# 3

# Market Structure and Market Power

The structure–conduct–performance paradigm, the old IO, starts with a given market structure and then investigates how firms behave in that kind of market. By contrast, the new IO has in some ways reversed the logic and begins by investigating how the firms' strategic behavior can affect the structure of the market. Yet despite these differences, the two approaches do agree that market structure or, the way the industry's producers are organized, affects what happens in the market place. A natural question that arises is how we can characterize a market's structure in a meaningful way.

In our review of basic microeconomics we saw that markets work well when firms are small relative to the size of the market. The idealized competitive market is one with numerous firms, each with a minimal market share. Yet such markets are relatively rare in the real world. Some markets have just 2 or 3 firms. Some have ten or twelve of unequal size. In what ways is this difference important? If there are 20 firms, does it matter if one firm has 60 percent of the market and the other 19 have just a bit more than two percent each? Alternatively, can we measure market structure in such a way that enables us to make some inference of market power? Can we create an index that allows us to say how close or how far a market structure is from the competitive ideal? Because such a roadmap could be of great use to policy makers it is worthwhile to explore the question at length.

## 3.1 MEASURING MARKET STRUCTURE

One way to think about an industry's structure is to undertake the following, simple procedure. First, take all the firms in the industry and rank them by some measure of size from largest to smallest—one, denoting largest; two; the next largest; etc. Suppose for example that we use market share as a measure of size. We could then calculate the fraction of the industry's total production that is accounted for by the largest firm, then the two largest firms combined, then the three largest firms combined, and so on. This gives us the cumulative fraction of the industry's total output as we include progressively smaller firms. Plotting this relationship yields what we call a concentration curve. It is called a concentration curve because it describes the extent to which output is concentrated in the hands of just a few firms.

Figure 3.1 displays concentration curves for each of three representative industries, A, B, and C. The firms' ranked sizes are measured along the horizontal axis, again with the first

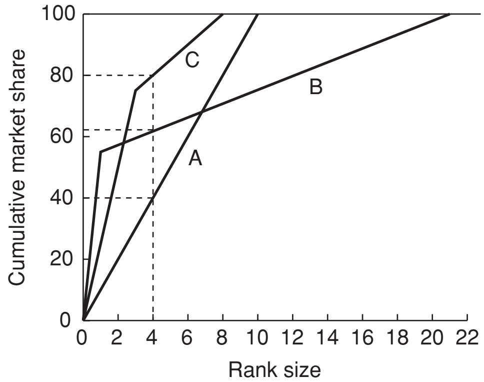


**Figure 3.1** Some possible concentration curves

firm being the largest. The cumulative market share is measured on the vertical axis. For example, Industry A has ten firms, each with a 10 percent market share. Industry B has twenty-one firms, the largest of which has a 55 percent market share. The remaining twenty firms all have a 2.25 percent share each. Finally, in industry C, there are three firms each with a market share of 25 percent and five firms each with a market share of 5 percent. For Industry B the vertical coordinates corresponding to the horizontal values 1 and 2 on this industry's concentration curve are 55 and 57.25, respectively. This reflects the fact that the largest firm has 55 percent of the market and the largest two firms have 57.25 percent between them.

Concentration curves are a useful illustrative device.[1] They permit one to get a quick sense of how industry production is allocated across firms from a quick visual inspection. However, often we need to summarize industrial structure with just a single parameter or index. One such popular index that focuses on the size of firms (relative to the industry) is the concentration ratio, $CR_n$, defined as the market share of the top $n$ firms. In the United States, the most frequent choice is the four-firm concentration ratio, $CR_4$, or the percent of industry sales accounted for by the top four firms. For the three hypothetical industries described above, we can identify the $CR_4$ concentration very easily. All we need to do is draw a vertical line from the value 4 on the horizontal axis to the relevant concentration curve and from that point read horizontally to the vertical axis coordinate. As can be seen, $CR_4$ is 40, 61.75, and 80, for A, B, and C, respectively. A similar exercise yields the eight-firm ratio $CR_8$ that also is often reported. Its value for markets A, B, and C is 80, 70.75, and 100 respectively.

An $n$-firm concentration ratio then corresponds to a particular point on the industry's concentration curve. It follows that the principal drawback to such a measure is that it omits the other information in the curve. Compare for example the four-firm and eight-firm concentration ratios just given for the A, B, and C industries. Industry A appears more concentrated than does industry B using the $CR_8$ measure but less concentrated when evaluated with the $CR_4$ index.

[1] Those familiar with the GINI coefficient typically used to measure income inequality will recognize the concentration curve as the industrial structure analog of the Lorenz curve from which the GINI coefficient is derived. For further details, see C. Damguard, "The Lorenz Curve," www.mathworld.wolfram.com/LorenzCurve.html.

## Reality Checkpoint

## Concentrating on Concentration

Just as we can measure the fraction of an industry's output accounted for by its largest firms, so we can measure the fraction of the economy's entire output, GDP, accounted for by its largest corporations. However, while it may make some sense to speak of a concentration index based on just the top four firms or top eight firms when speaking of a single industry, such a small number of firms would account for much too little of GDP to think seriously about. So, in the case of aggregate economic activity, we consider concentration ratios such as $CR_{50}$ or $CR_{200}$. Such measures can be constructed using data from the Census Bureau's Census of Manufactures. Economist Lawrence White (2002) made such calculations for the U.S. for various years up to the end of the twentieth century. Some of his results are shown below.

Aggregate concentration for manufacturing (value added basis), selected years, 1947–97 (%)

| *Year* | $CR_{50}$ | $CR_{100}$ | $CR_{200}$ |
|---|---|---|---|
| 1947 | 17 | 23 | 30 |
| 1958 | 23 | 30 | 38 |
| 1967 | 25 | 33 | 42 |
| 1977 | 24 | 33 | 44 |
| 1987 | 25 | 33 | 43 |
| 1992 | 24 | 32 | 42 |
| 1997 | 24 | 32 | 40 |

These data suggest that, at least since the 1950s, aggregate concentration in manufacturing has shown no increasing or decreasing trend. It is approximately the same in 1997 as it was in 1958 whether one looks at the top 50, 100, or 200 largest firms. White shows that somewhat similar results obtain if one looks at all nonfinancial corporations, or focuses on shares of employment or profit. This of course does not mean that firms are not getting bigger. If each firm grows at the same rate as the economy, each of us will find ourselves employed in larger and larger organizations over time even though concentration is stable. White shows that this too has been happening and that the size of the average firm has, correspondingly, grown.

Source: L. White: "Trends in Aggregate Concentration in the United States," *Journal of Economic Perspectives* (Fall, 2002), 137–60.

An alternative to $CR_n$ that attempts to reflect more fully the information in the concentration curve is the Herfindahl–Hirschman Index or more simply the HHI. For an industry with $N$ firms, this is defined as follows:

$$\text{HHI} = \sum_{i=1}^{N} s_i^2 \tag{3.1}$$

where $s_i$ is the market share of the $i$th firm. In other words, the HHI is the sum of the squares of the market shares of all of the firms in the industry. Table 3.1 illustrates the calculation of the HHI for industry C in our example. If we measure market share in decimal terms so that a firm with 25 percent of the market has a share $s_i = 0.25$, the HHI for industry C is 0.20. Compare this to a maximum value of HHI = 1.0, which would be the HHI if the industry were a pure monopoly with one firm accounting for all the output. However, the practice is often to measure the shares in percentage terms in which case the HHI for industry C is 2000, which compares with a maximum, pure monopoly value of HHI = 10,000 when shares are measured in this way. For industries A and B, similar calculations yield HHI = 1,000 and H = 3,126.25, respectively.

**Table 3.1** Calculation of the HHI for industry C

| | *Firm rank* | *Market share (%)* $s_i$ | *Squared market Share* $s_i^2$ |
|---|---|---|---|
| | 1 | 25 | 625 |
| | 2 | 25 | 625 |
| | 3 | 25 | 625 |
| | 4 | 5 | 25 |
| | 5 | 5 | 25 |
| | 6 | 5 | 25 |
| | 7 | 5 | 25 |
| | 8 | 5 | 25 |
| Sum: | | 100 | 2000 (HHI) |

Like a concentration ratio, the HHI measure has its drawbacks. However, it does have one very strong advantage over a measure such as $CR_4$ or $CR_8$. This is that the HHI reflects the combined influence of both unequal firm sizes and the concentration of activity in a few large firms. That is, rather than just reflect a single point on the concentration curve, the HHI provides, in a single number, a more complete sense of the shape of that curve. It is this ability to reflect both average firm size and inequality of size between firms that leads economists to prefer the HHI to simple concentration ratios such as $CR_4$. In our example, Industry B gets the highest HHI value because it is the one with the greatest disparity in firm sizes.

**Practice Problem 3.1**

Consider two industries, each comprising ten firms. In industry A, the largest firm has a market share of 49 percent. The next three firms have market shares of 7 percent each, and the remaining six firms have equal shares of 5 percent each. In industry B, the top four firms share the bulk of the market with 19 percent apiece. The next largest firm accounts for 14 percent, and the smallest five firms equally split the remaining 10 percent of the industry.

a. Compute the four-firm concentration ratio and HHI for each industry. Compare these measures across the two industries. Which industry do you think truly exhibits a more competitive structure? Which measure do you think gives a better indication of this? Explain.
b. Now let the three second-largest firms in industry A merge their operations while holding on to their combined 21 percent market share. Recalculate the HHI for industry A.

## 3.1.1 Measurement Problems: What Is a Market?

Whether one uses a $CR_4$ or HHI as an overall measure of a market's structure, it should be clear that the ability to make such measurements at all is predicated upon our ability to identify a well-defined market in the first place. In truth, this is not often easy to do. Consider, for example, the automobile industry. Is the relevant market one for passenger cars? Or are specialized vehicles, such as motorcycles, vans, and pickup trucks also part of the picture? Or think of the beverage industry. Does Pepsi compete only against other carbonated

**Table 3.2** Concentration measures for selected industries

| *Industry* | $CR_4$ | *HHI* |
|---|---|---|
| Breakfast cereals | 82.9 | 2445.9 |
| Soft drink mfg | 47.2 | 800.4 |
| Automobiles | 79.5 | 2862.8 |
| Textile mills | 13.8 | 94.4 |
| Paper mfg | 18.5 | 173.3 |
| Petroleum refineries | 28.5 | 422.1 |
| Petrochemical mfg | 59.8 | 1187.0 |
| Pharmaceuticals | 32.3 | 446.3 |
| Cement mfg | 33.5 | 466.6 |
| Aluminum sheet/plate/foil | 65.0 | 1447.0 |
| Computers and peripherals | 37.0 | 464.9 |
| Electric light bulbs | 88.9 | 2849.0 |
| Dolls, toys and games | 40.0 | 495.9 |
| Aircraft | 80.9 | 2562.2 |
| Semiconductors | 41.7 | 688.7 |
| Telephone equipment | 55.3 | 1061.1 |
| Plastic pipes/fittings | 24.8 | 241.3 |
| Toiletries | 38.6 | 564.2 |
| Women's footwear | 49.5 | 794.8 |
| Household refrigerators | 82.8 | 2161.6 |

Source: "Concentration Ratios in Manufacturing," Bureau of the Census, 1997; U.S. Census Bureau, Census of Manufactures, 2001, 2002

beverages, or should beverages such as fruit juices, iced teas, and flavored milk also be viewed as substitute products? Unless we have a clear procedure for answering such questions, any summary measure of market structure such as HHI will become an arbitrary statistic capable of being manipulated either upward or downward at the whim of the researcher. An analyst can then make $CR_4$ or HHI arbitrarily small or large by defining the market either broadly or narrowly.

In the United States, the Census Bureau is the custodian of the market definitions most frequently used. These definitions have recently changed somewhat in connection with the North American Free Trade Agreement. However, the logic underlying the earlier Standard Industrial Classifications (SIC) definitions and the current North American Industry Classification System (NAICS) is essentially the same. The Census Bureau first categorizes the output of business units in the United States into broad sectors of the economy, such as manufacturing, primary metals, agriculture, and forestry products, each of which receives a numeric code. These sectors are then subdivided further, and each is given a two-digit code. The manufacturing sector, for example, is covered by codes 31–33. These are each disaggregated further into the three-digit, four-digit, five-digit and six-digit levels. Each additional digit represents a further subdivision of the initial classification. Primarily because of the method by which the data are collected—through surveys of companies—the basis of all subdivisions is the similarity of production processes, rather than for example the substitutability in consumption. The classification system permits the construction of concentration data. Before compiling these data, however, the Bureau must determine how to

## Reality Checkpoint
## Industries Aren't What They Used to Be!

In a press release issued on April 8, 1997, the Executive Office of the President of the United States announced the introduction of a new industry classification system. They stated that the new system will enable the North American Free Trade Agreement (NAFTA) partners—the United States, Canada, and Mexico—to better compare economic and financial statistics and ensure that such statistics keep pace with the changing economy.

The new system—the North American Industry Classification System (NAICS)—will replace the countries' separate classification systems with one uniform system for classifying industries. In the United States, NAICS will replace the current Standard Industrial Classification.

NAICS, a flexible system that will take into account changes in the global economy, will help to support more informed economic and trade policies, more profitable business decisions, and more cogent public discussion and debate.

The NAICS was fully in effect as of the 1997 Economic Census. One can review this data as well as the translation of the data from the older SIC classification system at the Census Bureau's website, http://www.census.gov.

Source: Executive Office of the President, Office of Management and Budget, Washington, D.C., April 8, 1997. Available on the Internet at: http://www.census.gov/epcd/naics/pressrel.html

categorize production plants that produce more than one product. Its basic procedure is to assign a plant on the basis of that plant's primary product, as measured by sales. Once all the establishments are so assigned, total sales are computed for each market. Market shares and concentration indices are then calculated. These data are published regularly by the Census Bureau. Table 3.2 shows both $CR_4$ and HHI for a sample of well-known industries.[2]

The two measures of industrial concentration, $CR_4$ and HHI, are highly correlated, implying that each gives roughly the same description of an industry's structure. Yet while the $CR_4$ and HHI measures often tell the same story, the crucial question is whether or not it is the right story.[3] That is, to what extend do the four-digit industry classification codes and the associated measures of market concentration conform to an economist's idea of a market?

Generally speaking, we would like to include production establishments in the same market if the products that they produce are closely substitutable in consumption. Typically economists measure substitutability in consumption by the cross-price elasticity of demand $\eta_{ij}$. This is defined as the percentage change in demand for good *i* that occurs when there is a one percent change in the price of another good *j*. The mathematical definition of this elasticity is

$$\eta_{ij} = \frac{\partial q_i}{\partial p_j}\frac{p_j}{q_i} \tag{3.2}$$

[2] Further details are available on the Internet at http://www.census.gov/epcd/www/naics.html.

[3] A quite readable discussion of the advantages and disadvantages of each ratio is available in Sleuwaegen and Dehandschutter (1986) and Sleuwaegen et al. (1989).

If this measure is large and positive then goods *i* and *j* would be considered to be reasonably close substitutes.[4] Because the Census approach groups establishments more on the basis of similarity in production techniques than on the basis of substitutability in consumption its markets definitions do not always satisfy this criterion. For example, wood, ceramic tile, and linoleum are all used as flooring materials and therefore may be viewed as substitutes in consumption. Yet each is actually listed under a different three-digit NAICS code.

Other problems with the NAICS and similar classifications arise in connection with geographic considerations. The geographic boundaries of a market are just as vital to market definition as are the product boundaries. For example, virtually all newspapers operate in local markets where typically we find one or two other competitors at most. The fact that, taken as a nationwide industry, newspapers exhibit very low concentration measures may not be terribly relevant in terms of indicating the extent of choice available to consumers who purchase newspapers in a particular town or city.[5]

Another issue related to geography is foreign trade. When the volume of such trade is large, the relevant market may well be a global one instead of a domestic one. In addition, even if one looks at only the domestic market, the presence of foreign imports can mean that the measurement of market share will depend critically on whether one uses a production total or a sales total. Thus, General Motors, Ford, and Daimler-Chrysler account for roughly 80 percent of all domestic production, but closer to 60 percent of domestic sales as a result of automobile imports.

Finally, structural measures such as HHI and $CR_4$ have trouble reflecting the relationships between firms operating at different stages of the production process. The delivery of a final good or service to the customer often represents the last of many steps. These include the acquisition of the raw materials; their transformation into a semifinished good; the refinement of the semifinished good into a final consumer product and, thereafter, the retailing. In economics jargon, the initial raw materials phase is typically described as the upstream phase after which the product flows "downstream" through the various stages toward its final sale to the consumer. The relationship between upstream and downstream phases is therefore a vertical one, and there are several forms that this relationship can take. An upstream producer may own all the subsequent phases in which case we say the firm is vertically integrated. Alternatively, an upstream producer may offer franchising agreements or long-term contracts to downstream sellers. The existence and variability of such relationships can cause difficulty in measuring the structure of the market at any one stage of production. For instance, there are many bottling companies so that conventional measures of market concentration in the bottled tin and soft drink industry are rather low. In turn, this suggests a fairly competitive market. However, the reality is that most bottling companies do not compete with each other but, instead, are tied through strict franchise agreements to use one of the national upstream suppliers, such as Coca-Cola or Pepsi.[6] There is much less competition among bottlers than the concentration measure would suggest.

4 However, the presence of a high monopoly price may inflate the cross-elasticity measure a point originally emphasized by Stocking and Mueller (1955). That is, at the high price set by a monopolist, the cross-price elasticity may be large and indicate that other goods are substitutes when this would not be the finding had the monopolized industry been pricing competitively.

5 This issue becomes even more complicated for an industry where large, national firms operate in many local markets. For example, The *New York Times* owns a controlling interest in The *Boston Globe* as well as in other newspapers. The Gannet group controls the newspapers in more than two dozen markets. The banking industry outside the United States reveals a similar pattern of national ownership of local branches.

6 Some authors, for example, Gort (1962) and, more recently, Davies and Morris (1995), have tried to obtain a precise, quantitative measure of the extent of vertical integration.

In sum, interpreting the structural measures such as $CR_4$ and HHI is greatly complicated by a variety of factors such as regional markets, international trade, and vertical relationships. In addition, the standard approach of establishing categories on the basis of similarity in production techniques, rather than the degree to which they serve as substitutes in the eyes of consumers, means that most structural measures are far from ideal in terms of indicating the extent of market competition. Yet while it is well to recognize such limitations, it is equally important to recognize that some measures of industrial structure are probably better than none at all. Moreover, categorizing industries on the basis of closeness of shared production techniques does have its advantages. The most explicit theories of industrial structure link the configuration of an industry to the behavior of its production costs. Such a relationship only makes sense if the production technologies are sufficiently similar that we can make general, industry-wide statements about a typical firm's cost structure.

## 3.2 MEASURING MARKET POWER

Throughout this chapter, we have been thinking about market structure in the quite literal sense of how the industry's production of output is allocated across different firms. We have seen how summary statistics such as the $CR_4$ or HHI attempt to describe this configuration of firms in an industry much as a census taker might use similar statistics to describe the number and size of families in a geographic region. A large part of the motivation for these measures is the desire to summarize succinctly just where an industry might lie relative to the ideal of perfect competition. There is nothing wrong with this structural approach so long as one clear caveat is kept in mind. This is that a particular structure does not necessarily imply a particular outcome.

When we say that an industry is highly concentrated we are saying that the industry does not have many small firms, in contrast to the configuration that we associate with the competitive model. Does that necessarily mean then that prices charged in this industry are above what would prevail in a perfectly competitive market? The answer is not so straightforward. As we shall see in subsequent chapters, markets with even just two or three firms may come quite close to duplicating the competitive or efficient outcome.

The Lerner Index is one way to measure how well a market performs from an efficiency point of view. The Lerner Index *LI* measures how far the outcome is from the competitive ideal in the following way:

$$LI = \frac{P - MC}{P} \tag{3.3}$$

Because the Lerner Index directly reflects the discrepancy between price and marginal cost it captures much of what we are interested when it comes to the ***exercise*** of market power. For a competitive firm, the Lerner Index is zero since such a firm prices at marginal cost. For a pure monopolist, on the other hand, the Lerner Index can be shown to be the inverse of the elasticity of demand—the less elastic the demand the greater is the price-marginal cost distortion. (See the Derivation Checkpoint, "The Calculus of Competition," in Chapter 2 for a formal derivation.] To see this recall that for a monopolist the marginal revenue of selling an additional unit of output can be written as $MR = P + \frac{\Delta P}{\Delta Q}Q$. For profit maximization we set marginal revenue equal to marginal cost, or $P + \frac{\Delta P}{\Delta Q}Q = MC$. Rearranging and dividing by price $P$ we obtain

$$\frac{P - MC}{P} = -\frac{\Delta P}{\Delta Q}\frac{Q}{P} = \frac{1}{\eta} \quad (3.4)$$

where $1/\eta$ is the inverse of the elasticity of demand. The less elastic is demand, or the smaller is $\eta$, the greater is the difference between market price and marginal cost of production in the monopoly outcome. To drive the point home just a bit more deeply, recall that the perfectly competitive firm faces an infinitely elastic or horizontal demand curve. When such a large value is substituted for the elasticity term equation (3.4) it implies a Lerner Index of 0. Again, the perfectly competitive firm sells at a price equal to marginal cost. Note too that the Lerner Index can never exceed one and that it can only hit this maximum value if marginal cost is zero.

For an industry of more than one but not a large number of firms, measuring the Lerner Index is more complicated and requires obtaining some average index. A particularly straightforward case in this regard is that in which the commodity in question is homogenous so that all firms must sell at exactly the same price. If this is so, then we can measure a market-wide Lerner Index as:

$$LI = \frac{P - \sum_{i=1}^{N} s_i MC_i}{P} \quad (3.5)$$

Here, as before, $s_i$ is the market share of the $i$th firm and $N$ is the total number of firms.

The Lerner Index is a very useful conceptual tool and we will make reference to it throughout the remainder of this book. Like the $CR_4$ or the HHI, the Lerner Index is a summary measure. The difference is that the Lerner Index is not so much a measure of how an industry's production is structured as it is a measure of the market outcome. The greater is the Lerner Index, the farther the market outcome lies from the competitive case—and the more market power is being exploited. In this sense, the Lerner Index is a direct gauge of the extent of market competition.

Robert Hall (1988) uses a production theory approach to derive estimates of the Lerner Index for 20 broad manufacturing sectors in the U.S. These are shown in Table 3.3. Domowitz, Hubbard, and Petersen (1988) obtained similar but generally lower estimates of the Index using Hall's (1988) approach corrected for changes in raw material usage. Whereas Hall (1988) found an average price-cost margin of 0.577, Domowitz, Hubbard, and Petersen (1988) estimate the average to be only 0.37. Even this lower value, however, indicates a substantial degree of non-price-taking behavior.

Both the Hall (1988) and the Domowitz, Hubbard, and Petersen (1988) studies aim to get a sense of monopoly power in general, i.e., across a spectrum of industries. Hence, each is based on a cross-section of industries. Other studies, aimed at a narrower set of questions can also be useful. For example, Ellison (1994) tries to get evidence on game-theoretic models of cartel behavior. For this purpose, he studies railroad prices over time in the late nineteenth century. He estimates that, apart from price war periods, the Lerner Index was about 85 percent of what it would be under pure monopoly pricing. In other words, the collusive behavior of railroads at this time was capable of coming within 15 percent of the pure monopoly price distortion. Again, this is a considerable amount.

However, much like the structural indices, the Lerner Index also has its problems. To begin with, calculating the Lerner Index for an industry runs into the problem of market definition.

**Table 3.3** Estimated Lerner Index for selected industries

| *Industry* | *Lerner Index* |
|---|---|
| Food and kindred products | 0.811 |
| Tobacco | 0.638 |
| Textile mill products | –0.214 |
| Apparel | 0.444 |
| Lumber and wood | 0.494 |
| Furniture and fixtures | 0.731 |
| Paper and allied products | 0.930 |
| Printing | 0.950 |
| Rubber and plastic | 0.337 |
| Leather products | 0.524 |
| Stone, clay, and glass | 0.606 |
| Primary metals | 0.540 |
| Fabricated metals | 0.394 |
| Machinery | 0.300 |
| Electric equipment | 0.676 |
| Instruments | 0.284 |
| Miscellaneous mfg | 0.777 |
| Communication | 0.972 |
| Electric, gas, and sanitary services | 0.921 |
| Motor vehicles | 0.433 |
| Average | 0.57 |

Source: U.S. Census Bureau, Census of Manufactures, 2002, and various studies

In this respect, the relevant industry-wide estimate of the Lerner Index can be just as difficult to obtain as are good estimates of $CR_4$ and HHI.

Even when the market definition is reasonably clear, however, the Lerner Index is still difficult to measure. It is one thing to count the number and estimate the sizes of the various firms in an industry. Measuring the elasticity of demand is trickier. Measuring marginal cost is even more difficult. Unfortunately, even small changes in the assumptions one makes about the data can lead to sizable differences in estimated price-cost margins as illustrated by the differences between the Hall (1988) and Domowitz, Hubbard, and Petersen (1988) estimates above. Indeed, Ellison's (1994) study relied on data studied earlier by Porter (1983). Porter's (1983) estimate of the price distortion during collusive periods is only half as large as Ellison's (1994) estimate.

Moreover, even when the Lerner Index is accurately measured its interpretation can remain ambiguous. Suppose for example that each firm in an industry has to incur a one-time sunk cost *F* associated with setting up its establishment. Assume further that each firm's marginal cost is constant. Because each firm needs to earn enough operating profit to cover its sunk cost, the equilibrium price level will need to rise above marginal cost. That is, the Lerner Index will need to be positive. However, the more positive that difference is—the greater is the price-cost margin—the greater the number of firms that can cover the one time sunk cost. As a result, we might observe a high Lerner Index in a setting in which there are numerous firms, none of which is very large. In such a case, the high Lerner

Index might erroneously indicate little competition even though no firm has any significant market power.[7]

Conversely, the Lerner Index might underestimate market power in settings in which cost-reducing innovations are important. Suppose for example that an industry has an old and not very efficient incumbent firm with high marginal cost. As long as demand is somewhat elastic, such a firm may have no choice but to price relatively close to marginal cost. At the same time, the incumbent has a great incentive to take whatever actions it can that will keep a low cost rival from entering the market. In this case, the Lerner Index deceptively indicates a fair bit of competition because price is low relative to the incumbent's marginal cost when the relevant but unavailable comparison is the price with the potential rival's lower marginal cost.[8]

## 3.3 EMPIRICAL APPLICATION Monopoly Power—How Bad Is It?

A recurrent question in antitrust policy is just how costly imperfect competition is for the economy overall. If the losses from monopoly power are not large, then devoting any significant resources to antitrust enforcement to prevent such losses is probably not worthwhile. Such scarce resources would be better used in, say, increasing homeland security or providing relief to hurricane victims. If the economic costs of market power are large, however, then allocating resources to combat the abuse of that power is likely to be warranted. Hence, it would be useful if economists had some sense of just how serious the losses from monopoly power actually are.

In principle, economists have a clear measure of the economic loss caused by monopoly power. It is the deadweight loss or triangle that results from prices above marginal cost. In practice, however, measuring this loss is not so easy. This is because it requires getting estimates of cost and/or demand but, as with any estimate, these values are subject to some error. Unfortunately, rather small changes in the estimates can lead to rather large changes in the estimated welfare cost.

To understand the issues involved, let us start with the basic measurement of the welfare or deadweight loss that results from pricing above marginal cost. As shown in Chapter 2, this is the area whose height is given by the difference between price $P$ and marginal cost $MC$, and whose base is given by the difference between the competitive output $Q^C$ that would sell if $P = MC$ and the actual market output $Q$ that sells at the actual price $P$. Hence, the welfare loss $WL$ is:

$$WL = \frac{1}{2}(P - MC)(Q^C - Q) \tag{3.6}$$

It is convenient to express this welfare loss as a proportion of total sales revenue $PQ$ to yield

$$WL' = \frac{WL}{PQ} = \frac{1}{2}\frac{(P - MC)}{P}\frac{(Q^C - Q)}{Q} \tag{3.7}$$

[7] See, for example, Elzinga (1989).

[8] Hovenkamp (1994), among others, has made this argument.

Remember that the elasticity of demand $\eta$ is the proportionate increase in output in response to a given proportionate decrease in price. If the price were to fall from its current $P$ level to the competitive level of $P = MC$, then output would rise to the competitive level of $Q^C$. That is:

$$\eta = \frac{(Q^C - Q)/Q}{(P - MC)/P} \quad \Rightarrow \quad \frac{(Q^C - Q)}{Q} = \eta \frac{(P - MC)}{P} \tag{3.8}$$

Since we also know that the industry Lerner Index is $(P - MC)/P$, we can rewrite equation (3.7) as:

$$WL' = \frac{WL}{PQ} = \frac{1}{2}\eta(LI)^2 \tag{3.9}$$

Now recall from equation (3.4) earlier in the chapter that, for a pure monopolist, the Lerner Index is given by: $LI = (P - MC)/P = 1/\eta$. Then, in this case, the deadweight loss relative to industry sales will be:

$$WL' = \frac{WL}{PQ} = \frac{1}{2}\frac{1}{\eta} \tag{3.10}$$

That is, for the perfect monopoly case, the deadweight loss as a fraction of current industry sales is simply one-half the Lerner Index or one over twice the elasticity of demand. The intuition is that as the demand elasticity increases, the welfare loss shrinks because other goods are increasingly viewed as substitutes to the monopolized commodity. Note further the sensitivity of the welfare loss to the elasticity estimate. An estimate that $\eta = 1.5$ produces a welfare loss equal to 33 percent of revenue. An estimate of $\eta = 2$ reduces this amount to 25 percent of revenue. That is, a 0.5 change in the elasticity estimate yields an eight percent change in the welfare loss.

The first person to make calculations along the foregoing lines on a large scale was Arnold Harberger (1954). Using a sample of 73 manufacturing industries, Harberger (1954) took the departure of the five-year average industry rate of return from the five-year average for manufacturing overall as an approximation of $LI$. Because he worked with industry data, and because none of the industries was a pure monopoly, Harberger (1954) could not assume that his $LI$ estimate is the inverse of elasticity of demand, as we did in equation (3.10). Instead, he combined his $LI$ estimates with an assumed demand elasticity of $\eta = 1$ in equation (3.9). The dollar value of these estimated distortions is then given by multiplying $WL'$ by industry sales $PQ$. When Harberger (1954) added these dollar values up and extrapolated the results across the entire economy he found a surprisingly small welfare cost of monopoly—on the order of one-tenth of one percent of Gross Domestic Product. Currently, the budget of the Justice Department and the FTC is between one and two-tenths of one percent of GDP. While much of this is for activities other than antitrust enforcement, the low value of Harberger's (1954) estimate still raised a serious question about the cost-effectiveness of antitrust policy.

Harberger's (1954) approach however did not go uncriticized. Bergson (1973) noted that Harberger's (1954) procedure essentially used a partial equilibrium framework to obtain a general equilibrium measure. He demonstrated that, in principle, this could mean that Harberger's (1954) estimate considerably understated the actual loss. Cowling and Mueller

(1978) used firm-level data for 734 companies in the United States and 103 companies in the United Kingdom. The use of firm-level data means that Cowling and Mueller (1978) could apply equation (3.10) directly. Their estimated monopoly welfare costs range from four to thirteen percent of GDP in the U.S. and from four to seven percent in the U.K. These are considerably larger than Harberger's (1954) estimates.

An important source of variation in Cowling and Mueller's (1978) analysis is how advertising costs are treated in measuring *LI*. This calls attention to the importance of the marginal cost measure in general in determining welfare losses. This issue has been addressed more recently by Aiginger and Pfaffermayr (1997). They start by recognizing that without the pressure of perfect competition, firms can operate in an industry with different cost efficiencies. Hence, the average industry marginal cost $\overline{MC}$ is very likely not the minimum average cost that would be enforced if perfect competition were the rule. Aiginger and Pfaffermayr (1997) then make use of a result (one that we shall derive in Chapter 9) from a standard oligopoly model. The result is that the industry price-cost margin measure using $\overline{MC}$ is equal to the industry Herfindahl Index, denoted by $H$ (scaled from 0 to 1), divided by the elasticity of industry demand. That is:

$$\frac{P - \overline{MC}}{P} = \frac{H}{\eta} \quad \Rightarrow \quad \eta = H\left(\frac{P}{P - \overline{MC}}\right) \tag{3.11}$$

Substituting this result into equation (3.9), we obtain:

$$WL' = \frac{WL}{PQ} = \frac{1}{2}\left(\frac{P - MC}{P}\right)\left(\frac{P - MC}{P - \overline{MC}}\right)H \tag{3.12}$$

Note that the term $\left(\frac{P - MC}{P - \overline{MC}}\right)$ is greater than one because $MC$ is the marginal cost that would prevail under competition. Aiginger and Pfaffermayr (1997) measure this competitive $MC$ as the marginal cost of the most efficient firm in the industry under the assumption that this is the cost efficiency that would be required for competitive firms to survive. Effectively, their approach permits them to decompose the welfare cost of market power into two parts. One is the traditional welfare loss measure due to prices not equal to *industry* average marginal cost, $P - \overline{MC}$. The other is due to the fact that market power allows the survival of firms with higher than minimum costs, $\overline{MC} - MC$. Using data from 10,000 cement and paper firms in the European Union, Aiginger and Pfaffermayr (1997) find that the total welfare loss of market power in these industries is on the order of 9 to 11 percent of industry sales. Perhaps not surprisingly, they find that these welfare losses are largely due to the cost inefficiencies that imperfect competition permits. Thus, their estimate of the traditional welfare loss measure is on the order of 2 to 3 percent, while the cost inefficiency loss is on the order of seven to 7.5 percent. Extrapolating these estimates to the entire economy would yield results that are considerably closer to the Cowling and Mueller estimates (1978) than those obtained by Harberger (1954).

In evaluating all of these estimates it is useful to bear in mind two caveats (at least). First, an implicit assumption in all these calculations is that it is feasible to have perfect competition in all industries. As we shall see in the next chapter, however, costs and technology make this an unlikely outcome. In this sense, the estimates of welfare losses due to monopoly price distortions are too high as there is no way in which all industries could be freed of such market power. Second, the measures are taken from data in which active antitrust enforcement has been the norm. In this sense, the measures are an understatement of the potential for monopoly-induced welfare losses. Had there been no antitrust enforcement, there would have presumably been more market power abuses and the associated welfare losses would have been greater.

## Summary

This chapter has focused on the measurement of market structure and market power. We are very often interested in summarizing the extent to which an industry departs from the competitive ideal in a single number or index. The issue then becomes whether and how we can construct such a summary measure.

Concentration indices, such as the $CR_4$ or HHI, are explicit measures of a market's structure. Both look at firm shares as a fraction of the industry's total output. Both encounter important problems, such as the difficulty of accurately defining the relevant market. The HHI, however, is generally preferred by economists since it not only reflects the number of firms but also the differences in their relative sizes.

An explicit measure of market power is the Lerner Index. Since it is based on a comparison of price and marginal cost, this index directly addresses the extent to which the market outcome deviates from the competitive ideal. However, the need to measure marginal cost accurately, along with other measurement issues, makes the Lerner Index as difficult to employ as the structural indices. Estimates of the Lerner Index also serve as a useful starting point to estimate the actual efficiency costs of monopoly power. Many efforts have been made to do this for the entire economy in an attempt to get a general view as to how serious the problem of market power really is. These empirical studies have yielded a wide range of estimates of the aggregate deadweight loss as a percentage of gdp. The lower bound estimate is that monopoly power imposes only a small inefficiency cost of a few tenths of one percent of gdp. However, upper bound estimates range as high as 14 percent. A crucial parameter in such studies is the elasticity of demand assumed to be typical.

As long as the foregoing problems are recognized, the $CR_4$, HHI, and Lerner Index measures are useful starting points to characterize an industry's competitive position. However, an industry's degree of concentration and price-cost margin do not materialize out of thin air. Instead, these indices all derive from the interaction of a number of factors. One of those factors is the nature of production costs. The role of technology and cost play in shaping the industrial outcome is examined in the next chapter.

## Problems

1. The following table gives U.S. market share data in percentages for three paper product markets in 1994.

| *Facial tissue* | | *Toilet paper* | | *Paper towels* | |
|---|---|---|---|---|---|
| Company | % share | Company | % share | Company | % share |
| Kimberly-Clark | 48 | Procter&Gamble | 30 | Procter&Gamble | 37 |
| Procter&Gamble | 30 | Scott | 20 | Scott | 18 |
| Scott | 7 | James River | 16 | James River | 12 |
| Georgia Pacific | 6 | Georgia Pacific | 12 | Georgia Pacific | 11 |
| Other | 9 | Kimberly-Clark | 5 | Scott | 4 |
| | | Other | 16 | Other | 18 |

   a. Calculate the four-firm concentration ratio for each industry.
   b. Calculate each industry's H Index.
   c. Which industry do you think exhibits the most concentration?

2. An urban rapid-transit line runs crowded trains (200 passengers per car) at rush hours, but nearly empty trains (10 passengers per car) at off-peak hours. A management consultant argues as follows: The cost of running a car for one trip on this line is about \$50 regardless of the number of passengers. So, the per passenger cost is about 25 cents at rush hour but rises to \$5 in off-peak hours. Consequently, we had better discourage the off-peak business.

   Is the consultant a good economist? Why or why not?

3. Monopoly Air is the sole provider of passenger air service between Eldorado and Erewhon. It flies two flights per day in either direction with the typical flight being about 85 percent booked. A new entrant, Upstart Airways, has announced plans to offer additional service in the Eldorado–Erewhon market. However, Monopoly Air has filed a complaint with the local transportation authority arguing that it is a natural monopoly and that additional air service will only cause losses for both parties. As evidence, Monopoly Air cites the fact that, even now, its planes are not fully booked. Hence, it argues that the market is not large enough to sustain two, efficient-sized air carriers.

   Evaluate the argument put forth by Monopoly Air. What problems do you see in its logic? What information would you ideally like to have in order to determine whether or not this market is a natural monopoly?

4. We defined the Lerner Index $LI = 1/\mu$ where $\mu$ is the absolute value of the elasticity of demand. We also showed that $LI$ can be alternatively expressed as $(P - MC)/P$. Use these relationships to show that $LI$ can never exceed 1. What does this imply is the minimum demand elasticity we should ever observe for a monopolist?

## References


Aiginger and Pfaffermayr. 1997. "Looking at the Cost Side of Monopoly." *Journal of Industrial Economics* 44 (September): 245–67.

Bergson, A. 1973. "On Monopoly Welfare Losses." *American Economic Review* 63 (December): 853–70.

Cowling, K. and D. C. Mueller. 1978. "The Social Cost of Monopoly Power." *Economic Journal* 88 (December): 727–48.

Davies, S. W. and C. Morris. 1995. "A New Index of Vertical Integration: Some Estimates for U.K. Manufacturing." *International Journal of Industrial Organization* 13 (June): 151–78.

Domowitz, I., R. G. Hubbard, and B. Petersen. 1988. "Market Structure and Cyclical Fluctuations in Manufacturing." *Review of Economics and Statistics* 70 (February): 55–66.

Ellison, G. 1994. "Theories of Cartel Stability and the Joint Executive Committee." *Rand Journal of Economics* 25 (Spring): 37–57.

Elzinga, K. 1989. "Unmasking Monopoly Power: Four Types of Economic Evidence." In R. Larner and J. Meehan, Jr., eds., *Economics and Antitrust Policy*. Westport, CT: Greenwood Press.

Gort, M. 1962. *Diversification and Integration in American Industry*. Princeton: Princeton University Press.

Hall, R. 1988. "The Relation between Price and Marginal Cost in U. S. Industry." *Journal of Political Economy* 96 (October): 921–47.

Harberger, A. 1954. "Monopoly and Resource Allocation." *American Economic Review* 45 (May): 77–87.

Hovenkamp, H. J. 1994. *Federal Antitrust Law Policy: The Law of Competition and Its Practice*. St. Paul: West Publishing.

Porter, R. 1983. "A Study of Cartel Stability: The Joint Executive Committee, 1880–1886." *Bell Journal of Economics* 14 (Autumn): 301–14.

Sleuwaegen, L. and W. V. Dehandschutter. 1986. "The Critical Choice between the Concentration Ratio and the H-Index in Assessing Industry Performance." *Journal of Industrial Economics* 35 (December): 193–208.

Sleuwaegen, L., W. V. Dehandschutter, and R. DeBondt. 1989. "The Herfindahl Index and Concentration Ratios Revisited." *Antitrust Bulletin* 34 (Fall): 625–40.

Stocking, G. and W. Mueller. 1955. "The Cellophane Case and the New Competition." *American Economic Review* 45 (March): 29–63.