Chapter 6

Market Structure and Pricing

6.1. Nature of Markets

Theories of industrial organization generally acknowledge markets for products that are directly sold to the consumers. For, the ultimate value of production depends on their satisfaction. What the firm can recover out of the value to the consumer determines cost recovery and profits to the firm. In the context of biotechnology the two major markets for their products are pharmaceutical and agricultural products (mainly crops but they may also include animal products). As yet, there are a few such final products in the biotechnology industry. It may, as a result, be important to consider markets for some intermediate products as well.

Gamberdella et al (2000) consider four sets of variables as relevant sources of competitiveness.

- Size and structure of biomedical education and research
- Basic institutions governing labor markets, skilled researchers, and managers
- Intellectual property rights and patent laws
- Nature and intensity of competition in the final product market

It may turn out that within the pharmaceutical group the market for diagnostic kits will be different from that of prescription drugs. This happens due to two reasons. First, the technical complexity and the costs of production are far less in the context of diagnostics. Consequently, entry and exit are easier and a large number of firms may be expected in this market. Second, patients do not directly buy the diagnostic kits. Instead, it is the physicians who determine what need to be bought and used. Though they are expected to take the income of the patient into account in their choices it need not always be the case. The markets will surely change as the health insurance coverage increases. Even in a specific therapeutic class market demand depends on the combination of drugs that a physician prescribes and whether or not he chooses the combination produced by the same firm. In the context of biotechnology drugs it was noted that a firm may not have any particular advantage in producing a second drug merely because it was successful in the first. That is, quite independent of the physician's propensities, the market structure depends on the production and marketing competencies of the firm and its costs. The market for each drug may have its own dynamics if the economies of scope are not significant.

Two other aspects have been highlighted. First, within each therapeutic class there may be competing products based on biotechnology. The economies of scope and the nature of patent rights may determine the number of products of each firm and the number of firms in the market. Second, many drugs are such that substitutable products are currently produced through the use of chemical technology. Products of biotechnology may not be distinct and exclusive. There is also no assurance that such drugs will be cheaper. At least in the early stages of drug development, where the scaling up of laboratory technology is
still in progress, the chemical firms may have an advantage. The market for drugs of a given therapeutic class may therefore consist of both chemical and biotechnology firms.

Any one firm may find it advantageous to segment the market for its products based on the mechanism of drug delivery. For instance, they may consider the bulk market through the public health system as distinct from private prescription sales.

Large chemical firms are finding it increasingly advantageous for them to integrate into the biotechnology markets. Initially this may be the result of their competence in clinical tests and their ability to take a product through the regulatory process. The mergers and acquisitions may also eventually give them the scientific and technical competence that they may find expensive to develop in house.

Defining the nature of the market becomes complex if a network of firms, including NBFs and large chemical firms, produce a drug. For, even if the chemical firm has competitors for its product it has distinct dynamic advantages if it is highly connected to NBFs. However, the relationships between them are not arms length contracts. Instead, they are incomplete contracts of a long duration. In general, biotechnology firms in the pharmaceutical industry exhibit various degrees of vertical integration and contractual relationships. It is difficult to apriori claim that all links of the vertical chain belong to the same industry. Fundamentally, therefore, the degree of concentration in any therapeutic segment depends on a variety of factors.

Gamberdilla et al (2000) claim that concentration in the biotechnology industry is low because
- the industry is composed of many therapeutic classes and a wide range of technologies
- the successful introduction of a new drug within a class and its advantages do not last long. A major innovation is followed by product and process innovations by competitors
- an early innovator does not have any major advantage in introducing major drugs later

Consider the markets for agricultural biotechnology. There are three distinct segments here: seeds, crops, and animal products. Biopesticides and biofertilizers may also be sold independently and not necessarily embodied in seeds. Consider the market for seeds. The Bt varieties of cotton and corn or the Roundup ready soybeans are distinct classes by themselves. However, some competition is possible because some varieties have been developed to suit specific agricultural climatic zones. Even so it was observed that only a few firms dominate the market. For all practical purposes, the fine division achieved in conventional hybrid technologies will not be possible in biotechnology due to the high fixed costs of adaptations. The more important problem has been the tying of sales of seed with other fertilizers etc produced by the same firm. This effectively reduces the number of competing firms in the market. Competition is from the producers of conventional hybrid varieties though their technology is different. The difficult question
to address is whether the demand side relationships and/or the technical relationships should form the basis for defining the industry boundaries.

Given the preferences of the consumers, say, toward non-GM varieties of crops so long as they are available it would appear that the markets for GM and non-GM crops are distinct. However, the costs of labeling non-GM foods increases their cost and make GM crops more competitive at the margin. Taking GM and non-GM firms together to define an industry will perhaps be more reliable.

Some authors seem to feel that some biotechnology firms, especially NBFs, may be dealing only with intermediate level technologies. They may sell their products, contract with seed companies, or form joint ventures. The definition of markets and products to be included in the definition are subjective.

Rooijakkers et al (2005) argued that biotechnology industry is characterized by a dual market structure. On the one hand a group of large, integrated, international and established companies and on the other hand, a group of relatively small, specialized firms. In the usual industrial organization literature there will be competition within the two groups but nothing between them. In biotechnology industry the competition among large firms to force linkages with smaller firms is significant. Since learning effects are not very strong there may be no longer term alliances. Instead, there will be many short term contracts.

The boundaries for defining the level at which a market should be conceptualized is, as yet, a pragmatic choice depending on the purpose of analysis. In general, either technological and/or demand relationships determine the final choice.

6.2. Defining Market Concentration

Historically, the interest in market structure arises from the fact that the monopoly power of firms determines prices of products and welfare losses. The elasticity of demand, number of firms, four firm concentration ratios (based on market share of sales), and the Herfindhal index have been utilized.

It is well known that the Lerner measure of monopoly power

$$L = \frac{p - MC}{p} = \frac{1}{\eta}$$

depends on the elasticity of demand. The market structure can be characterized as a monopoly if $\eta$ is low. This measure enables the analyst to consider various degrees of monopoly power. Intuitively, the larger the number of firms the lower the concentration or the higher the degree of competition. Hence, the number of firms (or numbers equivalents as defined below) has been utilized to characterize the market structure.

Either due to economies of scale, the degree of diversification, or the economies of being established in the market, some firms tend to be big even when a large number of small firms exist in the market. This is typical of the biotechnology industry. For, as observed earlier, a fairly large number of small NBFs begin to explore the potential to
commercially exploit a scientific discovery. The successful firms, among these, will either merge with or are taken over by the large seed and chemical companies eventually. Studies by Pamolli and Ricabboni (1) consider these issues fairly exhaustively. The purport of this argument is that a few large firms may have all the effective market power even when the market has a large number of firms. The market share of the four largest firms is usually called the four-firm concentration ratio (CR4). Assume that the market consists of n identical firms. The market share of each of them will be 1/n and CR4 = 4/n. Consequently, n = 4/CR4 can be considered as the numbers equivalent in any general setting.

The Herfindhal index of concentration utilizes the market shares more explicitly. Let si; i = 1,2,…,n denote the market share of the i th firm. Then, the Herfindhal index of concentration is defined as $\text{H} = \sum s_i^2$

Observe that if $s_1 = 1$ and $s_i = 0$ for $i \neq 1$ this measure reduces to $\text{H} = 1$. On the other hand, if $s_i = 1/n$ for all i, $\text{H} = 1/n$. In general, $1/\text{H}$ is also a numbers equivalent concentration measure.

Pharmaceutical firms may have a market advantage if they are highly diversified. This may arise in one of two ways. First, by producing a variety of products they may experience economies of scope in demand (this will be considered in detail in the next section). In effect, they may be able to save on costs of promotion and may reach physicians more effectively if they have a diversified product range. Second, the advantages may be in the costs of production if there are economies of scope. That is, by spreading the fixed costs over a wider range of outputs the firm may be in a position to lower the prices of their products. A Herfindhal index of diversification will be useful in the first context. To take the production economies into account define $s_i =$ share of the i th product in the variable cost of the firm

Then, a similar Herfindhal index would indicate that a high value of $\text{H}$ cannot provide much of an advantage to the firm.

In the context of biotechnology many NBFs may not be producing any final product. They may still have some monopoly power while dealing with large firms. Conversely, a large firm that has extensive technological and/or financial links with NBFs will have advantages in dealing with them as well as in the markets for final outputs. Roijakkers et al (2005) characterize these as dual market structures. Basically the monopoly power of the large firm and the small firms is in their respective specialization and core competence. The number of links and the concentration of links may then characterize the market structure. The strength of the links may be measured by the number of patents or the finances offered as the case may be. Since the number of large firms in downstream markets is lower this type of concentration tends to increase while moving toward final product links.

It is quite clear that large chemical firms have advantages with respect to technical expertise, regulatory links, and finances (deep pockets and ability to take risks). These features may enable them to undertake a larger number of clinical trials of drugs for
eventual regulatory approval. An ex ante measure of the concentration of clinical trials may then be a good measure of ex post market power.

Field trials have the same function in the context of agricultural biotechnology. A large seed firm that is currently undertaking a large number of field trials for a variety of crops has the prospect of achieving greater market advantage by offering a more diversified product range.

Though a number of other finer points can be included in the construction of concentration indices this analysis captures the essential aspects of the degree of concentration in biotechnology markets.

6.3. Sources of Concentration

The sale of biotechnology gene components and fragments of cells are highly concentrated only because they are still under patent protection. However, more genes, owned by more NBFs, are entering the market thereby reducing concentration to some extent. With more licensing, compulsory or otherwise, the concentration in the downstream industries will reduce further. See, for instance, Schimmelpfenig (2004).

In very general terms concentration may be a result of economies of scale in the production process. Biotechnology research activities have been generally rather expensive. Hence, the large seed companies are basically a result of the desire to spread the costs of biotechnology over a wide range of output and the market. A natural monopoly like situation appears to operate. In the pharmaceutical market such advantages seem to be for products in specific therapeutic categories and for a limited time. The large fixed costs are also the reason for the emergence of scope economies. These may be related to production technology or to market demand. In general, as Malerba and Orsenigo (2002) pointed out, biotechnology innovations are not cumulative in so far as the development of one gene or protein does not create any advantages in developing another. Even so firms tend to diversify into a variety of gene and product discoveries in the hope that they can spread fixed costs over a diversified range of products. The technological economies of scope that a firm can hope to achieve are rather severely limited.

In the agricultural biotechnology context small companies have been able to operate on lower costs and develop niche markets for the product traits that they discover. However, the large chemical companies increasingly find that biotechnology based seed production generally complements the use of their chemical fertilizers, pesticides, and so on. For example, the herbicide tolerant roundup ready soybean production requires more of the compatible herbicide. Thus, the production of both may impart certain economies of scale and scope. In the context of insect resistant Bt varieties of corn, cotton, etc the chemical company experiences a reduction in the use of chemical insecticides. The production of Bt varieties of seeds, however, spread the fixed costs giving rise to some economies of scope. In general, as Just and Heuth (1993) and Malerba and Orsenigo (2002) remarked,
technology related economies of scope do not appear to be the major reason for product diversification of the large chemical companies.

A more plausible explanation is the economies of scope in demand. As Just and Heuth (1993) argued, scope economies in demand can be said to materialize if the firm can generate greater net profits by marketing two or more products together. In the pharmaceutical market certain chemical and biotechnology related products complement each other. This is especially valid in the context of diagnostic kits and drug cocktails for the treatment of AIDS. The other major source is the nature of physician prescriptions, public health schemes, and promotional activities of large firms. The chemical and seed firms in agricultural biotechnology area derive advantages from tie-in sales of biotechnology related seeds and chemical supplements. In the early stages of biotechnology innovation small firms, operating in niche segments, dominated the market. However, with subsequent developments it has become profitable for large firms to diversify so that they can take advantage of the economies of scope in demand. This tends to increase the concentration in the industry.

6.4. Monopoly Power and Pricing

Recent studies of the effect of monopoly power on the pricing of products tend to consider a market in which n firms produce and market homogeneous or very closely substitutable products. Subramanian ( ) and Watal ( ) are cases in point. To illustrate their essential argument consider a market with n firms. Let Yi the output of firm i;  i = 1,2,...,n. Assume that the market demand curve is
\[ p = a - \Sigma Y \]
where
\[ p = \text{price per unit of } Y \]
\[ Y = \Sigma Y_i = \text{total output sold by the n firms} \]
Postulate that the cost of production of the i th firm is
\[ C_i = c_i Y_i \]
Assume, further, that the firms are Cournot rivals. That is, they maximize profits by choosing their output taking the outputs of all other firms as parametric. The profit for the i th firm is then
\[ \pi_i = Y_i (a - \Sigma Y_i) - c_i Y_i \]
\[ = (a - c_i)Y_i - Y_i \Sigma Y_i \]
The profit maximizing choice of \( Y_i \) satisfies the equation
\[ (a - c_i) - Y_i - \Sigma Y_i = 0 \]
Summing over all i yields
\[ na - \Sigma c_i - (n+1) \Sigma Y_i = 0 \]
Therefore,
\[ \Sigma Y_i = an/ (n+1) - \Sigma c_i/ (n+1) \]
and, consequently,
\[ Y_i = a/(n+1) + \Sigma c_i/(n+1) - c_i \]
\[ p = (a + \Sigma c_i)/(n+1) \]
The Lerner measure of monopoly power of the i th firm is therefore
\[ L_i = (p - c)/p \]
\[ \frac{Y_i}{p} = \left( \frac{Y_i}{Y} \right) \left( \frac{Y}{p} \right) = s_i \frac{Y}{p} \]

where

\( s_i \) = market share of firm i

It should also be noted that the elasticity of demand is

\[ \eta = - \frac{(dY/dp)(p/Y)}{p/Y} \]

\[ = \frac{1}{\eta} \]

Hence, it can be concluded that

\[ L_i = \frac{s_i}{\eta} \]

It varies directly with \( s_i \) and inversely with the elasticity of demand. The level of the industry monopoly power can be represented by

\[ L = \sum s_i L_i \]

\[ = \frac{H}{\eta} \]

where

\( H \) = Herfindhal index of concentration

Consider the more realistic situation in which the products of the n firms are imperfect substitutes. Let the demand curve for the i th product be

\[ P_i = a - bY_i - \Sigma^* Y_j \]

where \( \Sigma^* \) is the summation over \( j \neq i = 1,2,\ldots,n \)

The profit of the i th firm is

\[ \pi_i = (a - c_i)Y_i - bY_i^2 - \Sigma^* Y_j \]

The profit maximizing \( Y_i \), maintaining the assumption of Cournot rivals, satisfies the equation

\[ (a - c_i) - 2bY_i - \Sigma^* Y_j = 0 \]

As before, summation over i results in

\[ na - \Sigma c_i - 2b\Sigma Y_i - (n-1) \Sigma Y_i = 0 \]

That is,

\[ \Sigma Y_i = \frac{(na - \Sigma c_i)}{(2b+n-1)} \]

It can be readily verified that

\[ L_i = \frac{(p_i - c_i)}{p_i} = \frac{1}{\eta_i} \]

where \( \eta_i \) is the elasticity of demand for the i th product in Cournot equilibrium. As is evident it is not possible to define \( s_i \) any longer and it should be no surprise that \( L_i \) does not depend on \( s_i \) of any sort.

As biotechnology matures it was noted that the large chemical companies, that originally produced agricultural chemicals or hybrid seeds, also tend to integrate into biotechnology based seeds. The usual argument in economic analysis is that such diversification enables the firm to practice bundling and tying and thereby derive monopoly power and associated benefit of increased profit. This issue can be best examined through a numerical example. A general result is of course not available because the phenomenon that will be emphasized in the following analysis is not universally valid.
To begin with assume that a biotechnology firm is producing seeds \((Y_1)\) and a chemical firm is offering complementary fertilizer/herbicide combinations \((Y_2)\). Let the demand curves for the two products be

\[ p_1 = 10 - Y_1 + Y_2 \]
\[ p_2 = 8 + Y_1 - Y_2 \]

Postulate that the costs of production are

\[ C_1 = 5Y_1 \]
\[ C_2 = Y_2^2 \]

If the two firms operate independently as Cournot rivals their profit maximizing choices will satisfy the equations

\[ 5 - 2Y_1 + Y_2 = 0 \]
\[ 8 + Y_1 - 4Y_2 = 0 \]

Consequently, the equilibrium output choices will be

\[ Y_1 = 4, \ Y_2 = 3 \]
\[ p_1 = 11, \ p_2 = 9 \]

and the total profit that both the firm obtain will be

\[ \pi = 42 \]

The bundling argument now suggests that the large chemical firm will find it advantageous to integrate the production of seeds based on biotechnology. This will provide it greater monopoly power and profit. The integrated firm can be expected to maximize total profits

\[ \pi = 5Y_1 - Y_1^2 + 2Y_1Y_2 + 8Y_2 - 2Y_2^2 \]

The firm therefore chooses

\[ Y_1 = 9, \ Y_2 = 6.5 \]
\[ p_1 = 7.5, \ p_2 = 10.5 \]

The bundling argument is that the firm will sell the seed and fertilizer together, rather than independently. The bundle they sell will be

\[ B = 1 \text{ unit of } Y_1 \text{ along with } 6.5/9 \text{ units of } Y_2 \]

The total profit for the integrated firm will then be

\[ \pi = 44.5 \]

and the firm gains by such diversification. This tying argument takes the market information as pivotal to such organizational change.

Suppose, however, that the farmer knows that one unit of \(Y_1\) must be combined with one unit of \(Y_2\) to obtain the maximum crop productivity. Then, when the firms are operating independently, only 3 units of \(Y_1\) can be sold. This reduces the combined profit to 31 and leaves an inventory of 1 unit of output with the firm producing seeds. This also implies a waste of resources both in the form of capital stock of the firm producing seeds and the variable factors utilized in production and inventory. It is of course possible that the firms learn over time and make some correction. However, such coordination is difficult to achieve and expensive. The integrated firm, that attempts to maximize profits without paying attention to the technical constraint, faces a similar problem. 2.5 units of \(Y_1\) remain in inventory and the profit reduces to 25.75. Bundling will not be an advantage if the constraint is neglected. It is reasonable to argue that the diversified firm has the ability to obtain the technical information and the managerial expertise to utilize it in its decision process. Under these assumptions the production constraint is
B = 1 unit of $Y_1$ combined with 1 unit of $Y_2$

The corresponding price per bundle will be 18. The profit function can now be written as

$$\pi = 13B - B^2$$

so that the optimal production choice is

$$Y_1 = 6.5 = Y_2$$

The profit for the firm is now 42.25. Tying agreements of this nature can be implemented by a diversified firm to its advantage. However, note that it reduces resource use (or optimize it) so that society also stands to gain.

The tendency in economic analysis is to condemn such monopoly practices. However, as the above analysis indicates, a certain amount of caution is necessary. For, the advantages, to the society, of the optimal resource use may outweigh the redistribution of the value to the firm.

It is rather clear from the foregoing analysis that firms in the biotechnology industry will have some market power. They may also experience higher costs. Due to one or the other of these factors the market price will be high. However, this does not necessarily imply that there is always a loss in social welfare. Instead, the efficient welfare maximizing choices depend on the demand and cost conditions of the specific case. Sweeping generalizations can be quite misleading.

6.5. Differential Pricing

Studies dealing with pricing of biotechnology products, and pharmaceutical products in general, concluded that the monopoly power granted by the IPR regime generally makes the prices higher. Some of them believe that poorer consumers, especially in the developing countries, will be deprived of life saving drugs because their ability to pay is low. Differential pricing arguments have been set up against this background. The primary argument is that markets should be segmented on the basis of their ability to pay and different prices set up in the two (or more) segmented markets. Three distinct formulations are discernible. They will be considered in turn.

Assume that the market can be segmented into two different elasticity zones. It is normally expected that the more vulnerable section of the consumers will have larger elasticity of demand. Suppose, now, that the firm maximizes profits by offering different prices in the two segments of the market. Let

$$p_1 = f(Y_1)$$

$$p_2 = g(Y_2)$$

represent the two demand curves. Similarly, assume that

$$C = c(Y_1 + Y_2)$$

is the cost function. Then, profit maximization requires that

$$MR_1 = MR_2 = MC$$

where

$$MR_1 = \text{marginal revenue in market 1}$$

$$= p_1 \left(1 - 1/\eta_1\right)$$

$$MR_2 = p_2(1 - 1/\eta_2)$$
and
MC = marginal cost
Consequently, the prices are such that
\
p_1/p_2 = (1-1/\eta_1)/(1 - 1/\eta_2)\
Therefore, the firm charges a lower price in the market where the elasticity of demand is higher.

The following exception should be noted. Assume that the market demand curves are
\[ p_1 = 10 - Y_1 \]
\[ p_2 = 20 - Y_2 \]
Let the cost of production be
\[ C = 0.5 (Y_1+Y_2)^2 \]
It can be readily verified that the profit maximizing choices of the firm are
\[ Y_1 = 0, \ Y_2 = 6.67, \ p = 13.33, \ and \ \pi = 66.7 \]
when the firm charges the same price from all the consumers. If the firm does discriminate its choices will become
\[ Y_1 = 1.25, \ Y_2 = 6.25, \ p_1 = 8.75, \ p_2 = 13.75, \ and \ \pi = 58 \ (approximately) \]
This does not increase profits for the firm. The firm will not cater to the segment where the willingness to pay is lower.

The low ability to pay does not necessarily mean greater elasticity. Instead, it may only mean a shift to the left with the same elasticity. Does the firm charge a lower price in the market where the willingness to pay is lower? Let the demand curves in the two markets be
\[ p_1 = 10Y_1^{1/2} \]
\[ p_2 = 20Y_2^{1/2} \]
Suppose the cost of production is
\[ C = 5(Y_1+Y_2) \]
It can be verified that the optimal choice for the firm is
\[ Y_1 = 1, \ Y_2 = 4, \ p_1 = 10 = p_2 \]
The ability for price discrimination is essentially due to the differences in the elasticity of demand whether or not it reflects the ability to pay.

One further aspect should be kept in perspective. Suppose a MNC is producing output at its home base and catering to both the home market and a foreign market. Then, price discrimination, as described above, occurs. However, note that the MNC has the option of producing in the foreign country where the costs of production may be lower. This, in itself, may enable it to offer a lower price in the foreign market. Some organizational issues should be taken into account for this possibility to materialize. These will be considered in the sequel.

The other two formulations are based on welfare maximization. Consider Fig. . Clearly, a monopoly firm will offer output at price \( p_m \). This maximizes its profit so long as it cannot discriminate between consumers. However, the welfare maximizing choice of output, \( Y_w \), can be restored if the firm offers the additional output at a price \( p_w \). The firm would be willing to offer it so long as the area ABC is positive and the markets are kept
segmented; i.e., output $Y_mY_w$ will not be sold once again to the rest of the market. As noted earlier there is a necessity for suitable organizational arrangements to achieve this.

Ganslandt et al (2001) argued that MC based pricing may not adequately cover the fixed costs of R&D. Therefore, they suggest that an organization, like the WHO, should create a fund that will reimburse pharmaceutical firms the entire sunk costs incurred in drug development. The above analysis does not fully support this viewpoint. However, an appropriate empirical evaluation is necessary to concretely assert that differential pricing suggested above will be adequate.

Ramsey pricing goes a step further. It seeks to maximize consumer utility subject to a zero profit constraint. Consider the problem

$$\text{Max } \int_{0}^{Y_1} f(y_1) \, dy_1 + \int_{0}^{Y_2} g(y_2) \, dy_2$$

subject to

$$Y_1f(Y_1) + Y_2g(Y_2) - C(Y_1+Y_2) = 0$$

Using the conventional Lagrange multiplier method the first order conditions for maximum yields

$$\frac{f}{g} = \frac{f(1 - 1/\eta_1) - c_1}{g(1 - 1/\eta_2) - c_2}$$

so that $f$ and $g$ satisfy the equation

$$c_1(1/g - 1/f) = 1/\eta_1 - 1/\eta_2$$

Consequently,

$$\frac{f}{g} = \eta_2/\eta_1$$

i.e., a higher price will be charged in the market with a lower elasticity of demand. However, this is much more difficult to implement. For, unlike the previous two cases the firm is not willing to adopt this scheme voluntarily (to maximize its profit).

Danzon (1997, 1998) considered the application of this principle to cover sunk costs. The following salient points may be recorded.
Ramsey pricing assumes a zero monopoly profits (a normal rate of return allowed). Hence, it is necessary to have a regulated price regime to implement such pricing. A free market operation will resist its use.

In the international context it is not possible to have a coordinated regulatory process for price fixation. In fact, some countries, that do not want to pay any part of the sunk costs, may negotiate lower prices.

From an operational viewpoint, regulated price regimes rarely produce meaningful information on the elasticities of demand. The basic foundation of Ramsey pricing may not be available to the regulator even within a given country.

Watal ( , ) examined some of the institutional issues involved in the implementation of differential pricing. The following two are crucial.

- It may be necessary to label the products for each of the markets. The colors used for drugs may be one such marker. Size and packing have been utilized extensively to delimit the markets. On the other hand, lower priced drugs may be available through public health schemes with the definite understanding that the physicians will provide them only to the poorer sections of the population.

- When trading is across national boundaries the low income country should be expected to guarantee that the low priced drugs will not be reexported. This can be covered under the WTO agreements. The issue of parallel imports has drawn considerable attention. See, for example, Maskus (2001) and Scherer and Watal (2001). A few details will be taken up in the next chapter. Suppose the MNC allows production in a low income country. Of course, technical capability is a prerequisite. In addition, the MNC needs a guarantee that its proprietary technology is safe and that low priced drugs will not be exported. Appropriate institutional arrangements will be necessary to make differential pricing successful.

The other thorny aspect is the nature of differential prices. For, under the transfer pricing regulations trade across national boundaries the lower prices

- cannot pretend that costs of production are lower than comparable products in the foreign country
- should not be such as to provide a greater rate of profit than comparable products in the foreign country
- should not result in a rate of return on capital in excess of that prevalent in the foreign country

Appendix 2 contains a more detailed analysis of these transfer pricing rules.

The other problem that has been receiving attention is reference pricing. Suppose a large firm offers a drug at a low price in a developing country. The consumers in the patent country of the firm want justification for why they are paying much higher prices. In other words, differential pricing limits the monopoly pricing power of the firm in all its markets.

On the whole, it can be concluded that at least in the short run until patent protection is exhausted it would be worthwhile to put some differential pricing in operation. This practice is already in existence with respect to TB and AIDS drugs.
6.6. Dynamic Pricing

The above two sections considered the pricing problem from a static perspective. However, two dynamic effects have been brought to light indicating that the actual prices may be lower.

First, it was noted that the adoption of GM varieties involve wide ranging changes in production practices. Consider the case of herbicide resistant roundup ready soybeans. These seeds allow no-till planting of crops and a higher density per hectare. As a result the machinery used for planting as well as spraying pesticide are different. Further, once the investments in the machinery are made they cannot be used elsewhere. That is, they are irreversible and sunk. The only way to recover the cost is by repeated use over time. Consequently, the firms try to avoid the possible loss of future market that may result from static monopoly pricing. In other words, pricing practices recognize the changing market over time and the fixed costs. The monopoly power of the seed producer will also decrease as a result. See, for example, Perrin and Fulginiti (2001), Demont et al (2004), and Weaver and Wessler (2004).

Second, in the pharmaceutical sector it was generally observed that, contrary to expectations, the prices are lower when a drug is under patent but increases once the generic drugs enter the market after the expiry of the patent. Bhattacharya and Vogt (2003) explain this in the following manner. Note that the physicians determine the demand for therapeutics in general. They find it costly to learn about new drugs constantly. The pharmaceutical companies tend to set up promotional campaigns that maximize the stock of information and experience with the doctors as a priority over static monopoly pricing. For, they wish to ensure a large market share before the generics enter the market. After the expiry of the patent the branded drug loses its more elastic segment of the market to competitive generics. However, the stock of goodwill that they accumulated with the physicians allows pharmaceutical firms to charge higher prices for their branded drugs. To an extent such price increases will also be necessary to recover the costs of promotion incurred earlier.

6.7. In Retrospect

Most biotechnology based products are in their early stages. As yet they are sold under patent protection. Consequently, the market is highly concentrated. A few adaptations of seeds, to suit different agro-climatic zones may make monopoly severe in specific segments but reduce it overall. When the patents are off and competition develops it is difficult to predict the degree of competition that emerges. For, unless costs can be reduced significantly, smaller market segments may not sustain a large number of competitive varieties. Competition may be effective only in markets like the diagnostic kits where the investments are low.
Labeling non-GM products may provide an effective means of discrimination. The increase in non-GM prices may offer some advantages to the GM varieties though consumer resistance may still be important.

Gambardella et al (2000) noted that "the competitiveness of the industry cannot be assessed by looking at the individual firms, but also at the broader set of institutions, infrastructures, and policies that influence the actions of companies, and even more important, at the dynamic interactions between these levels of analysis."