THE HISTORY OF THE STATIC EQUILIBRIUM DOMINANT FIRM PRICE LEADERSHIP MODEL

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INTRODUCTION

Dominant firms have played an important role in the analysis of imperfectly competitive markets for almost a century. Early static equilibrium models treated the dominant firm as a price leader and, therefore, passive quantity follower. There was little recognition that the large firm’s position might erode without the active use of its power to prevent rivals and potential entrants from expanding their market shares. Subsequent research recognized this internal inconsistency, thus incorporating strategy and dynamics into the models [Bain, 1949; Worcester, 1957; Gaskins, 1971]. These later models allowed the dominant firm to set prices sufficiently low to limit or deter entry, yet high enough to maximize the net present value of profits over time. The goal of this article is to look back at the development of the original static equilibrium model of a dominant firm, in which the large firm acts as a myopic price leader, without considering the implications of its action on its future market share or profits. We call this the dominant firm price leadership model.

The dominant firm in this model is expected to behave as a price leader in anticipation that its smaller rivals will behave as passive price followers. Consequently, the dominant firm derives its demand for a homogeneous product as a residual by subtracting its rivals’ aggregate supply from industry demand. It then maximizes its profits by behaving as if it locates the output level where its marginal cost (MC) equals marginal revenue (MR) derived from its demand, i.e., like a monopolist. In this model the rivals do, in fact, behave as price-takers. Consequently, the expectations of all sellers are fulfilled and a stable equilibrium results.

Equilibrium output in this market falls short of the competitive level, but exceeds the level that the dominant firm would offer for sale if it were a complete monopolist. In this situation the deadweight welfare loss is a weighted average of the efficiency losses of complete monopoly and of perfect competition (zero), the weights depending on the industry elasticity of demand, the aggregate supply elasticity of the dominant firm’s rivals, and the market shares of the dominant firm and its rivals. These market shares, in turn, depend on the technologies and factor prices available to each firm, and the number of rivals in the competitive fringe. The essence of the model is that the monopolist’s usual output restriction is mitigated by expanded output from the rivals.
the monopoly firm as a seller of the product with market power. This power arises from the ability of the firm to raise prices above marginal cost without losing all customers. The equilibrium price and output are determined by the interaction of supply and demand. The equilibrium price is above marginal cost, and the equilibrium output is less than the competitive output. This results in a deadweight loss to society, as the quantity produced is less than the socially optimal level of output. The monopoly firm benefits from this loss, as it is able to charge a higher price than marginal cost. This is a classic example of market failure, where the market does not allocate resources efficiently. There are several reasons why this may happen. First, the monopoly firm may have market power because of economies of scale or other market imperfections. Second, there may be barriers to entry, such as patents or government regulation, that prevent new firms from entering the market. Third, there may be externalities, such as pollution, that are not reflected in the market price. As a result, the monopoly firm will produce less output and charge a higher price than a competitive firm. This leads to a loss in consumer surplus, which is the difference between the maximum price a consumer is willing to pay for a good and the actual price paid. The loss in consumer surplus is equal to the area of the triangle between the demand curve and the price line. This is known as the deadweight loss. In the long run, if there are no barriers to entry, the monopoly firm will eventually be driven out of the market by new firms, who will enter because they see an opportunity to make a profit. This is known as market entry. In the short run, however, the monopoly firm will continue to produce at the output level where marginal revenue equals marginal cost, even though this may be less than the socially optimal level of output. This is because the firm is not able to predict the actions of new firms in the long run. The result is a loss in efficiency.
TABLE III

<table>
<thead>
<tr>
<th>Price (in thousands)</th>
<th>Quantity the cartel can expect to sell at each price</th>
<th>Cartel's returns</th>
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Increasing amounts at higher prices. His Table III (1908, 8) illustrates the first market situation.

Forchheimer substituted the 400 units supplied by the competitors from the industry into demand, yielding the quantity which the incomplete monopolist, i.e., the dominant firm, could sell at each price. Net revenue is maximized at a price of four. "The resulting price" he concluded "will be greater than the price under perfect competition and will yield a monopoly profit; but the resulting price is lower than the absolute [complete] monopoly price [since] it has elements of monopoly and perfect competition" (1908, 9). Where the supply elasticity of the outsiders is zero, Forchheimer argued that there is no specific outsider market share which indicates the existence of an incomplete monopoly market. But he went on to say that the greater the divergence between the competitive and monopoly price in this market, and the less responsive is quantity demanded to price increases, then the larger the market share of the outsiders can be without destroying the power of the incomplete monopolist. In his intuitive explanation of how the market share of outsiders depends on the mark-up and the demand elasticity, Forchheimer partially anticipated the later, and more complete, dominant firm analyses of Stackelberg (1934) and Stigler (1940).

Forchheimer next considered a situation where the competitive fringe offers greater quantities for sale at higher prices. In this case, the equilibrium for the incomplete monopolist example is at a price of $3$, where the cartel sells 900 units and its net revenue is maximized at $2,700$ as in his Table IV (1908, 11). He concluded that "the same general picture emerges" as in the case of completely inelastic fringe competitors' supply. At higher prices, the increased competitive power will affect the relative monopoly price, which will always emerge under the assumed circumstances. Incomplete as it is, Forchheimer's 1908 article appears to be the first attempt at a formal treatment of the dominant firm.

1921-1926: Viner, Knight, Hirsch

Two brief but interesting discussions of the dominant firm appeared in 1921. One was Jacob Viner's "Price Policies: The Determination of Market Prices," a chapter in Business Administration edited by L.C. Marshall. Although published by the University of Chicago Press, this discussion apparently went unnoticed until it was reprinted in 1958 (Spiegel, 1987, IV, 413). After describing price determination in various types of markets including competition, monopoly and what later became known as monopolistic competition, Viner examined what he called the "follow-the-leader method of price determination" (1958, 6-7) in a market consisting of "one producer controlling a large fraction of the total production . . . and smaller producers, [who] without any formal or informal agreement, will adopt this [the dominant firm's] price list as their own . . . . The smaller concerns will often welcome the leadership of the large producer in setting prices, as they are glad to escape price competition . . . and the leading producer by this method gains most of the advantages of monopoly control while avoiding the expense of eliminating competitors and the danger of government interference and of public resentment" (1958, 7). Just what determines the "price list" however is not described. Although Viner possessed a vast knowledge of the literature, including works published in German, his belief that "the leading producer . . . gains most of the advantages . . ." suggests he was unfamiliar with Forchheimer's tables.

Frank Knight also published a brief literary description of the dominant firm theory in 1921. Although his 1916 thesis, written under the guidance of Alvin S. Johnson and Allyn Young at Cornell, did not include a treatment of partial or incomplete monopoly, one of the additions to the original thesis which later appeared in Knight's famous Risk, Uncertainty and Profit (1921), mentioned "the essence of the theory of the dominant firm" (Stigler, 1987, III, 56). Knight wrote:
In many cases it might be profitable for the owner of a considerable block, though not the whole supply of an important productive service, to restrict its use and so increase the value of the product. Whether the owner of a part of a supply can gain by withholding some of that part from use will depend upon the fraction of the supply which he holds and on the flexibility of the supply obtainable from competing services and the elasticity of the demand for the product. In view of the fact that practically every business is a partial monopoly, it is remarkable that the theoretical treatment of economics has related so exclusively to complete monopoly and perfect competition [1921, 183, n.1].

Knight thus related equilibrium price in a dominant firm situation to the market share of the dominant firm, the price elasticity of market demand and the supply elasticity of the fringe firms, as Steckelberg [1934] and Stigler [1940] would later do. But, unlike Viner, Knight did not make explicit the crucial assumption that the smaller firms adopt the dominant firm's price. Furthermore, he seems to have been unaware that the model's application is limited to cases of partial monopoly where price leadership realistically could be assumed. Knight's remarks appeared in a footnote with no numerical or diagrammatical analysis. Like Viner's treatment, it apparently had no impact on the profession, although it may have influenced Stigler.

In 1929 another treatment of the dominant firm appeared, in an appendix to Julius Hirsch's League of Nations publication, National and International Monopolies From the Point of View of Labour, the Consuming Public, and Rationalisation. Although Hirsch did not cite the prior writings of Forchheimer, Viner or Knight, his numerical example for "incomplete monopoly" closely resembles Forchheimer's first case, where the competitors produce a fixed output regardless of the price established by the dominant firm. Unlike Forchheimer, however, he gave the separate total costs and total revenues for the dominant firm and identified an equilibrium price which maximizes the difference between the two to show a maximum of "profit with incomplete monopoly" [1926, 43]. Hirsch stated that where a strong cartel, i.e., a dominant firm, "lets outsiders live, the outsider usually adapts himself pretty closely to the price of the cartel," concluding that this situation will continue until "the loss of a really considerable part of the command of the market gradually forces [incomplete] monopolists back into the position of the free market" [1926, 43-44]. Thus Hirsch anticipated the long-run implications of the model and the subsequent limit price and dynamic optimal control models of a dominant firm [Bain, 1956; Worcester, 1957; Gossain, 1974]. Other than a summary of Hirsch's example by A. J. Nichol in 1930, there does not seem to be any other reference to this incomplete and rather unsatisfactory discussion of the dominant firm model.

1930: ZEUTHEN, NICHOL, VINDER

In 1930 the dominant firm model appeared three times, in books by Danish economist Frederik Zeuthen and by American A. J. Nichol, and in a student's notes of Jacob Viner's lectures given at the University of Chicago in the summer of 1930. In each of these presentations we see for the first time diagrammatic attempts to explain the pricing policy of the dominant firm.

Zeuthen, in his Problems of Monopoly and Economic Warfare, considered partial monopoly in the fashion of Forchheimer, whom he cited, assuming first that the competitors' output decision is completely insensitive to price, and second that competitors increase their production as the partial monopolist raises price. The former case is shown in Figure 1, where DD' represents the excess price curve. He concluded, "If now, his competitors take an amount K of his sales, the demand curve DD' from the point of view of the monopolist will be substituted by a curve D'D parallel with the former and the monopolist will limit his sales by half of what his competitors have taken" [1930, 18-19].

Zeuthen then examined partial monopoly where the fringe firms have increasing MC and the partial monopolist has, first, constant, and then increasing costs, as in Figure 2 A-B below.

Zeuthen began with the competitors' supply SS, reasoning that the distance of these curves from the "special y axis" indicates the "total supply of the competitors at the different prices (their marginal cost)" which, when subtracted from market demand DD, yielded the residual demand of the partial monopolist D'D' [1930, 25]. In Figure 2-A, the case of linear demand and cost curves, the equilibrium price is identified, as earlier, at the mid-point of his "excess price curve." And apparently the same procedure was followed in the case of non-linear functions in Figure 2-B. What is missing from Zeuthen's analysis is the marginal revenue concept, not surprising considering the date he was writing. Consequently, without further elaboration he concluded that, like absolute monopoly, partial monopoly has a definite solution. Whereas "price and quantity without competition will be p and q, the result here will be a price of p* a quantity for the [partial] monopolist of q* and a total quantity of q* [1930, 25]. Had Zeuthen introduced the marginal revenue curve for the partial monopolist, he would have anticipated the diagram in Stigler's 1940 article.

Archibald J. Nichol's Partial Monopoly and Price Leadership also appeared in 1930. In 1928 he attended a summer course given by Jacob Viner at the University of Chicago which he says aroused his interest in the problem of monopoly. The following academic
year he wrote his thesis at Columbia and published it in book form in 1930. It is interesting to learn [1930, 3] that the "manuscript in various stages of its development [was] read by Professor Jacob Viner" among others. Nichol cited Forshheimer and Hirsch, but not Knight or, indeed, Viner's 1921 summary of the dominant firm.

In Chapter II, "The Price Theory of the Partial Monopoly," after summarizing Forshheimer and Hirsch, Nichol sought to prove that the partial monopoly could dictate "within certain limits (which are to be ascertained) a price to the rest of the market which will not be altered by competition" [1930, 24]. Similar to Forshheimer, Nichol first considered a situation where the competitors supply a fixed quantity regardless of market price. He also examined "the influence of continuous-profit-seeking or avoidance of less on the part of the price-fixing agency itself" [1930, 25] when the fringe firms experience rising marginal costs. He illustrated this case as in Figure 3 below.

DD' is industry demand, and mc is "the marginal cost curve of competition" [1930, 29], which is subtracted from DD' to derive df, the demand curve for the partial monopolist. Nichol used C'C', as the average cost curve of the partial monopoly, instead of using its marginal cost curve, since, he says, the "partial monopolist will insist on at least 'breaking even' with cost of production all the time" [1930, 28]. He then searched for the "price which will yield the partial monopoly the maximum of continuous profit" [1930, 29], a price which will lie below QR, where all the sales are made by the smaller competitors, and above wt; any price below wt will result in losses because at those prices the dominant firm's average revenue dd' is less than its average cost C'C. He stated that "the partial monopoly may secure the maximum... profits [as] determined in step (2)," but in step (2) the price which would maximize the dominant firm's profits is not given—presumably due to the omission of the dominant firm's marginal revenue and marginal cost curves. All Nichol adds is that "[a]lthough geometric solution may be arrived at by the use of increment curves" [1930, 29]. Nichol's diagrammatic presentation thus does not go beyond that of Zeuthen. His verbal analysis is less satisfactory than Knight's 1921 treatment, which related the dominant firm's price to its market share and the price elasticities of the demand for the product and the competitors' supply. Neither Nichol nor Zeuthen described how a profit maximizing dominant firm would identify the price at which its and the fringe firms would sell, but both came perilously close.

During the summer quarter of 1930, Jacob Viner gave the graduate course in "Price and Distribution Theory" at the University of Chicago. A set of notes taken by M. D. Ketchum, one of the students in the class, was later mimeographed and survives. In lecture seventeen on Monopoly, Viner discussed what is referred to as a "follow-the-leader industry [where] one concern issues the price list and the other concerns believe that the costs of price competition are too great to fight the large concern" [Ketchum, 1931, 45-46], leading the dominant firm to perceive them as price takers. Ketchum's notes, in spite of erroneously indicating a profit maximizing equilibrium for the dominant firm at an output where marginal revenue exceeds marginal cost, clearly indicated that Viner was by this time subtracting the supply curve of the fringe firms from the market demand in order to derive the dominant firm's demand curve.

Stigler attended Viner's lectures in the early 1930s. In 1937 he credited Viner with a correct presentation of a diagram of the dominant firm model, adding that the solution "has not appeared in print." In a footnote he added: "The solution was first suggested by Professor J. Viner in lectures at the University of Chicago, so far as the writer knows"
many competitive sellers has the power to be a price-maker, while the other competitors remain price-takers. This is not described as monopoly, or incomplete monopoly, but as an analysis of the determinants of the price-maker’s power and its consequences for the competitive equilibrium condition of price equals MR and MC. Where one firm has price-making power a deviation between price and MR evolves. And he states (very much like the remarks of Frank Knight made some thirteen years earlier) that the extent of the deviation will be determined by (1) the price-maker’s share of the market, (2) the price elasticity of demand for the commodity, and (3) the price elasticity of supply of the remaining price-takers, in terms of the following equation [1934, 110].

\[ k' = p(1 + \epsilon \gamma) / X \gamma / \epsilon \]

where:

- \( k' \) = marginal revenue of the price setting seller
- \( p \) = market price
- \( \gamma / X \) = share of the market of the price setting firm
- \( \epsilon \) = price elasticity of demand for the commodity
- \( \sigma \) = price elasticity of supply (MC) of the price-taker sellers.

Stackelberg concluded that the smaller the market share of the price-maker the less is the divergence of \( p \) from MR and that as the share approaches zero, \( p \) approaches MR. He also remarked that the price elasticity of demand for the commodity and the price elasticity of the competitors’ supply cannot simultaneously be zero [1934, 110] if there is to be a unique equilibrium. On the following page [1934, 111] when he formally comes to incomplete monopoly, all he says is that we must not overlook the importance of the price-maker’s market share. There is no discussion of the manner in which the two elasticities affect the profit maximizing behavior of the dominant firm.

That Stackelberg understood the mechanics of the dominant firm model is clear. That he did not relate the degree of monopoly power, the divergence of \( p \) and MR, to the two price elasticities can only be attributed to the fact that he felt the analysis of incomplete monopoly, like monopoly and competition, had been adequately discussed by economists such as Forchheimer and especially covered in his thought-experiment when analyzing competition. His analysis of the dominant firm situation, correct as far as it went, was therefore not complete. Rightly therefore, Stackelberg’s fame rests on his invariable “asymmetric duopoly [model] that is known all over the world” [Kreile, 1967, IV, 460].

None of the presentations surveyed so far contain a complete treatment of the pricing policy of the dominant firm in terms of (1) an analysis relating the equilibrium price to market share, the price elasticity of demand for the commodity and the price elasticity of supply of the competitor firms and (2) a diagram showing how equilibrium price is determined by the intersection of the dominant firm’s marginal revenue and cost curves, that reveals the division of output between the dominant firm and the fringe of smaller competitors. This we first find in Stigler (1940).
Stigler then derived the equilibrium outcome algebraically, arguing that the dominant firm’s output and price would be a function of its share of the market (h), the elasticity of supply of the minor firms (c) and the market elasticity of demand for the product (\( \eta \)), as given in equation (2),

\[
p(t + h/(\eta - \varepsilon (1 - k))) = \Phi(x,)
\]

where the dominant firm’s marginal revenue is equal to its marginal cost \( \Phi'(x) \). In this equation Stigler used MC rather than MR but, since in equilibrium they are equal to each other, it is essentially the same as the equation in Stackelberg’s mathematical appendix. Stigler, however, extended Stackelberg’s interpretation of the equation by discussing the effects of the relevant elasticities, as well as the dominant firm’s market share on industry price and, by inference, industry output. He concluded with four generalizations (1940, 524):

1. The output of the dominant firm will decrease as \( k \) increases, if all other variables remain fixed.
2. The output of the dominant firm will increase as the elasticity of supply of the minor firms (\( x \)) increases, if all other variables remain fixed.
3. The output of the dominant firm will increase as the elasticity of demand (\( \eta \)) increases in numerical value, if all other variables remain fixed.
4. It follows by implication from equation (2) that there is no particular value of \( k \) for which this policy of pricing becomes profitable. The ratio \( k \) can be relatively small if \( \varepsilon \) is also small.

Although Stigler did not attempt a direct welfare analysis of the dominant firm model, it can be inferred from his four generalizations. The dominant firm’s price is inversely related to its output. Thus, as the dominant firm’s output diminishes, its price, and therefore industry price, rises and industry output declines. To the extent that price exceeds marginal cost of the dominant firm (and is equal to marginal cost of the smaller rivals who behave as price takers), price will always exceed aggregate marginal cost and output will necessarily fall short of the surplus maximizing competitive level. Greater output restrictions cause increased welfare losses; the dominant firm’s output level is systematically linked to resource allocation.

Thus most of the equilibrium dominant firm price leadership model had been analyzed and synthesized by Stackelberg by 1914. It was offered in essentially the form it appears in modern presentations by Stigler in 1940.

**SUMMARY**

The static equilibrium dominant firm price leadership model seems to originate with Karl Forchheimer in 1908. The record shows that both Frank Knight and Jacob Viner understood the essence of the model by 1921, but neither apparently provided a rigorous analysis of it. In 1930 both Archibald Nichol and Frederik Zeuthen transformed the model into graphical form. But neither included one of the critical behavioral characteristics of the model—the dominant firm maximizing its profits by setting its marginal revenue equal to its marginal cost.
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quantity, q, of the same good. Cournot solved this profit maximization problem mathematically assuming that the n firms act collectively as one. However, he neither dignified the model with a name, nor did he provide an economic interpretation of it.

In Forbush's first model, Cournot's n firms acting as one become a cartel acting as a price-setter fixed with competing firms producing at capacity a fixed output of 400 units, so that Cournot's n became 1. It appears that Forbushrewrote Cournot's model to analyze his first case of the dominant firm market and, in a phrase from Joan Robinson, mentioned the name of the emulator when he "found already at the Poles when he arrived there" (1939, xiv), although citing Cournot in an unqualified way.

In Dussin's dynamic optimal control model, a dominant firm with no rival advantage maximizes its long-run profit by setting price above the price necessary to limit entry, earning monopoly profit while it is, and letting its market share steadily erode.

1. E. H. Phelps, in his chapter on "Marginal Revenue," summarized the early history of the marginal revenue concept. The earliest attempt by Cournot (1838) and Marshall (1890) were not accredited to credit them for having invented "marginal revenue" (1897, 29). The earliest "printed occurrence of the phrase marginal gross revenue," he reported, appeared in an apparently very little read article by P. X. Zeuler entitled "The Influence of Dumping on Monopoly Profit" (1928, 605-606). Although Zeuler's view both Cournot and Marshall took to refer to Zeuler, we were able to trace this free use of the term by 1838.

REFERENCES

DO COMPETITIVE HOSPITALS REALLY ADOPT TECHNOLOGY FASTER?

AN ANALYSIS OF THE INFLUENCE OF ALTERNATIVE RELEVANT MARKET DEFINITIONS

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INTRODUCTION

Empirical evidence suggests that competitive hospitals have higher prices than monopoly hospitals, a result that is of course at odds with standard microeconomic theory (Farley, 1985; Robinson and Ulf, 1985). A common explanation for the anomalous effect of competition is the interplay between third party payment and technological advance. Third party payment, especially during the cost-based reimbursement environment of the 1970s and early 1980s, drove a wedge between the customer, or patient, and the price that was paid for care. This made it fruitless for hospitals to engage in price competition. Instead they competed by being the first to acquire the latest technology, attracting patients who associated the acquisition of technology with quality, and perhaps more importantly, physicians whose incomes could be augmented by the technology. This led to speedy adoption of unproved innovations, duplication of services in competitive markets, low utilization, high overhead, and inflated costs.

This explanation has had a strong influence on policies intended to promote cost containment in the hospital industry. Instead of focusing on ways to speed up the diffusion of cost saving technologies, an important policy goal in other industries, health economists and policy makers focused on limiting the diffusion of cost increasing medical technologies. The link between competition and technology provided an important policy tool. If it were true that competition spurred adoption, then costs could be contained by limiting competition, for example by allowing hospitals to close or merge. But reduction policies became popular, and mergers were often promoted.

Although the link between competition and technology adoption is intuitively plausible, it lacks empirical support. Studies of the diffusion of technology in hospitals have not found that competitors are quicker or more likely to adopt (Russell, 1978; Rapoport, 1975; Romero, Wagner and Lee, 1984; Lee and Waldman, 1985; Cromwell and Kinak, 1983; Sloan, Volack and Porrin, 1986; Schwartz and et al., 1991). Most have found that competition has no effect on adoption, and one of the latest, Sloan et al. (1986), found that monopoly hospitals are more likely to adopt. The failure of these studies to provide a robust result could be due to the lack of a relationship, or to the existence of different relationships for different technologies. However, it may may instead be an artifact of the methods used in the previous research. These studies all suffer from several methodological shortcomings. A major shortcoming is their use of standard geopolitical areas, such as county, city, or SMSA, to define relevant market.

This study examines whether the choice of relevant market area affects estimates of the effect of market structure on technology adoption. It compares the results...