*Chapter 7*

# CARTELS, COLLUSION, AND HORIZONTAL MERGER

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## Contents



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## 1. Introduction

Problems of industrial structure and concentration have concerned economists and politicians for at least a century. During this period, attitudes towards cartels, mergers, and collusion have undergone many changes. Nevertheless, no consensus as to an appropriate policy for dealing with increasing concentration has emerged. Instead we see trends in antitrust policy and in academic thought which evolve in a desultory fashion.

In the last decade, these difficulties have grown. Economic thought concerning collusive practices and mergers has changed profoundly, mainly in the light of game-theoretic analysis. Unfortunately, this change has not led to more general and robust conclusions. On the contrary, it is the source of a more fragmented view. The diversity of models and results, which are very sensitive to the assumption selected, suggests a "case-by-case" approach where insight into the ways in which firms acquire and maintain positions of market power becomes essential. It is nevertheless important to bring to light a typology of situations and practices for which recent developments in economic analysis offer sounder theoretical characterizations than in the past.

In this chapter we attempt to highlight the principal theoretical and practical problems of the economics of cartels, collusion, and horizontal merger. Due to space limitations, not all issues can be covered in depth or given equal weight. Furthermore, because the new theoretical approaches are not easily modified to encompass welfare considerations, except in a very partial-equilibrium setting, the positive side of the analysis has received more weight than the normative. Where coverage is summary, the interested reader can make use of the references at the end of the chapter.

The organization of the paper is as follows. In Section 2 the principal factors that facilitate or hinder collusion are considered. This is an informal discussion of the circumstances under which one might expect cartels to be stable or collusive agreements to be long-lived.

Section 3 deals with types and extent of horizontal collusion. Under this heading, we cover both explicit agreement and tacit collusion. The principal forms of explicit agreement are cartels, joint ventures, and horizontal mergers. Even though in principle these are easily distinguishable legal or illegal arrangements, it is not always simple to separate the underlying economic theory into neat categories. For example, the same considerations that might lead to a merger being privately profitable might also lead to the formation of a successful cartel. The division of the subject-matter is therefore sometimes arbitrary. In each category – mergers, cartels, and joint ventures – we try to cover both theoretical models and empirical evidence. The subject of mergers is particularly broad and we limit outselves to horizontal mergers between firms in the same product market.

The subsection on tacit collusion is not a highly technical theoretical presentation, which can be found in Chapters 5 and 6 of this Handbook. Instead, we consider the tools that can be used as instruments for tacit collusion and the likelihood of such collusion being successful. Under empirical evidence, we limit ourselves to models that are dynamic and explicitly game theoretic.

Section 4 deals with collusion, public interest, and government policy. Under this heading, we first consider the problem of identifying collusive behavior; the emphasis here is empirical. Subjects covered include testing for deviations from price-taking behavior and the conclusions that can be drawn from firm bidding strategies. We next consider collusion and restriction of competition. In particular we discuss theoretical and empirical measurement problems encountered in defining the geographic and product market where restriction of competition occurred and in estimating the deadweight loss due to this restriction.

Section 4 also discusses efficiency tradeoffs. Because many of these issues are dealt with in other chapters, the coverage here is very summary. The subjects that are discussed include static economies of scale, scope, and product variety and dynamic efficiencies of learning and innovative activity. Finally, industrial policy is considered. The discussion centers on market failures and when such failures might call for government intervention or some form of planning.

## 2. Factors that facilitate or hinder collusion

Whether firms collude tacitly or overtly, legally or illegally, they face many problems. First, an agreement must be reached. Second, as soon as price is raised above the noncooperative level, firms have an incentive to cheat on the collusive arrangement. If the agreement is to persist, therefore, there must be methods of detecting cheating. And finally, once cheating is detected it must be punished. Each stage in the process has its own peculiar problems. In spite of the difficulties faced by firms, however, we do observe successful collusion.

This section discusses the factors that facilitate or hinder collusion. Our presentation borrows heavily from Stigler (1964), Scherer (1980), Gravelle and Rees (1980), Hay (1982), Cooper (1986) and Salop (1986).

### *2.1. Reaching an agreement*

Sellers who recognize their mutual interdependence will have an incentive to cooperate as long as the profit which each can obtain when acting jointly is higher than when they act independently. And in fact, in a static framework with costless collusion, firms can always do at least as well when colluding as when acting noncooperatively. This is true because the noncooperative solution is always a feasible collusive outcome.

Let us take the case of two quantity-setting sellers. Denote firm $i$'s output by $q^i$, cost function by $C^i(q^i)$, and inverse-demand function by $h^i(q^1, q^2)$, $i = 1,2$. Then each firm's profit, $\pi^i(q^1, q^2)$ is $h^i(q^1, q^2)q^i - C^i(q^i)$.

Successful collusion means locating on the profit-possibility frontier. This frontier is associated with the set of output pairs $(q^{1*}, q^{2*})$ which solve

$$\max_{q^1, q^2} \pi^1(q^1, q^2) + \lambda\left(\pi^2(q^1, q^2) - \bar{\pi}^2\right), \qquad \bar{\pi}^2 \in \left[0, \Pi^{\mathrm{M}}\right]. \tag{1}$$

Joint-profit maximization obtains when $\lambda$, which is endogenously determined, equals one.

When firms are symmetric, reaching an agreement is relatively easy. In this case the equilibrium will be symmetric with $q^{1*} = q^{2*} = q^{\mathrm{M}}$, $\pi^{1*} = \pi^{2*} = \pi^{\mathrm{M}}$, and the collusive profit $\pi^{1*} + \pi^{2*}$ will equal the monopoly profit $\Pi^{\mathrm{M}}$. In other cases, however, unless side payments are possible, joint-profit maximization may not be a reasonable goal. Reaching an agreement is therefore more difficult when firm heterogeneities are introduced.

Let us first consider the asymmetries already incorporated into equation (1): product and cost differences. With product heterogeneity, each firm will charge a different price and quantities sold will be measured in diverse units. Instead of agreeing on a single price or industry output, therefore, it becomes necessary to agree on a whole schedule of prices or outputs, thus multiplying the possible points of disagreement. When each firm produces a range of products, negotiations can be simplified by tying all product prices to the price of a prespecified product.

With cost heterogeneity, difficulties with the division of profits arise. If industry profit is maximized, industry marginal revenue is equated to each firm's marginal cost. When firms have different marginal cost curves, therefore, joint-profit maximization requires that firms produce unequal output, earn unequal profit, and may even require that some firms close down altogether.

One way of obtaining the consent of participants is to divide the market by customer or by geographic region. Unfortunately, this will not usually lead to joint-profit maximization or location on the profit-possibility frontier. Many other non joint-profit-maximizing outcomes are also possible. Because they involve complex bargaining problems, however, it is difficult to characterize the solution a priori. Outcomes will often depend on the bargaining strengths of the parties involved.

Although often difficult to administer and sometimes illegal, side payments can be the most effective way of obtaining an agreement in a situation of product and cost heterogeneity. Side payments can be analyzed in the context of the model expressed by equation (1) and illustrated in Figure 7.1.

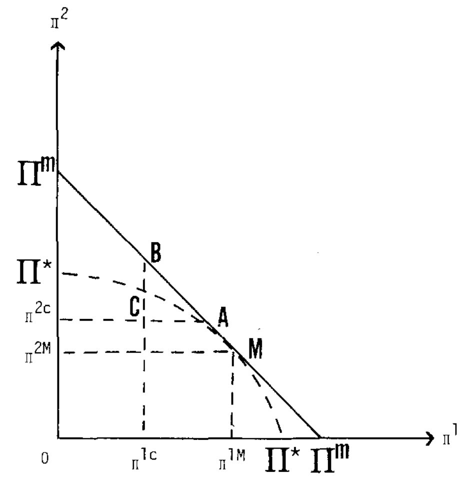


Figure 7.1. Possible collusive outcomes with and without side payments.

In the figure, firm 1's profit $\pi^1$ is on the horizontal axis and firm 2's profit $\pi^2$ is on the vertical axis. The dashed curve $\Pi^*$–$\Pi^*$ is the profit-possibility frontier without side payments. The point $M$ corresponds to the outputs that maximize joint profit $\Pi^*$. $M$ dominates all points within the rectangle $0\pi^{2M}M\pi^{1M}$, but not all feasible alternatives.

Indeed, suppose that the firms do not collude but adopt Cournot–Nash behavior. Let point $C$ represent the Cournot–Nash equilibrium with $\pi^{1C} + \pi^{2C} < \pi^{1M} + \pi^{2M}$. Without side payments, firm 2 will not accept the outcome $M$, given that it would lose $\pi^{2C} - \pi^{2M} > 0$. It is possible, however, for both firms to increase their profits simultaneously by agreeing to produce $q^{1M}$ and $q^{2M}$ and to divide the fruits of their joint action in such a way that firm 2, as well as firm 1, gains relative to its noncooperative prospect. This requires a side payment $S > 0$ from 1 to 2.

Let $\hat{\pi}^i$, $i = 1, 2$, denote the profit received by firm $i$, inclusive of side payments. The set of possible side payments $S$ from 1 to 2 defines a linear relationship:

$$\hat{\pi}^2 = \Pi^{\mathrm{M}} - \hat{\pi}^1, \tag{2}$$

which is represented in Figure 7.1 by the straight line $\Pi^{\mathrm{M}}$–$\Pi^{\mathrm{M}}$, the profit-possibility frontier with side payments. On this line, only the set of points on the segment $AB$ is acceptable to both firms. The exact point on the segment $AB$ that is chosen will depend on the relative bargaining strengths of the two firms.

The problem of reaching an agreement is still more delicate when one considers other types of asymmetry such as differences in preferences. For example, in a dynamic context firms may have different discount rates. In this case, they will disagree about the weights to be given to current and future profits. One firm may want to charge a high price, for example, even though entry is thereby encouraged, whereas the other may take a longer run view. Preferences can also differ about means of coordinating. For example, one seller may be willing to resort to illegal devices while the other may be only willing to collude tacitly.

Thus far, we have discussed situations where all information is known to all parties. If conditions in a market are stable and known with certainty, negotiations can be infrequent. Once uncertainty is introduced, however, agreements must be reached more often, thereby increasing negotiation costs. In addition, divergence of opinion about future conditions becomes likely. Firms can disagree about costs, demand, entry of rivals, and many other factors. Most important, these factors can make it impossible for firms to locate the profit-possibility frontier, a prerequisite for choosing a point on the curve.

Industries that are subject to rapid technical change find it particularly difficult to reach agreements. Technical change can introduce differences in product lines, production costs, and demand conditions. In addition, the pace and direction of innovation is difficult to predict.

Additional uncertainties are introduced when agreements cannot be overt, due to legal restrictions for example. In this case, firms must devise ways of signaling the need to change price or output. In the case of price-setting firms, a recognized price leader can be agreed upon or the price of a major input can be used as a focal point. These schemes may not lead firms to the profit-possibility frontier but may enable prices to remain above noncooperative levels.

Whenever a price must be raised, the firm to initiate the increase runs the risk of not being followed and therefore losing sales. One way to avoid this difficulty is to agree to give advance notice of price changes. In this way, by responding to one another's price announcements, firms can negotiate a new price through a series of iterations that involve no actual sales.

Our discussion thus far has centered around firms that collude on price or output. Firms, however, can choose from a rich set of nonprice instruments of rivalry, such as advertising, product quality, productive capacity, and R&D expenditure. Analysis of these alternate forms of collusion can be found in other chapters in this Handbook.

### 2.2. *Incentives to cheat*

Reaching an agreement is only the beginning of the process. When a collusive arrangement has been consummated, the mere fact that price is above the noncooperative level and that marginal revenue for a firm is greater than its marginal cost gives the firm an incentive to cheat. Unfortunately from the point of view of cartel stability, the more successful firms are at raising price, the greater is the incentive to chisel. A cartel therefore contains the seeds of its own undoing.

The incentive to increase output, or to cut price in the case of a price-setting cartel, will not be the same for all firms in an industry or for all industries. The elasticity of the individual-firm demand curve is an important factor affecting incentives: the greater this elasticity the greater the temptation to cut price and to increase sales. The firm-specific elasticities are affected by both the industry-wide elasticity and by the number and size distribution of firms. Very small firms are most apt to take price as parametric and therefore to expect large profits as a result of defection.

Both marginal and fixed costs can affect the profitability of cheating. When marginal costs rise steeply in the neighborhood of the collusive output, price cutting is less profitable. And when fixed costs are a high fraction of total costs, restricting output may result in excess capacity and therefore a temptation to cut price and increase market share.

Finally, if sales are large and infrequent or if detection lags are long, cheating is encouraged. Each of these factors implies that substantial increases in sales can be obtained from a single price cut and that cutting is therefore more profitable.

### *2.3. Detection*

Because incentives to cheat are pervasive, firms that enter into a collusive agreement must be able to detect secret price cuts or output increases initiated by rivals. In the following discussion we assume that price is the choice variable.

When price is not observable, firms may have to rely on the behavior of their own sales for detection purposes. If there are not many firms in a market, a secret cut by one firm causes a large fall in rival sales and will thus be noticeable. We therefore expect collusion to be more successful when sellers are few (but see Subsection 3.2.2 below).

Collusion should also be more successful when buyers are many. If the probability of detecting a single price cut, $\rho$, is independent of the number of cuts given, and if $n$ price cuts are given, the probability that cheating will be detected is $1 - (1 - \rho)^n$, which rapidly approaches one as $n$ increases.

Detection is also facilitated when sellers have more information about rival behavior. Information can be increased by individual firms getting together to pool sales information. This practice, however, may be frowned on by antitrust authorities. For this reason, firms may resort to trade associations for gathering and disseminating information.

Buyers can also be used to reveal price information. When price bids are open, prices are public knowledge. Under other circumstances, however, sellers may have to provide buyers with an incentive to reveal their offers. One method of doing this is to promise to match secret price cuts initiated by others.

Finally, an event that could happen by chance once is much less likely to be random if repeated. For this reason, temporal patterns of sales are more revealing than single-period information. When sales are frequent, therefore, detection is facilitated.

### *2.4. Prevention*

Detection by itself is not sufficient to deter cheating. It still remains necessary to punish the offender. Various forms of complex punishment strategies are discussed in the later sections on cartels and tacit collusion. Here we consider only practices facilitating prevention through self commitment and involving contractural arrangements or sales strategies.

In an attempt to deter cheating, virtually any punishment can be threatened. For example, a firm can announce that if cheating is detected it will cut price below average cost until the cheater is driven out of the market. Such a threat, however, may not be credible. If called upon to carry out the punishment, it might not be in the firm's best interest to do so. Announced punishments must therefore be credible if they are to deter.

It has long been recognized that threats can be made credible through precommitment. If a firm has no choice but to carry through with its threatened action, a punishment is believable. In the present context, precommitments can be achieved through the use of long-term contracts with buyers. We discuss contractual arrangements that have binding effects.

Some contractual clauses make defection more costly to sellers and are thus forms of self punishment. And others commit rival sellers to punishing defectors. One form of clause that is frequently found in contracts, the "most favored customer" clause, assures a buyer that if the seller ever gives a lower price to another buyer he will (retroactively) give the same cut to the buyer with the clause. The seller thus ties his own hands and makes it virtually impossible to cut price.

Another form of clause, the "meet or release" clause, assures a buyer that if a rival seller offers him a lower price, the seller with the contract will either match the price or release the buyer from the contract. The buyer is thus given an incentive to reveal lower offers. Many contracts do not include the release part of the clause. When this is true, the seller has again tied his own hands and committed himself to punishing his rivals by matching their price cuts.

It might be asked why buyers are willing to accept such clauses in their contracts if the end result is to raise their own costs. The answer is that each buyer individually values the clause but when all buyers accept such clauses, all are made worse off.

Similar precommitment can be achieved even when there are no long-term contracts. For example, many department stores offer to "meet competition". They guarantee that if a buyer can find a better price for the same item elsewhere, the lower price will be matched. The effect of this practice is very similar to a "meet or release" contractual arrangement.

An illustration of the effect of a "meet" clause (excluding the release option) is based on the simplest $2 \times 2$ structure for the prisoner's dilemma. Let us assume a duopoly, where each player can choose to charge the monopoly price $p^{\mathrm{H}}$ or a lower price $p^{\mathrm{L}}$. When both charge $p^{\mathrm{H}}$, each earns half the monopoly profit or 10, and when both charge $p^{\mathrm{L}}$ a lower profit of 5 is earned. However, when one charges $p^{\mathrm{H}}$ while the other charges $p^{\mathrm{L}}$, the low-priced producer captures most of the market and earns 12 whereas the high-priced producer earns only 3. This game is summarized by the following payoff matrix:

| | Player II | |
|---|---|---|
| Player I | H | L |
| H | (10, 10) | (3, 12) |
| L | (12, 3) | (5, 5) |

where $(\cdot, \cdot)$ denotes payoffs to players 1 and 2, respectively.

This game has a single noncooperative or Nash equilibrium, the dominant strategy $(p^{\mathrm{L}}, p^{\mathrm{L}})$. In this case, the Nash outcome is not Pareto optimal; both players would be better off if they could commit themselves to playing $p^{\mathrm{H}}$. Without commitment, however, each has an incentive to undercut.

The use of a meeting competition clause restructures the payoffs of the duopolists so as to facilitate the achievement and maintenance of the cooperative outcome. If each rival must meet the other's offer, the off-diagonal price pairs are unattainable. Given the remaining alternative, neither duopolist wishes to deviate from the Pareto optimal price pair $(p^{\mathrm{H}}, p^{\mathrm{H}})$.

### *2.5. Evidence*

Empirical tests of factors that facilitate or hinder collusion are of two sorts: econometric and experimental. In a series of experiments, Grether and Plott (1981) compare the pricing performance of an industry with and without certain types of contractual clauses, advance notice of price changes, and public price posting. They find that the combination of these practices is sufficient to raise price significantly above the level observed when the practices are removed.

Other experimental results suggest that the predictive power of the joint-profit-maximization assumption tends to vanish with a reduction of information about other agents' actions and with an increase in the number of firms [Friedman and Hoggatt (1980) and Plott (1982)].

Econometric tests have been undertaken by Hay and Kelley (1974) and by Jacquemin, Nambu and Dewez (1981). Hay and Kelley examine price-fixing cases handled by the U.S. Department of Justice in an attempt to determine what factors affect the likelihood of conspiring. They find that most cases involve ten or fewer firms and that when large numbers conspire, a trade association is almost always implicated. In addition, product homogeneity is found to significantly increase the probability of forming a conspiracy.

Finally, Jacquemin, Nambu and Dewez construct a dynamic model of the optimal lifetime of a cartel and test it using data on Japanese export cartels. Again, product homogeneity is found to be a factor that leads to longevity. In addition, cartels that involve the domestic as well as the export market are seen to be more successful. Overall, therefore, the empirical evidence is in substantial agreement with our a priori intuition.

## 3. Types and extent of horizontal collusion

### 3.1. *Explicit agreement*

Horizontal collusion can be explicit or it can be tacit. In this subsection we examine the principal forms of explicit agreement whereas Subsection 3.2 deals with tacit collusion.

There exists an entire spectrum of cooperative arrangements that fall between the poles of arm's-length interaction in a market and complete merger of assets. Public and private gains associated with these arrangements have to be measured relative to the alternatives available. These include colluding in the same fashion with a different firm and not forming a coalition at all but performing the functions internally or relying on the market. In addition, it is possible to enter into a different type of coalition, for example a joint venture instead of a licensing agreement or a merger instead of a joint venture.

We limit our analysis to three modes of formal cooperation, starting with the most flexible, a cartel, to the most complete, a merger, with, in between, the case of joint venture. To avoid confusion, we assume that a cartel is formed when a group of independent firms join forces to make price or output decisions.[1] This arrangement can be legal or illegal. In contrast, a joint venture occurs when two

[1]A cartel is distinguished from pure tacit agreement by the fact that participants meet to communicate and to select strategies.

or more independent firms join together to form a third firm – the joint venture – which one or several of the parents manage. The parent firms cooperate only through the venture. Finally, a merger between two or more firms occurs when their assets are combined. In this case, the constituent firms lose their independent identities and act as a unit.

### 3.1.1. Cartel arrangements

The principal problems facing a cartel are choosing a point on the contract surface, detecting deviations from the agreed-upon point, deterring such deviations, and limiting entry by outsiders. The problems involved in reaching agreement and in detecting cheating were discussed in the previous section. Here we deal with punishment strategies in greater detail and consider the conditions under which there exist stable cartels. The problem of entry is touched upon very briefly; those wishing more details are referred to Chapter 8 in this Handbook.

As we saw in Subsection 2.2, when a cartel is formed each participant may have an incentive to break away. By becoming a member of a price-taking fringe, for example, the defecting firm can free ride and increase its profit [Patinkin (1947), Bain (1948), and Stigler (1950)]. Strategies that deter defection must therefore be devised.

One of the first rigorous treatments of the issue of punishment is by Orr and MacAvoy (1965). They consider the problem faced by symmetric firms that choose price to maximize profit subject to linear demand and cost conditions. Lags in the dissemination of price information imply that individual firms have an incentive to undercut the agreed-upon price. To deter cheating, loyal firms must adopt punishment strategies.

Orr and MacAvoy consider two classes of strategies: exact matching of price cuts and choosing price to maximize the profit of loyal-member firms in the presence of cheating. Let us examine the first strategy.

In deciding whether to cheat, given that others will follow, the potential cheater must compare the present value of his profit stream when collusion is sustained at the collusive price $p^*$ to the present value when he defects. Let his single-period collusive profit be $\pi^*$. The present value of this stream is then

$$PV^* = \pi^*/r, \tag{3}$$

where $r$ is the discount rate.

Suppose that the detection lag is $\tau$. When the defector chooses a price $p^{\mathrm{d}} < p^*$, he receives a single-period profit $\hat{\pi}(p^{\mathrm{d}})$ for $\tau$ periods (corresponding to his own price of $p^{\mathrm{d}}$ and rival prices of $p^*$) and a profit of $\pi^{\mathrm{d}}(p^{\mathrm{d}})$ thereafter (corresponding to everyone charging $p^{\mathrm{d}}$). The present value of this stream is therefore

$$PV^{\mathrm{d}}(p^{\mathrm{d}}) = \{(1 - \mathrm{e}^{-r\tau})\hat{\pi}(p^{\mathrm{d}}) + \mathrm{e}^{-r\tau}\pi^{\mathrm{d}}(p^{\mathrm{d}})\}/r. \tag{4}$$

The cheater will choose $p^{\mathrm{d}}$ to maximize (4). Let $p^{\mathrm{d}*}$ be this maximized value.

To determine if cheating is profitable, we calculate the detection lag $\bar{\tau}$ that causes the cheater to just break even. This means that (4) with $p^{\mathrm{d}}$ replaced by $p^{\mathrm{d}*}$ is equated to (3) and solved for $\bar{\tau}$. Then, for all lags greater than $\bar{\tau}$, cheating pays. Orr and MacAvoy show that the potential defector is indifferent to remaining loyal only when $\tau = 0$. That is, when detection is instantaneous, $p^{\mathrm{d}*}$ equals $p^*$; in all other cases, however, price matching does not deter and defection pays.

In contrast, if the cartel adopts the second strategy and sets its price to yield the maximum profit for the loyal cartel members, given that a cheater is maximizing its own profit in the face of the cartel policy, cheating is deterred. In this case, both loyal members and the cheater have linear reaction functions which intersect at positive prices, and both equilibrium prices are lower than $p^*$.

Another approach to punishment is taken by Osborne (1976), who looks at possible strategies that a quantity-setting cartel of $n$ firms can use to deter cheating. Osborne's model is illustrated in Figure 7.2 for $n$ equal two. Firm outputs are shown on the axes and the line $C$–$C$ is the contract curve – the best that any one firm can do, given its rival's profit. The curves marked $\pi_j^i$ are isoprofit contours for firm $i$, where $j < j'$ implies that $\pi_j^i > \pi_{j'}^i$.

Suppose that the point $q^* = (q^{1*}, q^{2*})$ of joint-profit maximization has been chosen. If seller 1 considers his rival's output to be fixed at $q^{2*}$, he will increase his own output to $q^{1D}$ (point $D$). Firm 2, therefore, must devise a punishment

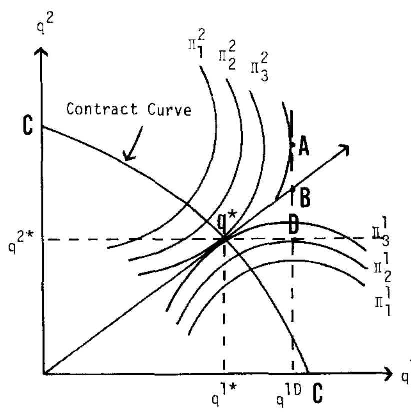


Figure 7.2. Maintaining market share can inhibit cheating.

to deter such cheating. Osborne shows that when one member cheats and increases output, if the other reacts so as to maintain market shares (moving to the point $B$) cheating is deterred. This is true because the line joining the origin and $q^*$ (the line corresponding to maintaining the market shares implied by $q^*$) is orthogonal to the gradient of each firm's profit function. As long as both firms know that they will always move along this line, they also know that cheating cannot increase profit.

A problem with the Osborne paper is that retaliation is assumed to be instantaneous. As Orr and MacAvoy demonstrated, however, detection lags make a difference. We saw that cheating is deterred in the Orr and MacAvoy paper as long as retaliation is instantaneous, but not when lags are introduced.

An additional problem is that Osborne's strategy is in general not credible or subgame perfect in the sense of Selten (1975).[2] Given that firm 1 is producing $q^{1D}$, firm 2 would be better off choosing the larger output associated with point $A$, where its isoprofit curve is tangent to the line $q^1 = q^{1D}$. And if the model were dynamic, this process would continue until Cournot–Nash outputs were reached.

In a comment on Osborne, Rothschild (1981) identifies precise conditions under which the quota rule will work in a static model. He shows that the successful application of Osborne's rule depends crucially on the number of firms in the cartel, its initial output level, and the size of the increase of the cheater's output.

From our discussion it should be obvious that without binding contracts cartel problems are very similar to those encountered by tacitly colluding firms. That is, collusion must be supported by noncooperative equilibrium strategies. Credible noncooperative strategies are discussed at greater length in Subsection 3.2 where repeated games are introduced.

Here we suppose instead that firms in a cartel give up trying to punish and simply let defectors form part of a price-taking fringe. Will any members remain in the cartel or will the industry become competitive? This is the problem addressed by d'Aspremont, Jacquemin, Jaskold-Gabszewicz and Weymark (1983) (hereafter DJGW) in the context of $n$ identical firms, $k \leq n$ of which participate in a price-setting cartel. When the cartel is formed, both cartel, and fringe members benefit. The problem is that fringe members benefit more. Firms in the cartel may thus be tempted to drop out and free ride.

DJGW define alternative notions of stability. Let $\pi^c(k)$ and $\pi^f(k)$ be the single-period profits that cartel and fringe members receive, respectively, when there are $k$ firms in the cartel. A cartel is said to be internally stable if, when a member leaves, its departure depresses price sufficiently so as to make defection

[2]A strategy is subgame perfect if at each decision point the induced strategy is Nash for the remaining game or subgame. The concept of subgame perfection was introduced in order to exclude the possibility that disequilibrium behavior is prescribed on unreached subgames.

unprofitable. Formally, a cartel is internally stable if

$$\pi^{f}(k-1) \leq \pi^{c}(k). \tag{5}$$

A cartel is said to be externally stable if, when a fringe firm joins, the resulting price increase is insufficient to compensate for the higher profit that could be earned by free riding. Formally, a cartel is externally stable if

$$\pi^{c}(k+1) \leq \pi^{f}(k). \tag{6}$$

A cartel is said to be stable if it possesses both internal and external stability. DJGW then show that with a finite number of firms, there always exists a stable cartel. With a continuum of firms, in contrast, a stable cartel does not exist.

The intuition behind their result is as follows. With a continuum of firms, each one has a negligible impact on price and profit and can thus ignore the effect of its entry and exit. Under these conditions, everyone free rides. With a finite number of firms, in contrast, profits change discretely with entry and exit and it never pays the last firm to drop out.

Building on DJGW, Donsimoni (1985) examines the impacts of variations in cost and demand conditions on the structure of the stable cartel. In the Donsimoni model, demand and cost functions are linear and costs vary across firms. As before, with a finite number of firms there always exists a stable cartel. In addition, the members of the stable cartel are the efficient firms (those with low costs). Finally, the size of the cartel is a decreasing function of the industry elasticity of demand.

The DJGW and Donsimoni papers assume that the cartel's objective is joint-profit maximization. Schmalensee (1985), however, points out that with cost asymmetries and in the absence of side payments, maximization of industry profit may not be a reasonable objective. Using the tools of cooperative bargaining theory to determine possible outcomes, he shows that a leading firm with a significant cost advantage is unlikely to join a cartel. His result obtains because noncooperative behavior yields the low-cost firm approximately its monopoly profit.[3]

In all the papers considered thus far, the number of firms in or outside the cartel is fixed at $n$. Selten (1984) considers the consequences of free entry. In general, joint-profit maximization permits a greater number of competitors in a market than noncollusive behavior. There are thus two forces at work. Collusive behavior leads to higher industry profit, which induces entry. And entry in turn depresses profit. Selten shows that under reasonable assumptions on demand and

[3]Other cartel-stability papers include Kobayashi (1982), d'Aspremont and Jaskold-Gabszewicz (1985), Donsimoni, Economides and Polemarchakis (1986), Ayres (1986), and Economides (1986).

cost, industry-wide profit can be increased when collusion is forbidden. Collusive behavior thus leads to both lower concentration and to lower profitability, violating our usual notions about structure–conduct–performance.

If, as in the Selten model, cartels are bad for business, we must ask ourselves why they exist. One possible answer is that firms are myopic and do not bind their own hands by, for example, lobbying for anticartel laws. Another possible explanation is that a large fraction of successful cartels are in industries where entry is difficult. This situation is typified by firms extracting an exhaustible resource. In order to extract, firms must possess reserves. Not only is the stock of reserves finite, in addition, many minerals occur in discrete deposits. When this is true, the number of potential firms is automatically limited.[4]

Most natural-resource cartels are legal organizations whose members are exporting countries. Many other forms of cartels have also been temporarily successful, ranging from firms that participate in criminal price-fixing agreements to groups of firms that adopt practices that are not illegal per se, but have the effect of keeping price above noncooperative levels. Three illustrative cases are discussed here.

The classic case of a price-fixing agreement is the electrical-equipment conspiracy of the 1950s. It involved at least 29 U.S. companies selling heavy electrical equipment. The conspiracy consisted of meetings to fix prices on standardized items as well as pricing formulas for custom products. In addition, shares of all sealed bids were assigned to each company. Some of these arrangements were very complicated. For example, a "phases of the moon" system was used to allocate low-bidding privileges. In spite of these arrangements, agreeing parties chiseled repeatedly and even touched off price wars, illustrating the difficulties of making a collusive agreement stick [Smith (1961)].

A somewhat intermediate situation is illustrated by the U.S. tobacco case of 1946. Tobacco producers were convicted of illegally conspiring to fix prices, even though the evidence was purely circumstantial. Evidence such as patterns of strikingly parallel pricing and purchasing behavior was used to sustain criminal charges. No formal agreement was ever detected [Nichols (1949)].

At the opposite extreme from the electrical-equipment conspiracy is the case brought by the U.S. Federal Trade Commission against the manufacturers of lead-based gasoline additives. Not only were no criminal charges brought, intent to conspire was not even claimed. The companies were charged with using practices such as advance notice of price changes and public announcements of prices that had the effect of raising price. This was thus a case of pure tacit collusion and signaling [F.T.C. (1981)].

[4]The literature on exhaustible-resource cartels is large. Many new dynamic issues are introduced by the intertemporal nature of the maximization problem. These include complex forms of strategic behavior, dynamic inconsistency, and open versus closed-loop solution concepts. These issues are discussed in Jacquemin and Slade (1986) and the references therein.

Whether a cartel is legal or illegal, there are natural forces that tend to reduce profitability. For example, high profits invite entry and defection by members causes instability which can eventually lead to breakdown. It is natural to ask, therefore, if cartelized industries are in fact more profitable than average.

The results from investigations into this question are mixed. For example, Asch and Seneca (1976) using U.S. data on firms that were convicted of conspiracy, find that collusive firms are considerably less profitable than noncolluders, whereas Phillips (1977), using U.K. data on trade associations, finds that effective price fixing has a weak positive effect on price–cost margins. If the Asch and Seneca results are believed, it could mean that Selten (1984) is correct – cartels are bad for business. However, it could merely mean that attempts at price fixing are more apt to be undertaken or detection is facilitated in industries where profits are falling.

### *3.1.2. Corporate merger*

The corporate merger is the ultimate form of collusion; when two firms merge, they cease to have separate identities and act thereafter as a single unit. Many motives have been advanced for the prevalence of merger activity and they differ according to its horizontal, vertical, or conglomerate nature.

In this chapter we are principally interested in the horizontal merger, the most troubling form from a policy point of view (due to its effect on concentration) and the one that is subject to the closest scrutiny from antitrust authorities. The reason for economists' concern with horizontal combinations can best be seen by exploring the relationship between industry concentration and pricing policy.

Contrary to what has sometimes been argued, it is possible to derive a relationship between an index of monopoly power such as the Lerner (1933–34) index and an index of concentration such as the $k$-firm concentration ratio, the Hirschman (1945, 1964)–Herfindahl (1950) (hereafter HH) index, or the entropy index. Derivations of this sort can be found in Saving (1970) and Cowling and Waterson (1976).

Consider an industry with $n$ firms producing a homogeneous product. Let $p = h(\sum_i q^i) = h(Q)$ be the inverse demand function, where $p$ is price, $q^i$ is the output of the $i$th firm, and $Q$ is industry output, and let $C^i(q^i)$ be total-cost functions. Each firm chooses $q^i$ to maximize profit

$$\max_{q^i} h(Q)q^i - C^i(q^i). \tag{7}$$

The first-order conditions for this maximization are

$$q^i\left(\partial h/\partial q^i + \sum_{j \neq i} \partial h/\partial q^j\, \partial q^j/\partial q^i\right) + p - MC^i = 0, \quad i = 1,\ldots,n, \tag{8}$$

where $MC^i$ is firm $i$'s marginal cost. Let $\varepsilon$ be the industry price elasticity of demand, $-(\partial Q/\partial p)(p/Q)$; $s^i$ be firm $i$'s market share, $q^i/Q$; and $r^{ji}$ be firm $i$'s conjecture about firm $j$'s response to a unit output change initiated by $i$, $\partial q^j/\partial q^i$. Algebraic manipulation of equation (8) yields:

$$\begin{aligned} L^i = (p - MC^i)/p &= (s^i/\varepsilon)\Big(1 + \sum_{j \neq i} r^{ji}\Big) \\ &= (s^i/\varepsilon)(1 + R^i), \end{aligned} \tag{9}$$

where $L^i$ is the Lerner index for firm $i$ and $R^i = \sum_{j \neq i} r^{ji}$ is $i$'s conjecture about the response of industry output to a unit output change on $i$'s part.

Equation (9) shows the familiar relationship between firm $i$'s price–cost margin, its market share, its conjecture, and the industry price elasticity of demand. To obtain a comparable relationship for the industry as a whole, (9) must be aggregated. Encaoua and Jacquemin (1980) show that when different firm-specific weights $w^i$ are used in the aggregation of (9), different indices of concentration emerge. Suppose, for simplicity, that $R^i = R$ for all $i$. Then if

$$w^i = \begin{cases} 1, & \text{for } i = 1, \ldots, k \text{ and } 0 \text{ for } i = k+1, \ldots, n, \\ s^i, & \\ \log_a s^i, & a > 1, \end{cases} \tag{10}$$

where firms are arranged in order of decreasing size, the corresponding aggregate price–cost margins $\bar{L}$ are

$$\bar{L} = \sum_i w^i L^i = \begin{cases} C_k(1 + R)/\varepsilon, \\ C_{\mathrm{H}}(1 + R)/\varepsilon, \\ C_{\mathrm{E}}(1 + R)/\varepsilon, \end{cases} \tag{11}$$

respectively, where $C_k$ is the $k$-firm concentration index, $\sum_{i=1}^{k} s_i$; $C_{\mathrm{H}}$ is the HH index, $\sum_{i=1}^{n} (s^i)^2$; and $C_{\mathrm{E}}$ is the entropy index, $\sum_{i=1}^{n} s^i \log_a s^i$.

Equation (11) shows how aggregate price–cost margins are related to standard indices of concentration, where the indices are determined by the aggregation scheme. It is obvious from (11) that $\bar{L}$, which is a measure of the output-market distortion, is directly related to industry concentration and to firm $i$'s conjecture and is inversely related to the industry price elasticity of demand.

A horizontal merger can thus affect industry price–cost margins in two ways: through the concentration index and through the conjectured response. It is often assumed that with fewer firms, behavior becomes more collusive ($R$ increases).[5] When this is the case, the two effects of a horizontal merger work in the same direction to increase the output-market distortion.[6]

The analysis thus far has been static. Pindyck (1985) defines an instantaneous Lerner index for dynamic markets and shows how it can be aggregated over time. A dynamic market is one in which price and output are determined intertemporally. Examples include markets for exhaustible resources and markets where learning effects, adjustment costs, or lags in demand are important.

The underlying feature of these markets is that full marginal cost, $FMC$, includes marginal user cost as well as marginal production cost, where marginal user cost is the present value to price-taking firms of future profit forgone due to an increase in output today. Marginal user cost is thus positive in exhaustible-resource markets and negative when learning occurs. $FMC$ is evaluated at the oligopoloy output level.

Pindyck defines the instantaneous Lerner index $L^*$ as

$$L_t^* = (p_t - FMC_t)/p_t = 1 - FMC_t/p_t. \tag{12}$$

The conventional Lerner index thus overstates the extent of monopoly power in exhaustible-resource markets, whereas it understates power in markets with learning.

To obtain a time-aggregate index, $I_{\mathrm{m}}$, (12) is weighted by expenditure and integrated to yield:

$$I_{\mathrm{m}} = 1 - \left( \int_0^\infty \mathrm{e}^{-rt} FMC_t Q_t \,\mathrm{d}t \Big/ \int_0^\infty \mathrm{e}^{-rt} p_t Q_t \,\mathrm{d}t \right). \tag{13}$$

This index describes the monopoly power of a firm looking into the future from a particular point in time. It will of course change with different choices of $t = 0$. $I_{\mathrm{m}}$ equals zero when the industry is competitive and increases as price deviates from full marginal cost.

Equation (13) gives the index of monopoly power for a single firm. It can be aggregated in one of several ways to obtain an industry-wide index and in general will be positively related to industry concentration.

[5]A recently proposed measure of aggregate power in organization is directly based on the ability of agents to induce a change of regime through coalition formation. The formula is the sum, taken over all possible coalitions, of the product of two probabilities for each coalition: its probability to form and its probability to become winning [d'Aspremont et al. (1987)]. In the framework of oligopoly theory, this index is viewed as the probability that a given coalition of firms will be able to induce a shift from a competitive to a noncompetitive regime [s'Aspremont and Jacquemin (1985)].

[6]When firms produce multiple products, some of which are substitutes and others complements, the calculation of an index of market power is more complex. With these complications in mind, Encaoua, Jacquemin and Moreaux (1986) derive an index of global market power for diversified firms.

So far we have assumed that the equilibrium relationship involves concentration and price. Nothing has been said about the effect of concentration on cost. There are two schools of thought on this subject. The first claims that high concentration, at least when monopoly power is protected, leads to higher costs and to what Leibenstein (1966) calls $X$-inefficiency. And the second maintains that the causality runs the other way. Low-cost firms increase their market shares at the expense of less efficient firms. As a result, low-cost firms have large market shares and high concentration is a mark of efficiency [Demsetz (1973) and Peltzman (1977), for example].[7]

Unless $X$-inefficiency is the predominant effect, however, increased concentration through merger tends to increase total industry profit and profit per firm. Nevertheless, it is not at all clear that the acquiring firm benefits from its efforts. This problem was recognized long ago by Stigler (1950) who noted that the promoter of a merger might expect to receive every form of encouragement from other firms, short of participation.

Recently, there has been a resurgence of interest in the subject of the private profitability of participating in a merger. We therefore conclude our theoretical analysis of horizontal merger with a discussion of these articles.

There are many reasons why mergers need not be privately profitable. For example, Dowell (1984) notes that when there are industry-specific nonsalvageable assets, it is possible for pre- and post-merger industry price and output to be the same. In this case, a merger does not result in increased profits, either for the industry as a whole or for the firms in the industry.

The intuition behind Dowell's result is illustrated in Figure 7.3. When there are nonsalvageable assets, the marginal cost of output expansion ($LRMC$) is greater than the cost reduction due to output contraction ($SRMC$). The firm's marginal-cost curve therefore has a discontinuity at the pre-merger (competitive) output level, $Q^c$. At this point, pre-merger price is determined by the intersection of demand and long-run marginal cost. After the merger, price is determined by the intersection of marginal revenue, $MR$, and short-run marginal cost. Even though the marginal-revenue schedule lies below the demand schedule $D$, it may cut the marginal-cost curve at its point of discontinuity and thus result in the same price/output combination. The result is a sort of "kinked supply curve" that leads to rigid prices for many demand schedules. Under these circumstances, firms have little incentive to merge. And even when the outcome of a merger is an increased price, nonsalvageable assets are a restraining factor.

[7]A complementary argument in favor of concentration through mergers is based on the idea of a market for corporate control [Manne (1965)]. According to this theory, failure to maximize profit reduces stock prices below their potential value, inducing takeovers and the replacement of old with new, more efficient managers. Empirical studies, however [see for example, Singh (1971)], suggest that it is unlikely that the reorganization that occurs after takeover leads to more profitable utilization of assets.

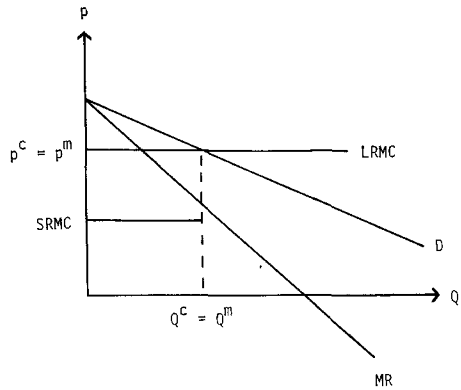


Figure 7.3. The effect of nonsalvageable assets on the post-merger outcome.

Using a completely different approach, Salant, Switzer and Reynolds (1983) (hereafter SSR) notice the curious fact that the effect of horizontal merger on a Cournot–Nash industry equilibrium can be to increase industry profit while at the same time reducing the profitability of the merged firms below the sum of their premerger profits. They consider the case of symmetric oligopolists facing linear demand and cost conditions (constant marginal costs). Under these assumptions, industry equilibrium is symmetric with each firm producing the same output and earning the same profit.

Suppose that there are initially $n$ firms and that each earns $\pi(n)$. When two firms merge, it will surely be the case that

$$\pi(n) < \pi(n-1) \tag{14}$$

and

$$n\pi(n) < (n-1)\pi(n-1). \tag{15}$$

These are standard conditions stating that the profit of each firm as well as total industry profit increases as the number of firms is reduced.

Under reasonable conditions on demand and cost, however, it can also be the case that

$$\pi(n-1) < 2\pi(n). \tag{16}$$

What equation (16) says is that the profit to the single merged firm can be less than the sum of the pre-merger profits of its constituent firms.

Notice that this is not a dominant-firm/competitive-fringe model. There are no price takers. In the new equilibrium, each firm shares the output restriction equally. The peculiar result obtains because there is nothing to distinguish the merged firm from the $n - 2$ nonmerged firms. In the new symmetric equilibrium, therefore, all firms produce $1/(n - 1)$ of the industry output.

This model, however, violates our intuitive notions of what a merger is all about. If we start with $n$ identical firms and two merge, we expect the result to be $n - 2$ small old firms and one large new firm. Deneckere and Davidson (1985), and Perry and Porter (1985), by introducing different notions of size, reverse the SSR results.

Deneckere and Davidson consider the case of price-setting firms producing differentiated products. In their model, when firms merge the merged firm can continue to manufacture the entire product line of each constituent firm. For example, if we start with $n$ firms each producing a single product, after a merger between two firms the new firm produces twice as many products as the remaining firms in the industry. Under these assumptions, the SSR results can be reversed.

Perry and Porter choose a different route. In their model, each firm has some fraction of a tangible asset $K$, whose total supply is fixed at one. When two firms merge, the newly created firm controls the assets belonging to each of its constituents. It is assumed that the long-run technology is subject to constant returns but that, due to the presence of the fixed factor $K$, each firm's short-run marginal-cost curve is upward sloping. A large firm (one with more $K$) can therefore produce the same output at lower cost than a small firm.

Two cases are considered, a dominant-firm/competitive-fringe model and an oligopoly with large and small firms. The results from the first model are very similar to those obtained by d'Aspremont, Jacquemin, Jaskold-Gabszewicz and Weymark (1983). For example, Perry and Porter find that there is always an incentive for a dominant firm to form. Whether or not additional firms merge depends on the precise demand and cost parameters. In general, however, there will be an equilibrium number of merged firms – a stable cartel.

The second model is closer to SSR. With increasing marginal costs, however, the incentive to merge usually remains. In fact, the SSR model is essentially the limiting case of the Perry and Porter model which obtains as the marginal-cost curve flattens.

There are thus many theories that can explain the stylized facts. Mergers can be unprofitable because they do not increase monopoly power, because they do not improve efficiency, or because, although they enhance monopoly power, this effect is more than compensated for by various forms of internal inefficiency, including managerial and financial aspects. With this perspective in mind, it is useful to turn to empirical studies for further insights. They are numerous and concern two main issues.

The first is the effect of mergers on aggregate and industrial concentration. In the United States, until the Celler–Kefauver antimerger act of 1950, horizontal mergers were dominant and are often viewed as having led to substantial increases in both overall and industrial concentration [Stigler (1950), Markham (1955), Weiss (1965)]. According to a study by McGowan (1965), concentration would not have risen at all in the 1950s if no mergers had been undertaken. The merger movement of the 1960s, however, was very different as it was conglomerate in nature. Although this new wave did not cause important increases in industrial concentration, it did contribute to maintaining a high level of aggregate concentration. It can indeed be argued that although overall concentration held more or less steady during much of the 1960s [White (1981)], the fact that acquiring firms were on average much larger than other companies implies that internal growth rates of the largest companies were less than the growth in assets for the manufacturing sector as a whole. According to Mueller (1972), the latter is what one expects if the largest companies are in the mature phase of their life cycle. In the 1970s and 1980s, merger activity has continued and it seems that aggregate concentration is again rising.

In Europe, the post World War II period was characterized by merger waves of impressive proportions. In the absence of significant antimerger laws, horizontal mergers remained dominant and transformed the corporate economy of Europe in the 1960s. With the exception of petroleum, the largest European firms are now of comparable size to the largest in the United States, and both are significantly larger than their Japanese counterparts. As a consequence, overall concentration has increased markedly. Between 1953 and 1970, the share of net U.K. manufacturing output supplied by the hundred largest firms rose from 27 to 40 percent [Hannah and Kay (1976)]; similar results occurred in France, Germany, Sweden, and in the Netherlands. For the EEC as a whole, sales of the 50 largest firms relative to gross industrial output increased from 15 percent in 1965 to 25 percent in 1976 [Jacquemin and Cardon (1973), Locksley and Ward (1979)]. Finally, although mergers were not the sole cause of increased concentration in European industries, they were a crucial factor. Estimations of industrial-concentration-ratio changes attributable to mergers in U.K. industrial sectors [Utton (1972), Aaronovitch and Sawyer (1975), Hannah and Kay (1976), Hart (1979), Prais (1981), Cowling et al. (1980)], and in West Germany [Müller (1976)] show a predominant role played by these mergers.[8]

A second issue is the effect of mergers on profitability. As discussed previously, increased profitability can derive from increased efficiency as well as from an increase in market power. The role of a purely arithmetic effect must also be taken into account. Indeed, when a firm below average profitability acquires

[8]According to Hart (1979) and Prais (1981), however, internal growth of firms was primarily responsible for increased concentration in the United Kingdom prior to 1950.

another firm having a higher profit rate, unless the merger causes a sufficient decline in the acquired firm's profitability, the combined profit rate of the two merged firms will automatically be higher than the acquiring firm's initial rate.

When measuring the effect of mergers on profitability, a timing problem is also present in the sense that it is necessary to observe the effects of a merger, not simply at the time it is announced and finalized, but over a sufficient period after the consummation. Most of the existing studies of the effects of horizontal merger show that on average they either had no effect or led to slight decreases in profitability, even if an extended period of time is considered [for the United Kingdom, see Singh (1971), Utton (1974), Meeks (1977), Cowling et al. (1980), and for Continental Europe, see studies in Mueller (1980)].

Studies have also been undertaken for the United States [for an early one, see Reid (1968) and the critical discussion in the *Journal of Finance* (June 1974)] and have led to the same type of conclusion. Recently, Mueller (1985) conducted an analysis for a sample of 280 U.S. mergers of the 1962–72 period. He found evidence of a significant averaging effect due to mergers, but once he controlled for this effect, no residual consequence on profits was found. Given that it is unlikely that mergers reduce market power generally, such results suggest, on average, that efficiency could have declined enough to offset benefits induced by possible increases in market power.[9]

After examining both theoretical and empirical studies, we conclude that the benefits of merger are not evident, either from the point of view of the shareholder or of society as a whole. A general presumption in favor of mergers, therefore, does not appear to be justified.

### 3.1.3. *Joint ventures*

A joint venture occurs when two or more firms join together to form a third, often with a particular project in mind. For example, the parents might incorporate to produce an input or to enter a geographic region where neither operates. The first is an example of a vertical and the second of a horizontal joint venture. We focus our attention on horizontal ventures.

The joint venture is thus a rather peculiar hybrid form of organization somewhere between interacting in a market and merging assets. It is a fairly common business arrangement but one that has received little attention from economists, at least at the theoretical level. The legal and antitrust implications of joint venture are analyzed by Mead (1967), Pitofsky (1969), and Brodley (1976, 1982) and the economic motives for participating in joint ventures are examined by Mariti and Smiley (1983).

[9]Another type of analysis concerns a merger's effect on shareholder returns. For a positive view, see the survey of Jensen and Ruback (1983) and for a criticism of the methodology see Mueller (1985).

As with most financial and economic arrangements, there are both efficient and inefficient aspects to joint ventures. We begin our discussion with an analysis of the inefficiencies.

The most obvious objection to a joint venture is that it has much in common with a cartel or horizontal merger. Through participation in the venture, the financial interests of the parents are linked. Parents will certainly not want to compete vigorously with the venture and may also compete less forcefully with each other. Joint ventures are particularly suspect when they take over existing operations of firms. Even when a new geographic region is entered, however, the venture may foreclose entry by an independent firm.

Joint ventures can assume many financial forms. To focus on the similarities between joint ventures and mergers, we analyze a particular financial arrangement, the partial-equity interest. Our discussion follows Reynolds and Snapp (1986). Other financial arrangements are considered by Bresnahan and Salop (1986).

Under a partial-equity interest, the output of a venture is selected by one partner, the controller, and profits are divided according to each partner's share of equity. Suppose that there are $n$ firms in the market for a homogeneous product. Let $h(Q)$ be the inverse-demand function, $C^i(q^i)$ be the $i$th firm's cost function, and $V^{ik}$ be the $i$th firm's ownership interest in the $k$th firm. Under these assumptions, the $i$th firm's profit can be written as

$$\pi^i = \Big(1 - \sum_{k \neq i} V^{ki}\Big)\big[h(Q)q^i - C^i(q^i)\big] + \sum_{k \neq i} V^{ik}\big[h(Q)q^k - C^k(q^k)\big]. \tag{17}$$

Assuming Cournot–Nash behavior and using the notation of Subsection 3.1.2, the first-order condition for the maximization of (17) can be manipulated to yield:

$$\begin{aligned} L^i &= (p - MC^i)/p \\ &= \frac{1}{\varepsilon}\left[s^i + \frac{\sum_{k \neq i} V^{ik} s^k}{1 - \sum_{k \neq i} V^{ki}}\right]. \end{aligned} \tag{18}$$

The comparable condition when there are no joint ventures is

$$L^i = s^i/\varepsilon, \tag{9'}$$

which is equation (9) with $R^i = 0$ (Cournot–Nash behavior).

We see that even when behavior is noncooperative, price–cost margins can be increased by joint ventures. For example, if there are ten identical firms and no joint ventures, the price–cost margin will be $1/10\varepsilon$, one-tenth the monopoly markup. If each firm has a 10 percent financial interest in every other, in contrast, the price–cost margin increases to its monopoly level of $1/\varepsilon$.

In addition, if the likelihood of collusion is increased by the venture, effects can be synergistic. Joint ventures, particularly those that are jointly managed, can be used as vehicles of coordination, both tacit and overt. For example, it is difficult to draw the line between discussions on pricing policy for the output of the venture and more general pricing strategies for the parents. Similarly, through the venture the parents can share cost information. The exchange of information can facilitate both agreement on a common policy and detection of defection from the agreement.

A common subsidiary can also enable firms to make the side payments that may be necessary to redistribute rents from collusion. Whereas it is difficult for completely independent firms to effect monetary transfers, when operations are linked side payments can be disguised in the form of cheaper supplies for, or unequal division of profits from the common project.

Finally, the venture can be used to exclude certain competitors in a market, thereby putting them in a disadvantageous position. This problem is particularly acute with vertical joint ventures, where competitors may not have access to a scarce input. With horizontal arrangements, the venture may be used to deny outside firms the use of a new technology or marketing facility.

Just as there are disadvantages to this particular form of organization, there are also advantages. Through the venture, firms can benefit from economies of scale in their production processes while remaining separate entities. Joint ventures are therefore very prevalent in industries where scale economies are important, such as automobile production.

Investment rationalization can also be a motive for participating in a venture. Such arrangements are therefore frequently observed in declining industries with high fixed costs, such as many metal industries.

When capital markets are imperfect, joint ventures can enable small firms to participate in projects that are otherwise beyond their means. This is an often advocated reason for allowing joint ventures in bidding for, and production of, offshore oil and gas. These arrangements can also enable small firms to diversify and share risks.

Joint ventures can be used to enter markets that are artificially restricted. In the presence of high tariffs and quotas, for example, foreign companies often enter into joint ventures with domestic firms, thus reducing costs to both producers and consumers.

Perhaps the most important economy associated with joint ventures is the production and exchange of information. Ordover and Willig (1985) and Grossman and Shapiro (1984), in discussions of cooperative arrangements in high-technology industries, advocate special treatment for research joint ventures. There are three reasons why this might be a good policy. First, scientific knowledge has many aspects of a public good. When firms cannot capture the rents from research, they tend to underinvest in the activity. Second, in high-technology industries monopoly rents are quickly dissipated as new products and processes are introduced. The problems associated with cooperation are therefore substantially lessened. And finally, when there is too much competition in R&D markets firms tend to introduce innovations too quickly, thereby dissipating the rents from the new product or process [Barzel (1968)]. Cooperative efforts can thus eliminate wasteful haste as well as duplication of effort.

R&D joint ventures are not completely benign, however. Vickers (1985) demonstrates that research joint ventures, insofar as they pool incumbents' incentives to deter entry, can be effective entry-deterring devices. He also shows that the formation of joint ventures for large innovations can weaken the incumbents' incentive to innovate by removing the competitive stimulus.

Because joint ventures are so prevalent in offshore oil and gas production, much of the empirical literature examines these arrangements. Rockwood (1983) tests whether joint ventures in bidding for U.S. offshore oil and gas leases increases the bidding-market power of firms. To do this, he examines cash bonuses bid for offshore tracts. He finds that joint ventures have had a significant positive impact on the level of cash bonuses and concludes that through joint ventures firms are able to offset the problems implied by imperfect capital markets.

Like Rockwood, DeBrock and Smith (1983) examine joint bidding in offshore petroleum-lease auctions and find that this practice leads to significant economies. They conclude that joint bidding increases the total social value of lease offerings without significantly decreasing the percentage of the social value captured by the government. They attribute their result to the pooling of information. Prior to bidding, participants engage in exploratory tests. The pooling of this information results in more accurate estimates of lease values. And better informed participants bid more aggressively.

Much of the evidence from offshore oil and gas bidding therefore seems to be positive. This evidence should be interpreted with caution, however, because there has been no effort to assess whether joint bidding facilitates coordination of output-market decisions. It is entirely possible that the government is made better off (because it receives more money for leases) while at the same time consumers are made worse off (because they pay higher prices for the product).

Although enhanced product-market power through joint ventures is not very likely in the crude-petroleum market (a world market) it is quite possible in others. Empirical research based on cross-industry analysis of a large sample of U.S. joint ventures [Berg and Friedman (1981) and Duncan (1982)] suggests that, when parents are horizontally related, a potential for market-power augmentation often exists.

A joint venture that has drawn much attention recently is that between General Motors and Toyota. These two giant companies have formed a subsidiary to produce subcompact cars at GM's previously closed plant in Fremont, California. In conjunction with this case, Bresnahan and Salop (1986) develop a method of modifying the Hirshman–Herfindahl concentration index to accommodate the peculiar financial arrangements of joint ventures. When they apply their index to the GM/Toyota data, they find substantial increases in the index due to the formation of the venture. The market for automobiles is highly concentrated internationally and becoming more so. A joint project between two of the largest firms in the industry, therefore, poses difficult problems from a policy point of view and deserves close scrutiny.

It is difficult to make sweeping judgements concerning the efficiency of joint ventures. As with other forms of cooperative arrangements, much depends on the particular circumstances and on the alternatives available. Just as with mergers, however, there is no a priori presumption in their favor. Firms wishing to undertake large horizontal joint projects should be prepared to argue convincingly in their defense.

### 3.2. Tacit collusion

Not all collusion involves explicit agreement. Collusive behavior can also be tacit. To explain how this can occur, we introduce a game-theoretic setting. We begin with an examination of the prisoner's dilemma introduced earlier. This simple game is analyzed in a one-shot and repeated-game framework. The general result is that even though there may be only one noncooperative solution to a one-shot or stage game, when the game is repeated it can have a very large number of noncooperative equilibria. Some of these outcomes involve higher payoffs for all players than the single-period solution and are thus said to be tacitly collusive.

The multiplicity of equilibria is one of the problems associated with the repeated-game approach. Instead of providing us with a theory of oligopoly, it can explain all possible behaviors. Moreover, it even suggests that almost all industries will be collusive almost all of the time. For this reason, many recent studies of tacit collusion are attempts to narrow down or restrict the set of outcomes. We will examine how this narrowing down is accomplished.

Another problem is that the story works too well, in the sense that strategies are devised so that no one ever has an incentive to cheat. In the models, therefore, only stationary equilibrium price/quantity combinations are observed. We know, however, that the real world is characterized by seemingly disequilibrium phenomena such as price wars. Other recent studies that we discuss attempt to explain this apparent contradiction between theoretical and observed behavior.

A final issue that we wish to pursue is whether the insights gained from the repeated-game approach are compatible with out intuitive notions about factors that facilitate and hinder collusion. We therefore examine such issues as whether collusion is easier when there are fewer firms in an industry and whether the sharing of information facilitates collusion.

### *3.2.1. Simple stories of tacit collusion*

Our presentation in this subsection is very informal. Those wishing a more rigorous treatment are referred to Friedman (1986).

Consider again the prisoner's dilemma introduced in Section 2. Without commitment, each player has an incentive to undercut his rival. The net result is that both are worse off than they would be if they could cooperate. When the game is played more than once, however, players can condition their behavior at any stage on observed past behavior of others. In this way, by threatening to punish undesirable actions and reward cooperation, it is at least possible for collusion to be enforced.

Consider, however, what happens when the game is repeated a finite number of times and there is no discounting. In the last period, because there is no future, everyone plays $p^{\mathrm{L}}$. And in the second-to-last period, because each knows that the other will play $p^{\mathrm{L}}$ in the last period no matter what happens in the current period, each player again plays $p^{\mathrm{L}}$. By backwards induction, the entire game unravels and we observe the noncooperative solution in every period. This is similar to the famous "chain-store paradox".

The situation is very different, however, when the game is repeated infinitely often or when there is uncertainty about the end of the game. Suppose that each player wishes to maximize his discounted stream of profits $\Gamma^i$,

$$\Gamma^i = \sum_{t=1}^{\infty} \delta^{t-1}\pi_t^i, \quad i = 1,2, \tag{19}$$

where $\pi_t^i$ is the $i$th player's profit in period $t$ and $\delta = 1/(1 + r)$ is the discount factor ($r$ is the discount rate). It is well known that if $\delta$ is sufficiently close to one, any individually rational outcome can be sustained as a credible Nash equilibrium of the repeated game. This is the content of the so-called "Folk Theorem" of repeated games.

To see why this works in the prisoner's dilemma case, consider a strategy introduced by Friedman (1971) that supports $p^{\mathrm{H}}$: each player cooperates initially and plays $p^{\mathrm{H}}$ in the first period and in every subsequent period until defection is observed. If either player defects, however, $p^L$ is played by both in the next period and forever afterwards. It is straightforward to derive the conditions on $\delta$ for which this is a credible Nash equilibrium for the repeated game.

A similar result holds if there is uncertainty about the end of the game. In this case, $\delta$ in equation (19) must be interpreted as the probability that the game will continue into the next period. When this probability is sufficently high, any individually rational outcome can be sustained.

The one-period prisoner's dilemma has a single Nash equilibrium ($p^L$, $p^L$). In a game with multiple equilibria, however, even when the game is repeated a finite number of times and there is no discounting, there can be a very large number of noncooperative outcomes. In the last period, each player will play Nash. Because there are multiple solutions, however, it is not clear which Nash outcome will prevail and there is therefore room for manipulative behavior. The game does not unravel and many tacitly collusive outcomes are possible. This issue is discussed by Benoit and Krishna (1985) and Friedman (1985).

The theoretical possibilities for tacit collusion are therefore large. If the game is repeated infinitely often, if there is uncertainty about the end of the game, or if the one-shot game has multiple equilibria, virtually any outcome can be sustained. It is hard to conceive of a real-world situation that is not characterized by one of these conditions. The question thus changes from "can tacit collusion occur?" to "what form is it likely to take?" This is the question that we explore in more detail in the next subsection.

Casual inspection also leads us to believe that tacit collusion is possible. The number of industries that have been accused of "conscious parallelism" is large and includes cement, drugs, dyes, lumber, theaters, and tobacco.

### 3.2.2. *Models of tacit collusion*

We have seen that the number of tacitly collusive strategies and outcomes is very large. If our object is to restrict this set, an obvious question to ask is: Is there an optimal strategy that is independent of the strategies chosen by the other players? Axelrod (1984) examines this issue in the context of the repeated prisoner's dilemma game and shows that the answer is no.

This is not the end of the question, however. For a practical test of strategy effectiveness, Axelrod designed a tournament. Game theorists were asked to submit their favorite strategies, which were played against each other in a series of computer simulations. The result was that the highest average score was obtained by the simplest strategy, tit for tat. Tit for tat consists of playing $p^H$ on the first move and in each subsequent move playing what the opponent played in the previous period.

As a further test, a second tournament was run. Each strategy from the first round was submitted to the second in proportion to its success in the first. This process was repeated many times. In the long run, tit for tat displaced all other rules and went to what biologists call fixation.

Tit for tat has three properties that are desirable: it is a "nice" strategy, that is, it does not defect first; it is provoked by the first defection of the other player; and it is forgiving – it does not punish forever. Strategies with these properties have also been analyzed for more complex games.

Kalai and Stanford (1985) study an infinitely repeated symmetric Cournot duopoly game with discounting. They limit their attention to strategies that are similar to tit for tat – linear reaction functions – and show that any pair of these functions gives rise to a unique pair of quantities in stationary equilibrium. These strategies are Nash for the infinitely repeated game.

Suppose that each player has the same reaction function:

$$q_t^i = \bar{q} + R\left(q_{t-1}^j - \bar{q}\right), \quad i = 1,2,\ j = 2,1,\ -1 \leq R \leq 1. \tag{20}$$

In equation (20), $R$ is the slope of the reaction function; a slope of one thus corresponds to tit for tat.

Each $R$ gives rise to a unique equilibrium output pair, $q^{1*} = q^{2*} = q(R)$. Nash strategies for the infinitely repeated game consist of playing $q(R)$ in the first period and thereafter following the reaction functions (20), with $\bar{q}$ replaced by $q(R)$.

Unfortunately, as Kalai and Stanford show, these strategies are not credible. The problem is that when one player defects, by reacting to one another as the functions (20) prescribe, the players stay off the equilibrium path for too long. This problem can be remedied, however, if the reaction time $\Delta t$ is shortened. The effect of shortening the time to response is twofold: punishment comes sooner and it is less costly for the punisher. Kalai and Stanford show that with short reaction times, strategies of the form of (20) have strong credibility properties. Similar results were derived independently by Anderson (1983).

The problem of a multiplicity of outcomes, however, has not been solved. Any quantity between the competitive and the monopoly can be sustained by varying $R$ between minus and plus one. To make the solution determinate, we must select a particular $R$.

MacLeod (1985) adopts an axiomatic-bargaining approach to reduce the number of equilibrium outcomes. He considers a class of reaction functions that depend only on previous-period prices and the opponent's price change. By introducing three axioms that these functions must satisfy, he reduces the solution to tit for tat.

Another reaction-function model is due to Brander and Spencer (1985). They consider the case of $n$ identical quantity-setting oligopolists and focus on the notion of entry to narrow down the set of equilibria.[10] In their model, a unique

[10] Brander and Spencer's model is not dynamic but it could be made so. Instead of $R$, they use a conjectural-variation parameter, $\lambda$.

price/quantity combination is associated with any $R$, given the number of firms $n$; and larger $R$'s correspond to higher profits. Profits, however, invite entry, which occurs until profitability is driven to zero. There is therefore a locus of $n/R$ combinations that are consistent with zero profits. The problem is to select among them.

Brander and Spencer determine a unique equilibrium by introducing a schedule reflecting how the ease of collusion $R$ depends on the number of firms $n$. With this additional assumption, we have two equations:

$$\Pi(n, R) = 0 \quad \text{and} \quad R = f(n), \tag{21}$$

which can be solved to yield a unique equilibrium $n^*$, and $R^*$.

It may seem that there are many ways to obtain unique outcomes. Those that we have considered, however, are slightly ad hoc. By invoking a set of axioms or by producing a function that relates $R$ to $n$, one merely pushes the indeterminacy back one stage. It still remains to explain where the axioms or the functions come from, and this is not a simple problem.

A very different approach to reducing outcomes is taken by Spence (1978), who explores the effect of imperfect information on reaction-function equilibria. In Spence's model, imperfect information consists of an inability of firms to monitor their rivals' actions. He shows that when imperfect monitoring is combined with randomness in the payoff functions, the set of reaction-function equilibria shrinks towards the set of Nash equilibria of the one-shot game. With perfect monitoring, the incentive to cheat must be weighed against the probability of detection. The probability of detection therefore works very much like the discount rate in previous models in that it causes future punishment to be weighed less heavily. As either departs from one, the set of sustainable outcomes shrinks.

With the models discussed thus far, strategies are credible or subgame perfect. They therefore deter cheating. A consequence is that only stationary equilibrium behavior is observed; that is, the same price–quantity combination is played in every period. We know, however, that seemingly disequilibrium behavior such as price wars is endemic to many markets. Models are therefore required that are credible but nevertheless exhibit price–quantity dynamics. We therefore turn our attention to such models.

Perhaps the best-known model of price wars is due to Green and Porter (1984) who, like Spence, explore the effects of imperfect information. In their model, price is determined by industry output and a random variable $\theta$. Each firm observes this price and its own output but cannot observe the output of its rivals. When an unusually low price is realized, there are two possibilities. Either demand is very low or a rival has cheated and increased production. It is therefore always possible for cheating to go undetected. Green and Porter show that cheating can be deterred by threatening to produce at Cournot–Nash levels for a period of fixed duration whenever the market price drops below some trigger price, $\tilde{p}$.[11]

The idea is to select a collusive output $q^i = q^*$, a trigger price $\tilde{p}$, and a punishment period $T$. An equilibrium trigger-price strategy $(q^*, \tilde{p}, T)$ always exists because $q^*$ can be taken to equal the Cournot level. There will in general, however, be many equilibria.

Porter (1983a) goes on to study the problem of selecting an optimal trigger-price strategy from the firm's point of view. He calculates values of $(q^*, \tilde{p}, T)$ that maximize expected industry discounted value, subject to the constraint that no firm wants to deviate from $q^*$. He finds that, in general, $q^*$ is greater than $1/n$ times the monopoly output. In addition, optimal industry output is a nondecreasing function of both $n$ and the variance of $\theta$.

This model not only limits the number of outcomes, it also reconciles seemingly disequilibrium phenomena such as price wars with equilibrium behavior on the part of implicitly colluding firms. With a trigger-price strategy, no firm ever cheats. Nevertheless, if the support of $\theta$ is large, price will periodically drop below $\tilde{p}$ and a period of Cournot–Nash reversion will ensue.

In the Green and Porter model, price wars occur only during downturns. Rotemberg and Saloner (1986) claim, however, that wars are at least as common during booms and build a model to explain this phenomenon. As with all such models, a firm's decision to defect involves weighing the single-period profit from cheating versus future losses due to induced noncooperative behavior. If demand is high, the benefit from undercutting is large. On the other hand, because punishments are meted out in the future when demand tends to return to its normal level, the punishment from deviating is less affected by the current state of demand. Price decreases therefore occur in good times.

Inability to detect cheating, as in Green and Porter, is not the only reason why price wars occur. In many markets, especially at the retail level, price is the firm's choice variable and it can be observed by all players. Slade (1985) constructs a model that produces price wars when there is little scope for cheating and secret price cutting.

Like the previous models, the Slade model relies on demand uncertainty, but uncertainty is of a very different sort. Instead of demand being stationary, it is subject to periodic but infrequent discontinuous shifts. When a demand shift occurs, in order to determine the new demand conditions and to calculate the new equilibrium prices, players must change prices. Price wars are therefore information-seeking devices. The dynamics inherent in the model are such that

[11]It has been shown [Abreu, Pearce and Stracchetti (1986)] that in this model a one-period reversion to an output greater than the Cournot–Nash output is the most effective way of policing the cartel.

considerable cutting and undercutting occurs before the new equilibrium is established.

In all of these models, price wars are equilibrium strategies of supergames; no one ever cheats. This is perhaps a shortcoming of the models from a practical if not from a game-theoretic point of view. Our intuitive feeling is that firms do intentionally cheat on collusive agreements (recall the electrical-equipment conspiracy) and that there are many reasons why price wars occur in addition to demand shocks. Nevertheless, economists have devised few theories to explain cheating in collusive agreements.[12]

In many models, the stochastic nature of demand and costs leads to firms having incomplete information. Stigler (1964), Spence (1978), and Green and Porter (1984) all show that when actions are not observable, detection of cheating is impeded and output restriction is less severe as a consequence. It is natural therefore to ask if oligopolists have private incentives to share information. If firms are going to collude explicitly then the answer is yes – sharing information facilitates reaching and enforcing an agreement. But what about tacit situations?

This question has been studied by many. Novshek and Sonnenschein (1982), Clarke (1983), Vives (1984), Li (1985), and Gal-Or (1985) analyze the effects of information exchange among oligopolists each of which has a private signal about the intercept of a linear demand function, and Fried (1984), Li (1985), Katz (1985), and Shapiro (1986) examine the effects of sharing information about firm-specific costs. These studies suggest that in many situations firms that do not plan to collude, while having an interest in acquiring information, do not find it to be in their private interest to share this information. To clarify the flavor of these results, we discuss Clark's model.

In this model, firms receive information about $a$, the random demand intercept net of unit cost, and must decide whether to share this information. Pooling of information has two consequences: it reduces the variance of the errors in the estimates of $a$ and it correlates the strategies that the firms choose. The first effect increases expected profits but, in Cournot competition, the second effect is detrimental. Clarke shows that the second effect dominates so that there is never a mutual incentive for firms to share private information unless they plan to collude. Reciprocally, information-sharing agreements and pooling schemes can be expected to signal collusion.

Other papers such as those by Vives (1984) and Li (1985) show that Clarke's result is not general but depends on specific assumptions. Vives demonstrates that the result depends on the assumptions of Cournot competition and of

[12]Our list of supergame price-war models is not exhaustive. For example, Maskin and Tirole (1988) construct a model that leads to Edgeworth cycles. The notion of cheating on collusive agreements was introduced by Stigler (1964). It has recently been developed in a repeated-game context by Rees (1985) among others.

homogeneous products, whereas Li shows that it depends on the assumption of uncertainty about a common (and not a firm-specific) parameter. When these assumptions are changed, other outcomes are possible. In particular, firms may wish to share.

Through these studies, therefore, we gain new insights into the effects of information acquisition and transition on oligopolistic behavior. Contrary to simplistic views, sharing can be compatible with the search for a noncooperative, noncollusive equilibrium. More important, circumstances under which sharing facilitates collusion can be identified.

Imperfect information can lead to other counterintuitive results. It is generally believed that collusion is more likely when there are fewer firms in an industry. Horizontal mergers are therefore viewed with suspicion. Davidson and Deneckere (1984), however, show that when a tacitly collusive agreement is enforced by a trigger-price strategy that is not sustainable, a merger reduces the chance that collusion becomes sustainable in the future.

The reason for their result is as follows. Enforcement of tacit collusion is easier when the threat point (the noncooperative outcome) is less desirable; that is to say, it is easier to threaten when the punishment is severe. A merger, however, increases the profitability of outside firms and, in particular, the threat point becomes more profitable. As losses due to retaliation decline, collusion becomes more difficult to sustain.

Other very different models can produce the same result – that collusion is easier to sustain when there are more firms in the industry. For example, Fraysse and Moreaux (1985) consider a market where there are $n$ symmetric potential Cournot competitors. The game is repeated a finite number of times and there is no discounting.

Because there are fixed costs, it is possible that in equilibrium not all firms will produce. It is not clear, however, which firms will be active. For this reason, there may be multiple noncooperative equilibria of the one-shot game and collusive behavior can arise even though the game is repeated only finitely often. The threat of excluding a deviant firm from the market is credible and therefore gives rise to manipulative behavior.

Fraysse and Moreaux show that tacit collusion can occur when there is an intermediate number of firms. There must be enough potential competitors so that multiple equilibria exist. But there must not be so many firms that profit is negative when all produce.

At this stage some broad conclusions can be suggested. The most striking result is the multiplicity of theoretical possibilities for tacit collusion, many of which can be enforced by simple strategies such as tit for tat or Nash reversion. In addition, seemingly disequilibrium dynamics such as price wars may not be evidence of cartel breakdown. Instead, they may be phases of equilibrium tacitly collusive strategies. We return to the (too) broad result that almost all industries can be tacitly collusive almost all of the time.[13] To go beyond this, it is necessary to analyze the particular circumstances of an industry in an attempt to determine the feasibility of collusion. In many cases, this will lead us back to the old notions of factors that facilitate or hinder collusion that were discussed in Section 2.

In addition, many theories seem to be in conflict with intuitive notions about structure–conduct–performance. For example, under many circumstances firms will share too little information from a social point of view. Also, the ease and strength of collusion may not be a monotonic function of the number of firms in the industry. These findings, if robust, add greatly to the complexity of competition policy. It seems necessary to examine empirical research such as the cross-industry studies covered in Chapter 17 of this Handbook to determine just how important these results actually are. Here we turn to some recent attempts to test for tacit collusion in a game-theoretic setting.[14]

### 3.2.3. *Testing for tacit collusion*

In this subsection we examine empirical models that are explicitly dynamic. Static models are discussed later under the heading of "testing deviations from price-taking behavior". Two questions are important in the dynamic literature. The first is whether it is possible to detect punishment phases or periods of price wars using data on prices and quantities, and the second is whether we can use price-war data to determine what strategies firms use to support tacitly collusive outcomes. In contrast, the principal question that the static literature explores (see Subsection 4.1.1) is just how collusive tacitly collusive outcomes really are. That is, they ask how far price deviates from marginal cost in a particular industry equilibrium.

Porter (1983b) tests the Green and Porter (1984) model of tacit collusion under uncertain demand. His principal object is to distinguish tacitly collusive from punishment phases. He uses weekly aggregate time-series data on the Joint Executive Committee railroad cartel from 1880 to 1886. This price-setting cartel controlled eastbound rail transportation from Chicago to the eastern seaboard for many years.

The econometric test exploits the fact that, if collusion is being supported by a trigger-price strategy, there will be periodic switches between collusive and

[13] When optimal (most severe) punishments such as those studied by Abreu (1986) are introduced, this result becomes even stronger.

[14] Our theoretical treatment of tacit collusion has been far from comprehensive. Many other tools for tacit collusion have been analyzed in the literature. For example, Rotemberg and Saloner (1985) study the role of inventories in supporting collusion, Bernheim and Whinston (1985) show how a common-marketing agency can generate a collusive outcome, and Brock and Scheinkman (1985) explore the effects of capacity constraints on the ability to punish defectors. Finally, Roberts (1985) shows how adverse selection can complicate detection and punishment. For a comparison of the supergame and state–space analysis of tacit collusion, see Fudenberg and Tirole (1986).

noncollusive output levels. The model thus lends itself to simultaneous-equation switching-regression estimation. The regression probabilities are unknown but endogenously predicted.

Porter finds that in reversionary periods behavior is Bertrand, as predicted by the model. And in collusive periods, Cournot outputs are produced. Firms therefore are able to improve their situation through repeated play but profit falls far short of the monopoly level. Finally, the hypothesis that no switches in firm behavior occurred is easily rejected by the data, lending support to the model of two regimes.

Slade (1987a) also tests for tacit collusion and finds support for profits higher than those implied by Nash behavior in the one-shot game. She uses daily time-series data on retail gasoline prices, sales, and unit costs that were collected in Vancouver, British Columbia, during a price-war period. The data pertain to individual service stations. As a consequence, demand, reaction, and cost functions can be estimated at a very disaggregate level. The empirical test discriminates between the continuous reaction-function and discontinuous punishment strategies developed in Slade (1985).

In a second test, Slade (1987b) develops Bayesian models where firms use price wars to learn about new demand conditions and about rival strategies. The technique of Kalman filtering is employed to model the learning process. She finds that the empirical evidence points to the use of very simple supergame strategies over more complex alternatives. This conclusion is not surprising, given that collusion in this market is purely tacit and that no overt communication takes place.

These studies conclude that repeated play enables firms to enhance their profit position vis-à-vis the noncooperative outcome of the one-shot game. Nevertheless, industry profit is far short of the monopoly level. In both industries, pricing decisions are made at frequent intervals. It therefore seems unlikely that high discount rates are the cause of failure to achieve near-monopoly profit. Instead, coordination and communication difficulties are probably greater than assumed in most theoretical analyses.

An interesting variant of the empirical-supergame approach can be found in Roberts and Samuelson (1985) who test for nonprice competition and collusion in the U.S. cigarette industry. They find that in some instances equilibria are not subgame perfect. If this were to become an empirical regularity, we might have to conclude that theoretical notions of perfection are too stringent.

## 4. Collusion, public interest, and government policy

Having completed our survey of models of collusive behavior, it is time to turn to issues of public interest and government policy. First, we look at empirical techniques that can be used to identify collusion. Next, we discuss methods of and problems associated with measuring the welfare losses due to restriction of competition. We then turn to possible efficiencies associated with concentration and the tradeoffs that must be made as a consequence. Finally, we consider whether market failures call for government intervention or some form of planning.

### *4.1. Identifying collusion*

We have already seen how the structure of markets might affect the ease of colluding. Factors that play a role include the number and size distribution of firms, the information structure of the market, firm technology and costs, and consumer tastes. Here we discuss empirical tests that can be used to identify collusion, both tacit and explicit. Under this heading, we cover econometric tests of deviations from price-taking behavior and patterns of firm bidding.

#### *4.1.1. Testing deviations from price-taking behavior*

There is a large literature on the subject of testing for the absence of price-taking behavior. These studies assess equilibrium deviations of price from marginal cost in specific industries. Rather than discuss each article, we set up a general method and then discuss possible modifications.

Consider an industry comprised of $n$ firms that produce a homogeneous product. We reproduce a typical firm's first-order condition for profit maximization, equation (9) from Subsection 3.1.2,

$$(p - MC^i)/p = (s^i/\varepsilon)(1 + R^i). \tag{9''}$$

Given data on prices, quantities, and the determinants of costs, equation (9″) can be estimated econometrically to obtain parameter values for the vector $R^i$.[15] This often involves estimating a demand equation, $n$ cost functions, and $n$ first-order conditions as a simultaneous system. Although the studies differ in many respects, this is essentially the approach taken by Iwata (1974), Cubbin (1975), Gollop and Roberts (1979), Geroski (1982), and Roberts (1984a).

When estimates of $R^i$ have been obtained, tests of various oligopoly models can be performed. For example, $R^i = -1$ is the relevant hypothesis for price-taking behavior and $R^i = 0$ tests the Cournot assumption. In addition, if certain firms are found to be price takers or Cournot–Nash players, while others have positive conjectures, dominant-firm and Stackelberg models can be evaluated.

There are many possible modifications to this procedure. For example, Bresnahan (1987) and Slade (1986c) consider differentiated products and Appel-

[15] If there are many firms in the industry, some structure must be placed on $R^i$ and $MC^i$.

baum (1979, 1982) analyzes the use of aggregate data. In addition, estimated $R$'s can be related to exogenous factors that can contribute to the likelihood of collusion [Anderson (1984)], to the characteristics of the firms [Slade (1986c)], to the ease of entry [Spiller and Favaro (1984)] or to the role of import competition [Ilmakunnas (1985)]. Finally, Gelfand and Spiller (1987) assess oligopolistic interaction in multiple-product markets and Roberts (1984b) tests for the presence or absence of nonprice competition among firms.

Estimated conjectures can best be interpreted as providing a convenient summary description of market behavior, which will often involve a mix of cooperative and noncooperative elements. With this in mind, Schmalensee (1987) suggests a natural measure of the extent to which industry behavior is collusive. This measure is $1/\phi$, where $\phi$ is defined by

$$\phi = \sum_{i=1}^{n} 1/(1 + R^i). \tag{22}$$

The measure is generally confined to the unit interval, with $1/\phi = 1$ implying perfect collusion.

Another approach to testing price-taking behavior relies on discrete shifts in exogenous variables to identify modes of pricing conduct. Just and Chern (1980), Sumner (1981), Bresnahan (1982), and Sullivan (1985) are examples of this second class. It is clear that responses to either demand or supply shocks can differ according to industry conduct. Just and Chern examine a radical change in production technology in a market where buyers have market power and Sumner and Sullivan look at changes in tax treatment in a market where sellers have market power.

The methods that rely on shifts in exogenous variables require both pre and post-change data. Baker and Bresnahan (1985), however, develop a technique for assessing a change in market power (due to a merger in their case) from pre-change data alone. When potential and not actual gains or losses are to be assessed, this method should prove useful.

As is expected, the findings of these studies differ, depending on the industry examined. Some industries are best characterized by price-taking, others by Cournot, and still others by dominant-firm behavior modes. Most, however, do not fit neatly into a particular category. Nevertheless, price taking seems to be the exception rather than the rule. This may just mean, however, that industries that are obvious oligopolies were selected for the tests.

Finally, a problem with all of these approaches is that it is impossible to distinguish pure tacit collusion from illegal price-fixing or other explicit cartel agreements. What matters for the empirical estimates is the outcome and not the cause of noncompetitive pricing. This problem seems difficult and perhaps impossible to overcome.

The normative implications of noncompetitive pricing are discussed in Subsection 4.2.

#### 4.1.2. Bidding strategies

Two questions emerge when examining bidding strategies. The first is whether particular patterns of bidding are associated with collusion and the second is whether competition in bidding is desirable.

The conventional wisdom holds that identical bids suggest collusion. For example, federal agencies in the United States are required to report cases of identical bids. However, it is not clear why members of a cartel would decide to bid identically. When they do, the problem of output allocation is not solved. Much more conducive to allocating the rents from collusion in a prespecified manner is a system of rotating low bids (the system practiced by the electrical-equipment conspiracy).

In an empirical analysis of U.S. firms that were successfully prosecuted for collusive bidding, Comanor and Schankerman (1976) find that a system of rotating bids is more likely when participants are few. When large numbers of firms are involved, however, identical bids are found more frequently. Because firms can be very ingenious in devising rotating systems, and because identical bids can be the result of identical firms operating in competitive markets, it seems difficult to draw general conclusions about collusion from bidding patterns. Nevertheless, Hendricks and Porter (1987), using data on offshore oil and gas leases, find evidence that neighbor firms coordinate their bidding decisions.

The second question deals with the optimality of competitive-bidding systems. Wilson (1977) shows that under reasonable assumptions, when the number of bidders increases, the value of a winning bid converges to the true value of the item being auctioned. Competition in bidding therefore seems desirable.

Many markets where bidding is important, however, are characterized by few participants and uncertainty about the value of the item being auctioned. This is particularly true of markets for mineral leases and offshore oil. Reece (1978) shows that under these circumstances, firms capture a large share of the rent and advocates government-sponsored exploration programs as a consequence. This is a type of collusion in the form of information sharing. DeBrock and Smith (1983) conclude that under the same circumstances, joint bidding by firms (which results in private information sharing) is more efficient than a noncooperative system.

Our assessment is therefore that noncooperative bidding is not always optimal. In markets where firms are few and information is scarce, some form of cooperation may be preferable.

### 4.2. Collusion and restriction of competition

In this subsection we deal with the detrimental effects of collusion. The discussion centers on the measurement of welfare loss in both partial and general-equilibrium settings. It is well known that distortions in an economy lead to losses in productive efficiency. Whether it is possible to measure these losses and whether efficiency should be the sole welfare criterion are the issues addressed here.

### 4.2.1. Market definition

In the discussion of the effects of concentration on pricing, it was implicitly assumed that a market was well defined. For example, equation (9) shows that deviations from marginal-cost pricing are directly proportional to market share, $q^i/Q$. But what is $Q$? Before a market distortion can be measured, it is necessary to agree upon a market.

It is generally recognized that a market has two principal dimensions, product characteristics and geographic extent. Because most products have close substitutes and because many geographic markets overlap, however, it is rarely easy to delineate either dimension exactly.

To facilitate discussion, suppose that we focus on a market as the ideal product line and geographic region from the point of view of firms wishing to collude. That is to say, a market should be large enough so that price can be raised above marginal cost without generating repercussions from outside that bring it back down, and it should be small enough so that it can be coordinated efficiently. Within this framework, we can ask about the principal determinants of the market.

When delineating a product market, one must consider close substitutes. If two commodities are substitutes in use, it is not profitable to restrict the output of only one because consumers will easily switch. Similarly, if two commodities are substitutes in production, it is not profitable to restrict the output of only one because plants that produce the second will quickly convert. Second-hand markets must also be considered. Many recycled products are virtually identical to new and therefore severely limit the market power of primary producers.

When delineating a geographic market, one must consider transport costs, artificial barriers such as tariffs and quotas, and the other costs of transaction across regions. If, transaction costs are low relative to price, two regions should be in the same geographic market for a given product. Considerations of geographic-market extent are extremely important for open economies. For example, it is meaningless to say that Belgian industry is highly concentrated if Belgium is not the appropriate market.

In addition to product and spatial characteristics, markets also have a time dimension. It is in general true that markets are larger in the long than in the short run. With the passage of time, consumer tastes and production technologies change, transport costs are lowered, and artificial barriers can disappear.

Most empirical market-definition studies concentrate on the spatial aspects of markets. However, similar techniques can be used to delineate product markets. There are two standard approaches; one can look at trade flows or at the behavior of product prices over time.

Elzinga and Hogarty (1973) set up a test based on trade flows. They consider a region to be a market if imports and exports are not important. A problem with trade statistics, however, is that they do not detect overlapping markets where, for example, A trades with B, B trades with C and so forth. Nevertheless, in the case of differentiated products, trade statistics may be the only reliable information.

In the case of international markets, it is not clear whether import figures (trade flows) or the entire productive capacity of foreigners should be used in calculating market shares. Landes and Posner (1981) suggest that if foreign products can penetrate a market, barriers are sufficiently low so that all foreign production could be diverted.

Leitzinger and Tamor (1983) examine this issue by testing whether U.S. industry profitability is more highly correlated with U.S. or with world concentration ratios and find that world concentration is a significantly better predictor. If this is true for the United States, it is apt to be even more so for smaller more open economies. Neverthelesss, there are many markets such as sand and gravel that are distinctly local and one should not jump to the conclusion that all markets are worldwide. A careful analysis is required in each case.

When products are relatively homogeneous, the time-series behavior of prices can be used to identify markets. Stigler and Sherwin (1985) provide a static analysis of the use of prices in market delineation. Because there may be lags in price responses across regions, however, a static analysis is insufficient.

Dynamic models are developed by Horowitz (1981), Spiller and Huang (1986), and Slade (1986a). Horowitz tests for the dynamic stability of price differences across regions after a shock has disturbed them from their equilibrium values. Slade uses time-series tests for causality and exogeneity to see if price determination in one region is statistically exogenous to the process that determines prices in another. Finally, Spiller and Huang use switching-regression techniques to distinguish periods of arbitrage from periods of autarky as supply, demand, and transport conditions change.

Special market-definition issues pertaining to unique markets are discussed by Ordover and Willig (1985) for R&D and by Slade (1986b) for natural resources.

### 4.2.2. *Measuring welfare loss*

Suppose that we can divide an economy into sectors that represent valid markets. It is then possible to estimate the deadweight loss due to oligopoly pricing in each sector and to sum over the sectors to obtain an economy-wide loss measure. This is the procedure used by Harberger (1954), criticized by many, and followed by an even greater number.

First, one should note that this procedure captures only the efficiency aspects of the loss due to monopoly pricing. We put this aside for the moment.

Assume that an economy consists of $N$ sectors. Let $p$, $q$, $MC$, and $\varepsilon$ be vectors of prices, quantities, marginal costs, and price elasticities of demand for the different sectors. Harberger used the formula for deadweight loss $D$,

$$D \simeq 1/2\, \Delta q^{\mathrm{T}} \Delta p, \tag{23}$$

due to Hotelling (1938) to approximate the economy-wide loss. In (23), the symbol $\Delta$ represents a change due to oligopoly pricing.

Expression (23) can be written as

$$D \simeq -1/2(p - MC)^{\mathrm{T}} M(p - MC), \tag{24}$$

where $M$ is a diagonal matrix with each diagonal element $M_{ii}$ equal to

$$M_{ii} = -\varepsilon^i q^i / p^i = \partial q^i / \partial p^i. \tag{25}$$

$M_{ii}$ is evaluated at the distorted prices. Using the fact that, when marginal costs are constant, $(p^i - MC^i)/q^i$ equals the rate of return on sales, $D$ can be expressed in terms of observable variables alone.[16]

Hotelling derived his formula by disregarding higher-order terms in a Taylor-series expansion of a utility function. (23) therefore yields an approximate measure when deviations from competitive pricing are small. Neverthelesss, Harberger applied the formula to an economy where distortions were sizable. Substantial error can therefore be expected. His conclusion is that $D$ is less than one-tenth of 1 percent of national income. Similar studies by Schwartzman (1960) and others yield similar conclusions.

Bergson (1973) gives a systematic analysis of the problems inherent in this sort of calculation. He criticizes the model on two counts, both of which are familiar to welfare theorists. First, demand in Harberger's analysis is Marshallian demand. In order for it to be possible to calculate what Bergson calls net compensating variations from Marshallian demand curves, it must be true that income effects are zero.

Second, equation (23) neglects all general-equilibrium effects in that it is assumed that price changes have no repercussions in other sectors. In order for (23) to yield correct answers, therefore, it must additionally be true that all cross elasticities of demand are zero. These are very severe restrictions.

To remedy these problems, Kay (1983) proposes a general-equilibrium formula for estimating deadweight loss based on an expenditure function, a tool that is borrowed from the optimal-taxation literature. Let $E(p, u)$ be the minimum expenditure needed to achieve utility $u$ at a vector of prices $p$.[17] Then $D$ is

$$D = E(p, \bar{u}) - E(MC, \bar{u}) - (p - MC)^{\mathrm{T}} q, \tag{26}$$

[16] Harberger assumed that $\varepsilon^i$ equals one for all $i$.

[17] We assume a representative consumer in order to abstract from distributional effects.

where $\bar{u}$ is the utility at distorted prices. Using a Taylor-series expansion, this expression can be approximated by

$$D \simeq -1/2(p - MC)^{\mathrm{T}}\left((\partial q^i/\partial p^j)_{\bar{u}}\right)(p - MC), \tag{27}$$

where $(\partial q^i/\partial p^j)_{\bar{u}}$ is a full matrix of cross partials evaluated at $\bar{u}$.[18]

The informational requirements for computing $D$ from (27) are large indeed. Instead, Kay derives upper and lower bounds on $D$ corresponding to the assumptions that all firms play Nash and collusively, respectively. Because the spread in these bounds is wide, Kay concludes that at least potentially, substantial monopoly losses are possible.

Even though the informational requirements for calculating actual losses using general-equilibrium methods are large, the successful construction of applied general-equilibrium models which incorporate noncompetitive sectors [see, for example, Harris (1984)] means that such exercises are not beyond reach.

Another attack on the Harberger approach emerges from the rent-seeking literature [Tullock (1967) and Posner (1975)]. The basic idea is that the existence of an opportunity to obtain profits will attract resources into efforts to obtain monopolies up to the point where all monopoly profits are dissipated. The last term in equation (26), therefore, which represents monopoly profit, should not be subtracted when losses are estimated. If we call this term $\Pi$, then the true social cost of monopoly is $D + \Pi$. Using Harberger's numbers, Posner calculates the social cost of monopoly at 3.4 percent of national income, a considerably larger number than 0.1 percent. Cowling and Mueller (1978), in an independent study, calculate $D + \Pi$ to be 13 percent of gross corporate product.

Finally, let us recall the role of what Liebenstein (1966) calls $X$-inefficiency. Once external pressures are reduced so that cost minimization and profit maximization are not required for survival, technical inefficiency and organizational slack can emerge within the firm. The effect can be to increase $MC$ and therefore to reduce measured $D$ as well as measured $\Pi$, with a resulting understatement of deadweight loss.

Others claim that social costs are less than $D + \Pi$. For example, Littlechild (1983) argues that not all profit is due to monopoly. When one takes into account windfall gains and managerial creativity as sources of profit, losses are very much reduced. Finally, Rogerson (1982) constructs a game-theoretic model to show that the Posner claim is true only at the margin. Firms may be inframarginal because they are incumbents or because they have lower costs of gaining the information required to participate. As a consequence, not all rent is transformed

[18] Equations (24) and (27) look very similar. It should be noted, however, that in (24) $\partial q/\partial p$ is evaluated for movements along the Marshallian demand curve, whereas in (27) movements are along the Hicksian demand curve.

into costs. In both models, the social cost of monopoly lies somewhere between $D$ and $D + \Pi$.

So far we have discussed only economy-wide measures of deadweight loss. One rarely has the opportunity, however, of moving from a distorted to a totally undistorted economy. More relevant is the question of calculating efficiency gains due to moving a single sector towards undistorted prices. Here, the prospects for even approximate measurement are much poorer.[19] The theory of second best tells us that we cannot even predict the sign of the change, no less the magnitude. Neverthelesss, this is the important policy issue faced in all antitrust cases.

Attempts at measuring welfare changes in a partial-equilibrium setting usually finesse the issue. For example, Dansby and Willig (1979) assume that welfare is a function solely of the outputs of the firms in the industry, thus bypassing all general-equilibrium considerations.

Dixit and Stern (1982) suggest the use of shadow prices to circumvent issues of second best. For example, they advocate using shadow wage rates when there is unemployment and shadow prices for imports when currencies are overvalued. Issues of second best, however, arise in closed, fully employed economies. Neverthelesss, this is a step in the right direction in that it deals with issues of less than full employment ignored by others.

The difficulties associated with calculating efficiency gains in a partial-equilibrium setting do not lead us to conclude that governments should abandon all policies towards monopolization and merger. Instead, we believe first that there is no general a priori argument or evidence suggesting that monopoly distortions in an economy are negligible; and second, that economic policy should not be based on issues of productive efficiency alone but should take into account the many consequences of monopolization including distributional and employment effects [for an early view, see Adams and Dirlam (1976)]. This prescription of course only complicates the problem. Nevertheless, the profession has in general gone very far in one direction and has tended to neglect the others.

Efficiency gains or losses may not even be the largest source of welfare change. For example, consider the effect of OPEC. Prior to OPEC it could be argued that world oil prices were too low. Multinational producers did not have property rights in the Middle East and were thus most likely neglecting user costs in making pricing decisions. In contrast, after OPEC, prices may have been too high due to monopoly power. It is difficult to deduce anything about efficiency under these circumstances, even when the conditions for neglecting general-equilibrium effects are met. In contrast, few would feel that the massive transfer of wealth from consumers to the owners of oil-producing properties was negligible from a welfare point of view.

[19]One can, of course, use GE formulas to calculate these losses, but often only single-sector data are available.

For a more concrete example, Comanor and Smiley (1975) estimate the impact of monopoly profit on the distribution of household wealth in the United States. Unlike the Harberger results for efficiency, they find that the presence of monopoly has had a major impact on the degree of inequality. In fact, they estimate that the relative wealth position of over 93 percent of households would be improved in the absence of monopoly pricing.

Employment effects could also be important. General-equilibrium formulas for deadweight loss are based on the assumption that when workers are released from the monopolized sector, they find jobs in the competitive sector. This assumption, however, is often not realistic. For example, if INCO closes its mines in Sudbury, Ontario, workers have few alternatives, at least in the short run. If the opportunity wage rate elsewhere is zero, losses due to monopolization will be large indeed. This assumption is very extreme and not likely to be met in practice. Neverthelesss, it also seems unrealistic to assume full employment when calculating losses.

These considerations suggest that perhaps too much time is being spent in estimating the area of triangles and not enough effort is being expended on assessing other consequences of monopoly.

### 4.3. *Efficiency tradeoffs*

In the previous subsection we considered the detrimental effects of concentration and collusion. Here we examine possible efficiencies. Much has been written on this subject, which is very broad.[20] We limit ourselves to a brief treatment of specific issues most of which are covered at length elsewhere in this Handbook. In particular, we consider the static economies of scale, scope, and product variety and the dynamic efficiencies of learning and technical change.

#### 4.3.1. *Static efficiencies*

Economies of scale have long been proposed as an antitrust defense [see, for example, Williamson (1968, 1977) and the references therein]. The formal analysis of economies of scope, in contrast, is somewhat more recent [see, for example, Willig (1979), Panzar and Willig (1981) and Waterson (1983)]. The two sorts of economies, however, can be analyzed in a similar framework.

Economies of scale are said to exist whenever long-run average cost declines with output. This can occur either because there are set-up costs or because marginal costs decline as production expands. Economies of scope arise when joint production of two or more products is cheaper than the cost of producing

[20] For example, see Dewey (1959), McGee (1971), and Bork (1978).

the products separately. Again, the economy can work either through fixed or through marginal cost. We assume that the products produced are substitutes so that under monopoly there is a tendency to restrict the output of both.

When either economy occurs, there is a tradeoff between cost reduction and output restriction as the number of firms varies. The net effect will in general depend on many factors including the own and cross-price elasticities of demand, the own and cross-output elasticities of total cost, the degree of collusion in the market, and whether the nature of collusion changes with the number of firms.

By making sufficient assumptions about demand, cost, and collusion, one can obtain partial-equilibrium formulas for the sizes of cost savings and surplus reductions. This is not our intention here. Rather, we simply wish to emphasize that, when scale and scope economies exist over a broad range of outputs, under a fairly wide range of assumptions few firms may be preferred to many. In addition, the optimal market structure will almost never be perfectly competitive.

Whether or not mergers are beneficial under these circumstances, however, is a very different issue. Mergers occur between existing firms whose cost structures are not completely flexible. When two firms merge, it is not clear if cost reductions can be realized ex post. For example, if the economy is due to fixed costs, it may be impossible to realize a cost saving without closing one firm's production facilities. As with most complex issues, detailed analysis is required for each special case.

A further question is: When there are economies of scale or scope, does a free-entry equilibrium result in an optimal number of firms? This problem is analyzed by von Weizsacker (1980), Perry (1984), and Mankiw and Whinston (1986) who conclude that the answer is no. In particular, the circumstances under which there will be too many firms so that entry restrictions are desirable are not pathological.

The analysis when there is a variety of products is not very different from the analysis of scale and scope. Suppose that each firm produces a single product but that products differ across firms. Suppose, in addition, that average costs decline with output. Variety is valued by consumers who have heterogeneous tastes. In this case, the tradeoffs are between product variety (which equals the number of firms), market power (which may be inversely related to the number of firms), and cost savings (which are inversely related to the number of firms). Again, the precise directions and magnitudes of these effects depend on tastes, technology, and other market parameters. In formal analyses of this situation Spence (1976) and Dixit and Stiglitz (1977) show that it is possible for a free-entry equilibrium to result in too many firms (too much variety). When this is true, entry restrictions could again improve welfare.

The same caveat, however, about ex ante and ex post applies here. When a merger between two existing firms occurs, there may be little change in either the number of products produced or the cost of producing these products. Nevertheless, the presumption is that mergers reduce variety.

In the previous analysis of variety, differentiation is horizontal. That is to say, if all products are offered at the same price, consumers differ in their preferences (some prefer red and some prefer blue cars, for example). If differentiation is vertical, when prices are equal everyone prefers the highest quality (everyone wants a high-speed car). Shaked and Sutton (1983) show that with vertical differentiation and price competition, if variable costs do not increase too rapidly with quality, there exists a limit to the number of firms that can profitably coexist in the market. Under these circumstances, a structural policy designed to increase the number of firms in a market would result in reduced welfare.

Economies of scope, scale, and product variety, therefore result in complex tradeoffs that must be weighed in forming competition policy. Determining the optimal number of firms is never a simple problem. One can say, however, that when these economies are prevalent, approximating the competitive outcome is not a reasonable goal.

#### 4.3.2. Dynamic efficiencies

Dynamic economies occur over time and, as with most intertemporal problems, the issues are even more complex than with static economies. We examine two dynamic effects: learning and technical change.

Learning is said to occur when unit cost declines with cumulative output. In assessing competition policy, it is important whether learning occurs within an industry or within a firm. When the benefits of learning cannot be captured by firms, there is no incentive to have fewer firms in an industry. Under these circumstances, however, another set of problems arises due to the public-good nature of learning. Ghemawat and Spence (1985) discuss this distinction. In the standard economic analysis of learning [Spence (1981) and Fudenberg and Tirole (1983)] learning is firm specific.

The special dynamic issues that arise as a consequence of learning, such as the possibility of strategic behavior, are beyond the scope of this chapter. The interested reader is referred to the references above. From the point of view of competition policy, however, learning bears a resemblance to scale economies. For example, there exists a tradeoff between cost reduction and output restriction as the number of firms varies. The calculation of the sizes of these effects is even more complex than with static economies but the same qualitative conclusions hold. In particular, it is not generally the case that more firms are preferred to less or that unregulated markets lead to optimal outcomes.

Technical change, which expands the production possibilities available to society, is perhaps the most important dynamic economy. Few economists would disagree with the claim that the dynamic-efficiency gains from continuing innovation far outweigh the static gains from marginal-cost pricing. In addition, in markets where innovation is frequent, competition policy can be less vigilant. Monopoly rents will be constantly eroded as new products and processes are introduced. The real question is what role market structure plays in the innovative process.

The debate about the relationship between market structure and innovation has been going on at least since the time of Schumpeter (1934) and yet economists still hold diametrically opposed views on the subject [see Nelson and Winter (1982) for a discussion of the issues]. It is, however, possible to make a case for the position that perfectly competitive markets can be inimical to technical change.

First, it is not always easy to capture the rents from innovation. When knowledge takes the form of a public good and there are few firms in an industry, however, private and social costs of innovation differ less than under competition. As a consequence, underinvestment in research is less dramatic. Second, if capital markets are imperfect and internal funds are needed to finance R&D, oligopoly rents can provide these funds.

However, if empirical evidence were to suggest a positive correlation between market concentration and innovation, such a correlation would not reveal the direction of causation.[21] In the previous examples, it was claimed that a concentrated market could be conducive to innovation. The reverse pattern could also be true. A firm that innovates successfully may grow and capture a larger share of the market, causing concentration to increase.

We have seen how competitive markets may not be conducive to research. At the opposite extreme a monopolized market may also be inimical to innovation. Without the pressure of rivals, a monopolist may have few incentives to invest in R&D. In addition, the monopolist has a vested interest in protecting current product lines.

Dasgupta and Stiglitz (1980) build a theoretical model that confirms many of these intuitive notions concerning the relationship between market structure and innovation. In their model, at least for low levels of concentration, there is a positive correlation between concentration and R&D effort. In addition, they find that there may be excessive duplication of effort in an unregulated economy, in the sense that too much is spent relative to the cost reduction produced. Finally, they find that a pure monopolist underinvests in R&D.

We thus see that with dynamic economies, similar conclusions hold as with static. Conditions of perfect competition as well as of monopoly may not be optimal. In addition, unregulated markets may not result in efficient outcomes.

[21] The reader is referred to Chaper 19 in this Handbook for an in-depth discussion of the empirical evidence.

With dynamic efficiencies, however, we must add to these shared complexities. The problems of weighing tradeoffs are even more difficult because it is insufficient to merely determine magnitudes of effects. The time pattern of costs and benefits must also be considered.

To conclude, an analysis of the multiple aspects of efficiency and of the second-best problems characterizing many situations suggests that it would be presumptuous to identify precisely the efficiency consequences of most business conduct and to advocate fine-tuned optimal antitrust rules. Nevertheless, these difficulties do not lead us to conclude that governments should abandon all policy towards monopolization and merger.

We know that there is no theorem proving the optimality of non-neoclassical, Schumpeterian forms of competition [see, for example, Marris and Mueller (1980)]. The inability of firms to appropriate a sufficient proportion of consumers' surplus can lead to a composition of product types and a rate of technical advance which can vary widely from what would be socially desirable. In our opinion, the general presumption must be that an antitrust policy augmenting competitive forces is needed to enhance economic efficiency. The burden of proof that specific practices which appear to represent a restriction of competition actually represent an increase in competition in a second-best sense or in the relevant dynamic and uncertain framework must be supported by those wishing to adopt these practices.

### *4.4. Industrial policy*

Most countries seem to accept the need for some form of antitrust policy. It is believed that many monopolies and cartels are detrimental to the public interest and that therefore public authorities should be wary. Anticombines laws and the vigor of enforcement of these laws vary from country to country. Nevertheless, there seems to be a consensus that this is a legitimate government activity.

Behind the acceptance of the need for antitrust policy lies the notion that competitive markets are socially optimal and that therefore industries should be made workably competitive. It is of course also accepted that some industries such as communications are natural monopolies. These industries are therefore either nationalized or regulated.

We have just seen, however, that in many instances competitive-market structures are not optimal and that the workings of an unregulated market mechanism, even in the absence of scale economies, can result in inefficient outcomes. A question that naturally comes to mind, therefore, is whether antitrust policy is enough or whether there is a need for an overall industrial policy. This is the final question that we wish to address.

The term industrial policy is very broad and ranges anywhere from a plan concerning the desired number and size distribution of firms in every industry to a vague intent to subsidize certain types of activity while discouraging others.

More specifically, there are two extreme views of industrial policy.[22] For many, the best industrial policy is no policy at all. Where a policy aims at slowing down the process of structural change and keeping alive declining sectors, it damages the rest of the economy. And when it tries to influence growth through the redeployment of human and physical capital, it often lacks valid criteria. In both cases, allowing the government to replace markets as the allocator of resources raises the familiar issues of political failures and rent-seeking behavior [see, for example, Curzon-Price (1981)].

At the other end of the spectrum, some argue that free-market forces do not establish appropriate outcomes and that market failures are significant. A voluntary policy based on a national consensus and a close relationship between government and enterprises could then represent a substantial improvement in social welfare [see, for example, Magaziner and Reich (1982)].

More recent approaches adopt less sanguine views and try to establish connections between the vague concept of industrial policy and recent theoretical works in industrial organization [Geroski and Jacquemin (1985), Yarrow (1985), and Dixit (1986)]. A central issue is the strategic behavior of governments; governments as well as firms appear to be players. By committing themselves to suitable policies, they are able to change the outcome of the oligopoly game.

In this sense, every country has an industrial policy. The problem with existing policies, however, is that they are not written down, openly debated, and agreed upon. Instead, they come in through the back door in the form of investment-tax credits, depletion allowances, tariff protection, tax-free status, and other forms of subsidies and special tax treatment. These policies have unacknowledged effects. For example, capital-intensive industries may be encouraged at the expense of those that are more labor intensive.

An advantage to an articulated industrial policy is that special treatment of certain industries has to be justified and reconciled with an overall pattern. Instead, what we see today is privileges going to industries with outstanding lobbying skills. The results surely cannot be efficient.

In this subsection we examine cooperative behavior that governments can usefully encourage. There are many areas where noncooperative solutions are suboptimal. Some of these situations take the form of a prisoner's dilemma. Excessive expenditures on advertising or wasteful duplication of R&D effort are just two examples. In these instances, even firms might welcome the opportunity to have their hands tied – to precommit themselves to less effort. It is therefore not only the consumer that might benefit from government intervention.

[22] For various approaches to industrial policy, see the papers published in Jacquemin (1985).

We would like to single out two areas where we feel that special policy might be beneficial. These areas, which lie at opposite extremes, are R&D intensive industries and declining industries.

The public-good nature of knowledge has already been stressed. When this is an important consideration, firms underinvest in basic research. Patents are a partial remedy to the problem but do not eliminate it entirely. In addition, duplication of R&D effort can be wasteful and can lead to less cost reduction than if firms shared information. In line with the U.S. and EEC Regulations on cooperative research,[23] a lenient antitrust policy towards research joint ventures or cooperative laboratories could aid the dissemination of information and therefore increase efficiency.

Research activities can also be very risky. When risk is coupled with the need for large up-front outlays, private firms may be hesitant to undertake potentially profitable activities. Some forms of basic research require long periods from initial undertaking to final payoff. If firms have shorter planning horizons or higher discount rates than society, again, socially beneficial projects may not be undertaken.

Finally, "first mover" advantages coupled with effective barriers based on sunk costs such as R&D expenditures characterize many high-technology industries, and small historical accidents (such as which firm was the first to innovate) can have a large cumulative role in the temporal unfolding of an industry. This opens the door to a number of strategic issues including the role of government in R&D subsidies and in encouraging concerted actions to overcome existing barriers or to favor one equilibrium outcome over another. Government support may lead to equilibria in which favored firms choose to enter the international market while rivals have to decide otherwise. These situations are typified by industries such as aerospace, semicondutors and computers.

All of these factors point toward the need for cooperative research programs where governments play an active role. We do not mean to imply that all countries should subsidize high-technology industries. This would be particularly inappropriate in regions where labor is in excess supply and technological improvements move firms in the direction of capital intensity.[24] We do feel, however, that special cooperative policies might be warranted.

At the other extreme we have declining industries. Economic theories of firm exit rarely point to the optimality of a market solution [Ghemawat and Nalebuff (1985), for example]. We do not mean to suggest that governments should subsidize dying industries and prolong their lives artificially. It is often easier,

[23]For the United States, see the National Cooperative Research Act of 1984, Pub.L. 98-462, 98 Stat. 1815, and for the EEC, the block exemption Regulation R&D Agreements, *Journal of the European Communities*.

[24]It is often true, however, that high-technology industries are labor intensive. This accounts for the fact that many electronics firms are located in countries of moderate development in the Far East.

however, for a program of rationalization to proceed in an orderly fashion if it has the participation of an uninvolved party such as the government.

Indeed, in exit games the question of who goes first is at the heart of strategic competition. In various circumstances, it can be shown that even when it is clear to all that a market is in decline, each firm may decide to remain and, in such circumstances, there may be persistently low returns and little innovation in the industry over long periods of time. Outside intervention might then be needed to implement a program of rationalization to ensure exit in an orderly fashion.

Here again, there is little need for antitrust vigilance but for a different reason. With an industry that is dying, deviations from marginal-cost pricing have only a transitory impact on welfare. Government intervention in declining industries should therefore lean towards cooperative solutions rather than being concerned with the losses due to concentration.

By singling out particular industries that could benefit from cooperation, we do not wish to propose specific solutions to special problems. Rather, we wish to emphasize that there are many areas where cooperation at the national and international level can be beneficial.[25] The most important point, however, is that there is a need for countries to articulate, debate, and reach a consensus on industrial policy. Leaving this important area to special-interest lobbyists as is current practice does not seem likely to lead to efficient outcomes.

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[25]Because of arguments similar to those discussed in the case of private agents, countries have strong incentives to engage in noncooperative behavior even though the outcome is worse for all. In order to overcome these difficulties, it is necessary to design institutions that will enforce cooperative behavior and that do not ignore the strategic aspect of group decision-making. As shown by the Gibbard–Satterthwaite theorem [see, for example, the discussion in Green and Laffont (1979)], however, it is impossible to solve all the incentive problems involved in such a design.

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