Notes 4: Monopoly and Monopsony

I. Monopolies and Their Behavior

A firm is a monopoly if it is the only supplier of a product for which there is no close substitute. A monopoly sets the price of its product without concern that the price might be undercut by rivals. A monopoly faces a downward sloping demand curve.

A. The Monopolists’ Maximization Problem

1. Revenue

The revenue of a firm (R) is given by $py$, where $p$ is the price of the product and $y$ is the level of output. In market equilibrium, the price depends on the amount consumed and produced.

For a competitive firm, we assume that this price is beyond the firm’s control, because the firm has only a small impact on the total amount produced. A monopoly, however, is by definition the only producer. It’s output $y$ is the same as the industry output $Q$. Thus:

$$y = Q(p) = D(p)$$

Therefore, for a monopoly, the price received is a function of the quantity produced. This is called an inverse demand function since $p$ is a function of $y$ ($Q$), instead of $y(Q)$ being a function of $p$.

$$p = D^{-1}(y) = g(y)$$

The monopolists’ revenue is therefore:

$$R = py = g(y)y$$  \hspace{1cm} (1)$$

If the inverse demand function is linear and given by $p = g(y) = A - By$, then revenue is given by

$$R = py = g(y)y$$
$$= (A - By)y$$
$$= Ay - By^2$$

For example if the inverse demand function is

$$p = 200 - 2y$$

then revenue is given by

$$R = py = g(y)y$$
$$= (200 - 2y)y$$
$$= 200y - 2y^2$$
2. **Cost**

As usual, we define the cost minimization problem for the firm as follows:

\[
C(y,w) = \min_x \sum_{j=1}^{n} w_j x_j \quad \text{such that } x \in V(y)
\]  

(3)

where \(V(y)\) is the input requirement set for the firm. This gives the minimum cost way to produce the level of output \(y\) given the technology \(V(y)\) and input prices \(w\). This is the same as for a competitive firm.

3. **Profit maximization**

Once the firm has determined the least costly way to produce each output level it chooses the level of output which maximizes profits. Specifically, it has the following maximization problem

\[
\max_y p(y) - C(y,w)
\]

\[
\Rightarrow \max_y g(y)y - C(y,w)
\]  

(4)

Notice that the problem differs from that of the competitive firm since \(p\) is a function of \(y\).

For the inverse demand curve \(p = 200 - 2y\), we obtain

\[
\max_y p(y) - C(y,w)
\]

\[
\Rightarrow \max_y (200 - 2y)y - C(y,w)
\]

\[
\Rightarrow \max_y 200y - 2y^2 - C(y,w)
\]  

(5)

4. **Marginal revenue**

The change in revenue that results from the production of one more unit is called marginal revenue. For a competitive firm this is equal to output price but for a monopoly this is different since the sale of one more unit will have an impact on the price.

5. **Marginal cost**

The change in cost that results from the production of one more unit is called marginal cost. This is basically the same for a monopoly and for a competitive firm with the same technology and competitive factor markets.
B. Graphical Analysis of Marginal Revenue

The monopolist will consider how much to produce at the margin by determining whether the production of one more unit will increase revenue $R$ by more than it will increase cost. Consider the demand curve below where the firm is initially charging the price $p_0$ and is considering lowering the price to $p_1$. The firm will sell more units but will receive a lower price for all units.

Marginal revenue is given by the area $B-A$ since the firm now sells $y_1$ units at a price of $p_1$. The loss in revenue is given by $(p_1 - p_0)y_0$ while the gain is given by $(y_1 - y_0)p_1$. This then gives

$$MR = (y_1 - y_0)p_1 + (p_1 - p_0)y_0$$
$$= p_1y_1 - p_1y_0 + p_1y_0 - p_0y_0$$
$$= p_1y_1 - p_0y_0$$  \hspace{1cm} (6)$$

What is important to recognize is that $p$ is not independent of $y$, but will vary as $y$ varies. Consider the same diagram as above where the change in $y$ is the same but occurs at a much lower level of $y$. It is clear that marginal revenue ($B-A$) is much larger in this case than in the original one.
Now consider the same change in $y$ at high overall levels of $y$.

In this case the marginal revenue is much smaller and is probably negative as $B$ seems smaller than $A$. The firm then compares marginal revenue to the marginal cost of producing the unit and decides whether to proceed.
C. Analytical Analysis of Profit Maximization

The monopolist’s profit maximization problem is as follows

\[ \pi = \max_y \left( py - C(y, w) \right) \]

\[ \Rightarrow \pi = \max_y \left[ g(y) y - C(y, w) \right] \tag{7} \]

The problem differs from that of the competitive firm since \( p \) is a function of \( y \). If we differentiate this expression for profit with respect to \( y \), we use the product rule. Doing so, we obtain

\[ \frac{d\pi}{dy} = g(y) + \frac{dg}{dy} y - \frac{dC}{dy} y = 0 \]

\[ \Rightarrow p + \frac{dp}{dy} y - \frac{dC}{dy} y = 0 \tag{8} \]

\[ \Rightarrow p + \frac{dp}{dy} y = MC \]

\[ \Rightarrow MR = MC \]

where \( MC \) is the cost of producing the last unit of output or marginal cost and \( MR \) is given by the change in revenue with respect to output or

\[ MR = p + \frac{dp}{dy} y \]

\[ = p(1 + \frac{1}{\varepsilon}) \frac{dy}{dy} \frac{p}{dy} \]

\[ = p(1 + \frac{1}{\varepsilon}) \]

\[ \varepsilon = \frac{dy}{dp} \frac{p}{y} \quad \text{is the price elasticity of demand} \tag{9} \]

As the price elasticity of demand rises, marginal revenue falls at any given price. Notice also that marginal revenue is negative if the elasticity of demand is between zero and negative one. Marginal revenue is positive only if the demand curve is elastic. Therefore, a monopolist will always produce at a quantity at which demand is elastic, since marginal cost is never negative. For a linear inverse demand function marginal revenue is given by
\[ p = A - By \]
\[ R = (A - By)y \]
\[ = Ay - By^2 \]
\[ MR = A - 2By \]
\[ = (A - By) + (-B)y \]
\[ = p + \frac{dp}{dy}y \]

D. Tabular Analysis of Monopoly
Consider a monopolist with cost function given by

\[ C = 100 + 6y - .4y^2 + .02y^3 \quad (10) \]

Marginal cost is given by

\[ MC = 6 - .8y + .06y^2 \quad (11) \]

Assume the demand curve facing the firm is given by

\[ y = 68 - 2p \]
\[ \Rightarrow p = \frac{y - 68}{-2} \]
\[ = \frac{68 - y}{2} \]
\[ = 34 - \frac{1}{2}y \quad (12) \]

We can compute total revenue as

\[ TR = py \]
\[ = (34 - \frac{1}{2}y) y \]
\[ = 34y - \frac{y^2}{2} \quad (13) \]
Marginal revenue is given by

\[ MR = \frac{dTR}{dy} \]

\[ = \frac{d\left(34y - \frac{y^2}{2}\right)}{dy} \]

\[ = 34 - y \]  \hspace{1cm} (14)

We can also compute marginal revenue using the formula in 6 or 7 as \( p + \frac{dp}{dy} y \) which gives

\[ MR = p + \frac{dp}{dy} y \]

\[ = 34 - \frac{1}{2} y + \frac{-1}{2} y \]

\[ = 34 - y \]  \hspace{1cm} (15)
In table form we can then summarize the information as follows

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Perusing the table it is clear that the optimum level of production is 20 with a price of 14.
E. Numerical Analysis of Profit Maximization

The monopolist’s profit maximization problem is as follows

\[ \pi = \max_y [py - C(y,w)] \]
\[ \Rightarrow \pi = \max_y [g(y)y - C(y,w)] \]  \hspace{1cm} (16)

Using the same functions as used in the table above (and equations 8-10) we can derive a numerical solution. This will give

\[ \pi = \max_y py - C(y,w) \]
\[ \Rightarrow \pi = \max_y [(34 - \frac{1}{2}y)y - (100 + 6y - .4y^2 + .02y^3)] \]  \hspace{1cm} (17)
\[ = \max_y [34y - \frac{1}{2}y^2 - 100 - 6y + .4y^2 - .02y^3] \]

Taking the derivative with respect to \(y\) will yield

\[ \frac{d\pi}{dy} = 34 - y - 6 + .8y - .06y^2 = 0 \]
\[ \Rightarrow .06y^2 + .2y - 28 = 0 \]  \hspace{1cm} (18)
Using the quadratic formula gives

\[ .06y^2 + .2y - 28 = 0 \]

\[ \Rightarrow y = \frac{-0.2 \pm \sqrt{0.2^2 - 4(0.06)(-28)}}{2(0.06)} \]

\[ = \frac{-0.2 \pm \sqrt{0.04 - (-6.72)}}{(0.12)} \]

\[ = \frac{-0.2 \pm \sqrt{6.76}}{(0.12)} \]

\[ = \frac{-0.2 \pm 2.6}{(0.12)} \]

\[ = \frac{2.4}{(0.12)}, \text{ or } \frac{-2.8}{(0.12)} \]

\[ \Rightarrow y = 20 \text{ or } y = -23.333 \]  \hspace{1cm} (19)

This can also be factored as follows

\[ .06y^2 + .2y - 28 = 0 \]

\[ \Rightarrow 6y^2 + 20y - 2800 = 0 \]

\[ \Rightarrow (6y - 120)(y + 23.33) = 0 \]

\[ \Rightarrow 6y = 120 \]

\[ \Rightarrow y = 20 \]  \hspace{1cm} (20)

F. Graphical Solution

We can obtain the solution graphically by plotting marginal cost, demand and marginal revenue and finding the intersection of marginal cost and marginal revenue.
The optimum occurs at the output level 20 with marginal revenue and marginal cost of 14. The demand curve implies that the firm will be able to charge $24 for the product.

II. Comparison of Monopoly with Competition

A. Quantity Produced

In a competitive market firms produce where price is equal to marginal cost. For a competitive industry the supply curve is the sum of the marginal cost curves and so the equilibrium quantity will be where demand and marginal cost intersect. As is clear in the diagram below, since the marginal revenue curve lies below the demand curve, the quantity produced by a monopolist will be less than in a competitive industry.

The monopolist will produce output $y_m$ and charge price $p_m$. In competition the price will be $p_c$ with output $y_c$. 
B. Price-cost Margin

We can represent the amount by which the monopoly price exceeds the competitive price by using the optimality condition for the monopolist. The optimality condition is given by \( MR = MC \). This can be rewritten using the definition of marginal revenue in terms of the elasticity of demand as follows:

\[
MC = MR = p + \frac{dp}{dy} y \\
= p(1 + \frac{dp}{dy} p) \\
= p(1 + \frac{1}{\varepsilon}) \\
\Rightarrow MC = p(1 + \frac{1}{\varepsilon}) \\
\Rightarrow MC = p + \frac{p}{\varepsilon} \\
\Rightarrow p - MC = -\frac{p}{\varepsilon} \\
\Rightarrow \frac{p - MC}{p} = -\frac{1}{\varepsilon}
\]

(21)

The larger \( \varepsilon \) is, the closer price will be to marginal cost. (In perfect competition, we assume that, for each firm, \( \varepsilon = \infty \). The demand curve is infinitely elastic at a particular price determined by the market.) Since the monopolist will always operate in the elastic portion of the demand curve, the price-cost margin will be between 0 and 1. We say that a firm has monopoly power if this index is positive.

C. Welfare Loss From a Monopoly

We can compute the loss to society of a monopoly (relative to the competitive outcome) using standard partial equilibrium welfare analysis. Consider the diagram below where the consumer and producer surplus under monopoly and competition are compared.
If we change from a monopoly to competition, consumers gain the area A+B. The firm loses the area A due to lower prices but gains the area C due to increased production. The area C-A is negative, so the firm is worse off under competition. However, society as a whole gains A+B+C-A = B+C. Thus B+C is the deadweight loss from monopoly. This area is often called the “deadweight loss triangle.”

D. Rent-seeking Behavior and Monopoly
The loss from monopoly may be larger than just the deadweight loss since the monopolist may spend portions of the profit seeking to maintain the monopoly through legislation, bribery, lobbying, unfair practices, etc. Such behavior is called rent-seeking.

III. Creating and Maintaining a Monopoly

A. Ways to Originate and Perpetuate a Monopoly
1. Economies of scale (natural monopoly)
   If marginal cost is decreasing as production rises, one firm will emerge as the only survivor. Others will not be able to compete because they are smaller and do not enjoy the same scale economies.

2. Special knowledge prevents imitation
   A firm may possess special knowledge that allows it to produce a product that cannot be imitated by other firms.

3. Special knowledge allows lower costs
A firm may have access to a production techniques that allow it to produce at lower costs than other firms. No other firm can compete with it.

4. Legal protection
   A firm may use patent or copyright law to protect a monopoly position.

5. Government restrictions
   In some markets the government has legislated a monopoly. Examples include taxi-cabs, electricity and other utilities, some telephone services in some areas, etc.

6. Strategic actions
   Firms may prevent entry other firms through controlling essential inputs.

B. Possible Benefits of Monopoly
   1. Motivation for research and innovation
      The motivation of receiving monopoly profits may encourage more innovation and research than would otherwise occur.

   2. Negative externalities
      In situations where production exceeds the social optimum due to negative externalities such as pollution, a monopolist who restricts output may increase social welfare.

C. Natural Monopoly
   In some industries it is efficient for only one firm to produce all of the output. When total production costs would rise if two or more firms produced instead of one, the single firm in the industry is called a natural monopoly. If a firm has increasing returns to scale at all output levels, it will have a decreasing average cost curve and will be a natural monopoly.

   Even if average cost is not declining everywhere, the firm may still be a natural monopoly if costs are downward sloping in the region of production which is relevant. (If demand is always between 50 and 100 and marginal cost is decreasing in this region, then there will be a natural monopoly.) There will also be a natural monopoly if, for all relevant levels of demand, the firm’s average cost is less than that of any potential competitor.

   Consider the diagram below. Suppose that the production technology is characterized by the marginal and average cost curves $MC_1$ and $AC_1$. 

The firm will produce amount $y_m$ and charge a price of $p_m$ with profits equal to the area $A$. If another firm with the same cost curve enters the industry, for levels of output less than $y_m$, their average cost of production will be higher than $p_c$ and perhaps even higher than $p_m$. If this cost is higher than $p_m$, the firms will not be able to make a profit, so no other firm will enter. If this cost is lower than $p_m$ but higher than $p_c$, then the incumbent firm can lower its price and cause the entrant to lose money. Thus, the entrant will be forced to leave. There is room for only one firm.
Alternatively, consider a firm with a U-shaped average cost curve in an industry where demand is small compared to optimal scale.

The monopolist will choose a price such that \( MC = MR \) and will produce output \( y_m \). The firm will earn profits equal to area A. If the firm were forced to choose a price equal to marginal cost at \( y_{MC} \), as in the competitive solution, the firm would have losses equal to area B. Thus there is no way to attain the competitive solution. An alternative might be to force the firm to choose a price equal to average cost. This is the point where the demand curve intersects the average cost curve. This will result in an output level less than other competition, but more than other monopolies.
IV. Monopsony

A. Definition

A single buyer in a market is called a monopsony. We usually assume that the price faced by a consumer is unrelated to that consumer’s consumption, because there are many other consumers and the price is determined by the total market demand. However, if there is only one consumer, then the price will depend on the amount purchased. Thus, for a monopsonist, we have

$$ w = f(x) $$

where $w$ is the price of the input or good, and $x$ is the amount purchased.

B. Graphical Example

Suppose that there is only one buyer for a factor of production. The market supply and firm-level demand curves for the factor are given below.

![Monopsony Pricing Diagram]

The firm must pay increasingly more for each incremental unit of the factor. This fact is represented by the upward sloping marginal outlay (MO) schedule. This lies above the supply curve just as marginal revenue lies below the demand curve. The firm maximizes its payoff by choosing the point where demand intersects marginal outlay. The firm will purchase fewer units of the factor than a competitive firm. The price paid $w_m$ which is less than the competitive price, $w_c$.

C. Examples

1. Local labor markets and company towns
2. Meat packing in local markets
3. Local markets in general but where the monopsonist must pay attention to other buyers in more distant markets.