48 = 49 - 48 = 1 \]

... 

The 10th consumer has the reservation price at \( P = 100 - 10 = 90 \), but the actual price is just 50 so he has consumer surplus equal 90-50=40. If TOT wants him to try its service, it has to charge at the price of

\[ P = (100 - Q)(1 - \tau) - CS = (100 - 10)(1 - 0.5) - 40 = 45 - 40 = 5 \]

... 

The 25th consumer has the reservation price at \( P = 100 - 25 = 75 \), but the actual price is just 50 so he has consumer surplus equal 75-50=25. If TOT wants him to try its service, it has to charge at the price of

\[ P = (100 - Q)(1 - \tau) - CS = (100 - 25)(1 - 0.5) - 25 = 37.5 - 25 = 12.5 \]

... 

The 50th consumer has the reservation price at \( P = 100 - 50 = 50 \), but the actual price is just 50 so he has consumer surplus equal 90-50=0. If TOT wants him to try its service, it has to charge at the price of
\[ P = (100 - Q) (1 - \tau) - CS = (100 - 50) (1 - 0.5) - 0 = 25 \]

Here, you should be able to see a large first-mover advantage because the 25th consumer would rather continue using TRUE service at the price of 50 rather than trying TOT service at any price greater than 12.5. The 10th consumer would rather pay 50 if TOT charges price more than 5. The 50th consumer, receiving zero consumer surplus from TRUE, is indifferent between paying 50 to TRUE or trying TOT at \( P = 25 \). Hence, we can see that the demand for TOT starts at any price less than or equal to 25. Clearly, if TOT is capable of charging \( P = 0 \), it would be able to capture all consumers in the market. At \( P = 0 \), TOT will have 100 consumers. We can then construct the demand for TOT as

\[ P = 25 - \frac{1}{4} Q_{TOT} \quad (\text{why?}) \]

Comparing TOT demand with that of TRUE

\[ P = 100 - Q_{TRUE} \]

We see that the lower demand curve places TOT at a tremendous disadvantage against TRUE. While TRUE can charge 50, TOT will have to charge any price below 25.

The situation is even worse if there are significant sunk cost entering the internet industry. Suppose that there must be a sunk cost of 400 in each entrance. Suppose that the marginal cost providing internet service is constant at 10. We can see that the profit for TRUE would be

\[ 50 \times 50 - 10 \times 50 = 2,000 \]

since TRUE had already paid for its sunk cost. The profit maximizing price for TOT would be

\[ MR_{TOT} = 25 - \frac{1}{2} Q_{TOT} = 10 = MC \]

\[ Q_{TOT} = 30, \quad P_{TOT} = 25 - \frac{1}{4} 30 = 17.5 \]

\[ \pi_{TOT} = 17.5 \times 30 - 10 \times 30 - 400 = -175. \]
If this is the case, TOT would find it impossible to enter the market. In addition, TRUE is also able to respond aggressively and lowering price below 50 while still earning a substantial economic profit. This serves as an additional deterrent to entry.