

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

(assuming increasing marginal cost) induced by the price leader's higher price. The monopolist accepts the burden of restricting output for the whole industry. Although the model implies a smaller deadweight welfare loss from restricted output than does complete monopoly, the overall welfare implication is ambiguous. The dominant firm price leader may attract costly excess capacity to the industry. The equilibrium distribution of output implies a higher marginal cost of production from fringe firms' plants than from the dominant firm, insuring short-run production inefficiencies as well. How these weigh against the allocative gains is unknown.

This analysis has been an established part of the accepted wisdom of oligopoly theory since World War II. The static equilibrium dominant firm price leadership model received renewed attention in the 1980s as a basis for competition policy analysis. Landes and Posner, in a lengthy 1981 *Harvard Law Review* article, argued that for Sherman Act enforcement, market power should be analyzed using the model. The *Harvard Law Review* subsequently committed a large part of its 1982 volume to comments on the Landes and Posner article.¹ Blair and Kaserman, in their 1985 book, *Antitrust Economics*, use the model four times, not only to analyze price leadership but also to analyze partial conspiracies, market division agreements, and boycotts. Furthermore, the model has been adopted by some antitrust authorities as one of two essential ways to evaluate whether a merger "may have the effect substantially to lessen competition" -- the other way being the likelihood that the acquisition would induce a cartel to form in the industry.

To support a claim of monopolization under the Sherman Act, the government or a plaintiff must first persuade the court that the defendant possesses sufficient market power to monopolize. For years such arguments hinged on the market share of the defendant or the number and size distribution of the leading few sellers in the market. In at least four recent cases, however, courts have relied on the static equilibrium dominant firm model to conclude that market power *cannot* be inferred from a defendant's market share alone; it also depends on the supply elasticity of fringe sellers and potential entrants, as well as the market demand elasticity.² In the Ball Memorial case, for example, the court concluded that the defendant insurance companies lacked market power in spite of their sizable market shares because relevant sunk costs were negligible, facilitating entry and creating a very elastic fringe supply. The U.S. Federal Trade Commission has also employed the dominant firm model. In *FTC v. B. F. Goodrich and Diamond Shamrock* [1988] [110 FTC 207] the Commission organized its entire analysis of a merger around two questions: (1) would the merger create a dominant firm and, if so, what constraints would limit the market power of the firm? And (2) would the proposed merger alter market conditions so that the likelihood of successful collusion increased?

The dominant firm price leadership model has also attracted attention from modern industrial organization scholars [Gisser, 1986; Suslow, 1986]. Cohen and Cyert [1975, 246-248] report behavior from the beryllium, retail grocery and steel industries that appears consistent with the behavioral premises of the model. Perhaps the most systematic empirical effort to test the dominant firm models (both the static equilibrium dominant firm price leadership model and the dynamic limit pricing model) was conducted by Alice White [1981]. White found that dominant firms earn considerably higher rates of return than other firms, holding constant industry concentration. A search for the market share necessary to take advantage of dominance revealed distinctly improved profitability when the largest firm accounted for fifty percent or more

of an industry's total sales. Whether dominant firms earn more because of the exploitation of their market power, because of product differentiation based on their dominant share, or because of greater production efficiency than other firms could not be disentangled by White.

In spite of its role in antitrust policy and industrial organization research, the dominant firm price leadership model is usually described without attribution. Fifteen of 23 modern intermediate microeconomics texts we surveyed include the model, but not one offers a hint about its origins! A similar proportion of industrial organization texts include the dominant firm price leadership model, and a few of them even trace the model's lineage. Scherer and Ross [1990] attribute it to Forchheimer [1908] and Nichol [1930]; Clarkson and Miller [1982] ignore Forchheimer, but cite Nichol and Stigler [1940]; McGee [1988] cites Forchheimer, and Baldwin [1987] lists Zeuthen [1930] and Stigler [1940] as leading contributors to the development of the model. Beyond this, citations surrounding the dominant firm price leadership model in industrial organization texts are either to empirical tests of the model or nonexistent.

It is our purpose in this essay to identify and recognize the scholars who, throughout the first half of the twentieth century, brought the static equilibrium dominant firm price leadership model from an embryonic idea to the popular model that has been a staple in oligopoly theory over the past fifty years. The story begins with Karl Forchheimer shortly after the turn of the century,³ and ends with a comprehensive presentation of the static equilibrium model by George Stigler in 1940, the form in which it has been used ever since.

1906-1908: FORCHHEIMER

In the winter semester of 1906-07, Alfred Weber, the brother of Max Weber, gave a seminar on the problem of monopoly and cartels at Prague's Charles-Ferdinand-University. Karl Forchheimer gave a lecture on incomplete monopoly to the members of Weber's seminar and later published an article based on his seminar presentation. The article appeared in 1908 in the prestigious *Jahrbuch für Gesetzgebung, Verwaltung und Volkswirtschaft im Deutschen Reich*, then edited by Gustav Schmoller.⁴ Forchheimer's analysis constitutes the first formal treatment of the dominant firm.

Forchheimer did not use diagrams, but rather employed four numerical examples, two for a monopoly [1908, 5, 6] and two for an incomplete monopoly [1908, 8, 11], i.e., a dominant firm faced with competition from a fringe of smaller competitors. Two of his tables (Table 1 and 2) were patterned after those in Richard T. Ely's *Monopolies and Trusts* [1900, 115, 121, 123, 125, 126, 128] where, in the case of a complete monopolist, equilibrium price maximizes the difference between total revenue and total cost, and therefore monopoly profits.⁵ In his examples, Forchheimer interpreted equilibrium price for a complete monopolist as the price which maximizes total revenue. Unless marginal costs are zero, this is incorrect. In his discussion of a competitive market and of an incomplete monopoly market, however, it is clear that Forchheimer used the term revenue to mean net revenue.⁶

For a complete monopoly Forchheimer argued that the equilibrium price would be higher and the quantity produced lower than under competition [1908, 5-6]. He then considered two cases of a dominant firm, which he called incomplete monopoly: the first where, due to short-run technical limitations, competing firms produce a maximum of 400 units regardless of the market price,⁷ in the second case, competitors supply

TABLE III

Price	Quantity the cartel can expect to sell at each price	Cartel's returns
10	---	---
9	---	---
8	(500-400 =) 100	800
7	(700-400 =) 300	2100
6	(900-400 =) 500	3000
5	(1100-400 =) 700	3500
4	(1300-400 =) 900	3600
3	(1500-400 =) 1100	3300
2	(1700-400 =) 1300	2600
1	(1900-400 =) 1500	1500

increasing amounts at higher prices. His Table III [1908, 8] illustrates the first market situation.

Forchheimer subtracted the 400 units supplied by the competitors from the industry 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.

TABLE IV

Price	Demand at this price	Competition at this price	Demand the cartel is facing at this price	Cartel's returns
10	100	---	---	---
9	300	---	---	---
8	500	---	---	---
7	700	---	---	---
6	900	900	---	---
5	1100	800	300	1500
4	1300	700	600	2400
3	1500	600	900	2700
2	1700	500	1200	2400
1	1900	400	1500	1500

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, 813]. 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 strong 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, 193, 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 Stackelberg [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 1926 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 firm⁸ [Bain, 1956; Worcester, 1957; Gaskins, 1971]. 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.

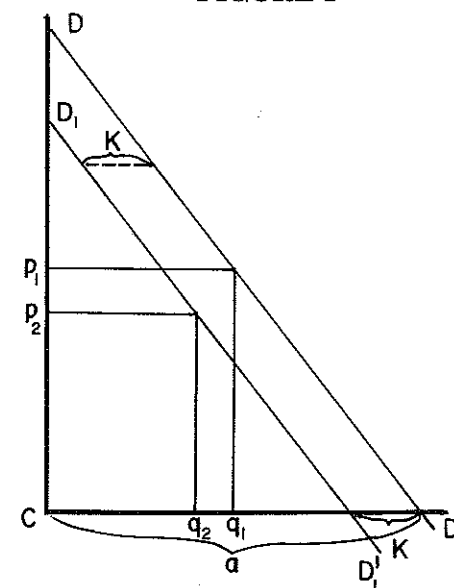
1930: ZEUTHEN, NICHOL, VINER

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_1D_1' parallel with the former . . . and the monopolist will limit his sales by half of what his competitors have taken" [1930, 18-19].

FIGURE 1



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 costs)" which, when subtracted from market demand D_1D_1' , yielded the residual demand of the partial monopolist D_2D_2' [1930, 22]. 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.⁹ 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_1 and q_1 , the result here will be a price of p_2 , a quantity for the [partial] monopolist of q_2 , and a total quantity of q_3 " [1930, 23]. 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 roused his interest in the problem of monopoly. The following academic

FIGURE 2

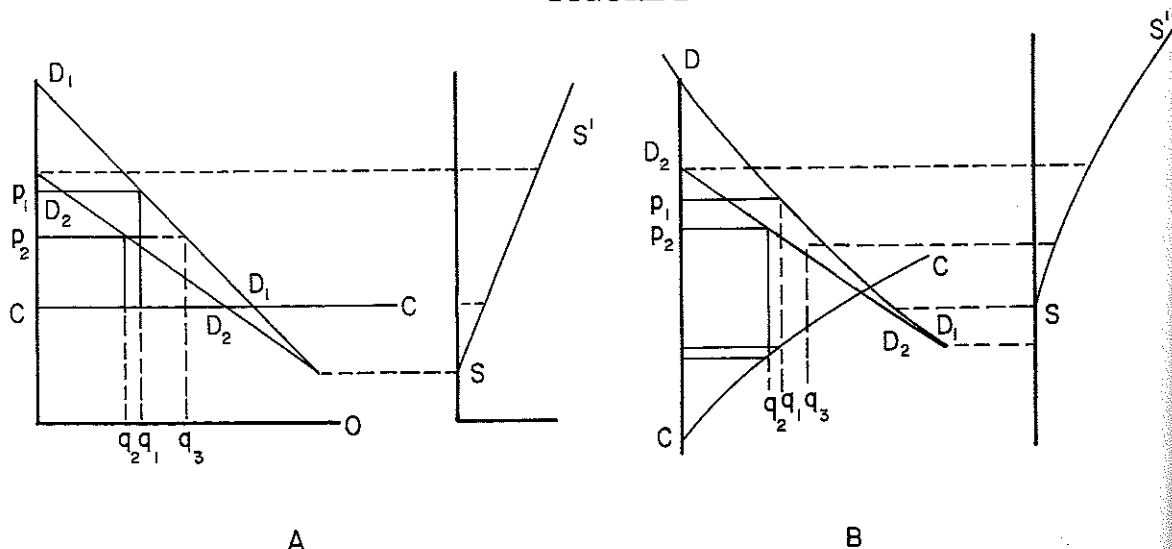
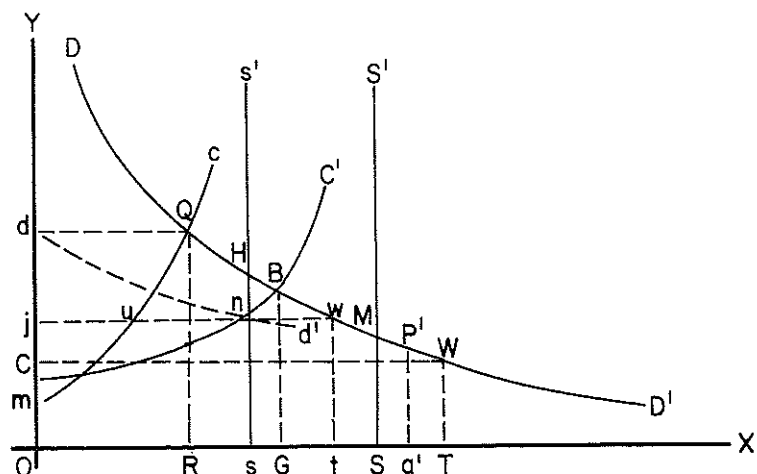


FIGURE 3



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 Forchheimer 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 Forchheimer 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 Forchheimer, 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 loss on the part of the price-fixing agency itself" [1930, 28] 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 dd' , the demand curve for the partial monopolist. Nichol used CC' , as the average cost curve of the partial monopolist, 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 CC' . 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]nother 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 it 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 indicate 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"

[Stigler, 1937, 716-717). Stigler went on to give an accurate verbal description of the dominant firm diagram, a diagram which he published in 1940, again crediting Viner.¹⁰

1934: STACKELBERG

While at the University of Cologne in 1934, Heinrich v. Stackelberg published his *Habilitation* thesis *Marktform und Gleichgewicht* which "had a lasting influence on price theory" [Krelle, 1987, IV, 469]. Stackelberg considered a duopoly situation characterized by two roughly similar size firms, both of which initially have the power to be price-makers. In this situation one firm may decide to act as a follower, because it thinks it will maximize its profits by being a price-taker, and the other firm assumes the role of price leader, because it thinks this strategy will maximize its profits. The leader then sets the market price to maximize its profits, after taking into account the fact that at that price, which the follower takes as given, the follower will obtain a share of the market, producing the quantity at which its MC is equal to the price (MR to the follower) determined by the price leader.

This market form is analytically similar to the dominant firm price leadership model. It is called asymmetrical duopoly by Stackelberg [1934, 22]. Stackelberg argued that equilibrium in this case is temporary, at best, since the competitively acting firm is one firm rather than a group of smaller firms, and roughly equivalent in economic strength to the price setting firm. Consequently, there is nothing in this market situation to prevent the follower from changing its strategy to that of a price leader; it would be tempted to do so upon realization of how profits are divided when it is a follower. If the follower also aspires to be a leader, this asymmetrical duopoly degenerates, first into duopoly in which both firms aspire to be the leader, and eventually into pure monopoly.

Covering the same analysis in a chapter on oligopoly in his 1948 book, Stackelberg argued that "[o]nly if one duopolist tries to reach his independent position and the other simultaneously tries to reach his dependent position will there be equilibrium.... The conditions of demand must be of a very special character and the costs of each producer must be widely different, if, in the same market, one [profit maximizing] duopolist is going to find it advantageous to take up his independent position at the same time as the other finds it most profitable to adopt his dependent position" [Peacock translation, 1952, 198]. Consequently, asymmetrical duopoly, while analytically similar to the dominant firm model, differs from it in that a stable equilibrium is not expected unless, as in the case of the dominant firm price leadership model, the price-maker faces not a rival of equal strength, but a group of smaller firms acting as a fringe of competitive price-takers.

Notwithstanding that his main concern was with the analysis of duopoly/oligopoly market situations, in his discussion of complete monopoly Stackelberg defined "incomplete monopoly," citing Forchheimer [1934, 16, 111], as a case where a single seller controls a considerable part of the market supply while "its competitors have such a small fraction of the supply that each of them considers the price as an independent variable" [ibid.]. Here we actually have a market structure identical to the dominant firm price leadership model, but Stackelberg does not develop the analysis of this case.

In his Mathematical Appendix, however [1934, 106-138--almost a fourth of the entire book], after showing that in competition, equilibrium price will equal both MR and MC [1934, 108], Stackelberg suggested a thought-experiment in which one of the

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 develops. 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].

$$(1) \quad k_j' = p[1 + y_j/Y][1/[\epsilon - \sigma_j(1 - y_j/Y)]]$$

where:

k_j' = marginal revenue of the price setting seller

p = market price

y_j/Y = share of the market of the price setting firm

ϵ = price elasticity of demand for the commodity

σ_j = 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 essentially 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 unstable "asymmetric duopoly [model that] is known all over the world" [Krelle, 1987, IV, 469].

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].

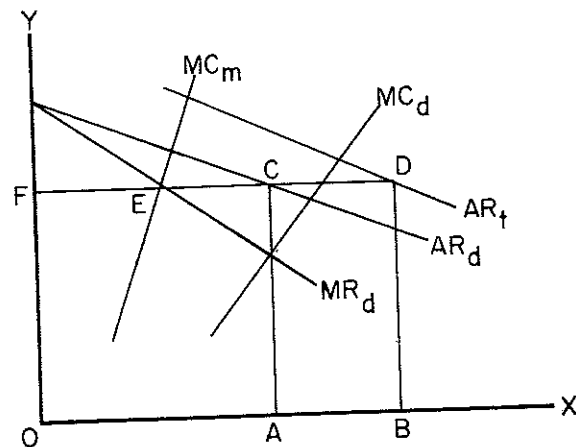
1940: STIGLER

Stigler's main purpose was to survey the literature on "classical duopoly" from Cournot [1838] up to the time he wrote [1940], including Stackelberg's first book [1934]. Prior to considering classical duopoly explicitly, however, he states, "it may be permissible to restate a case in which there is no doubt concerning the solution—that of the dominant firm . . ." [Stigler, 1940, 522]. He noted that little attention had been paid to the dominant firm in "the Anglo-Saxon literature" and cited Forchheimer, Zeuthen and Nichol, adding that his own graphical exposition "owes much to Professor Viner" [ibid.]. Curiously, Stigler did not mention Stackelberg in the section 7 on the dominant firm although in opening his discussion of classical duopoly, he referred the reader to Stackelberg "for a comprehensive survey of the literature of duopoly" [1940, 525n].

According to Stigler, a dominant firm market form exists, when "one firm sells such a large proportion of the commodity . . . that the other (small) firms individually ignore any effect they may have on prices; and . . . this dominant firm behaves passively, i.e., it sets the price and sells the remainder after the minor firms have sold all they wish at the ruling price" [1940, 522-23].

His analysis began with a diagram (our Figure 4) in a form which has been repeated many times in the industrial organization literature. Stigler showed the supply curve for the minor firms (the horizontal sum of their marginal costs) as increasing and at each price, subtracted the minor firms' quantity supplied from market demand (AR_t) to obtain the dominant firm's residual demand function (AR_d), and by straightforward construction, its marginal revenue (MR_d). The intersection of the dominant firm's MR_d and MC_d yields its profit maximizing quantity, OA (or ED), and price, OF, with the minor firms supplying FE (or CD) of the total market quantity, OB.

FIGURE 4



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 (k), the elasticity of supply of the minor firms (ϵ) and the market elasticity of demand for the product (η), as given in equation (2),

$$(2) \quad p\{1 + k/[\eta - \epsilon(1 - k)]\} = \phi'(x_d)$$

where the dominant firm's marginal revenue is equal to its marginal cost $\phi'(x_d)$. 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 (ϵ) increases, if all other variables remain fixed.
3. The output of the dominant firm will increase as the elasticity of demand (η) 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 ϵ 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 1934. 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.

Heinrich von Stackelberg completed the model analytically in 1934 in the form of asymmetrical duopoly, albeit in a market he characterized as lacking a stable equilibrium. In his rendition the "fringe firms" consisted of a single seller who might have elected to reverse roles and be a leader. Finally, in 1940 George Stigler combined Stackelberg's comparative statics with the assumption of price-taking fringe rivals (as initially postulated by Forchheimer) to produce an equilibrium model as it is used in modern neoclassical economics.

NOTES

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1. See Brennan [1982], Kaplow [1982], Ordover, Sykes and Willig [1982], and Schmalensee [1982].
2. See e.g., *Valley Liquors, Inc. v. Renfield Importers, Ltd.* [1987] [822 F.2d 656]; *Ball Memorial Hospital, Inc. v. Mutual Hospital Insurance, Inc.*, and *Mutual Medical Insurance, Inc.*, [1986] [784 F.2d 1325]; *Broadway Delivery Corp. et al. v. United Parcel Service of America, Inc.*, et al. [1981] [651 F.2d 122]; and *In Re Air Passenger Computer Reservations Systems Antitrust Litigation* [1988] [694 F. Supp. 1443].
3. Forchheimer (1880-1959) was born in Prague, where he was educated and started his career as a civil servant. He was the son of Otto Forchheimer, a business man, and Johanna Forchheimer, née Fürth. He studied law at the Charles-Ferdinand-University and took economics courses taught by Professors von Wieser, Zuckerkandl, and Rauchberg. After graduating in 1903 with a law degree, he joined the Department of Revenue and published six articles which were on the education system in Bohemia, the comparison of the living standard of workers in the U.S.A. and Prussia, the dominant firm model, the stressed financial situation of the *Kronländer*, and the housing policy of what would eventually become Austria. In 1913 he was promoted and moved to the Central Commission for Statistics in Vienna. In 1917 he joined the newly created Department of Welfare, which was initially in charge of the welfare of World War I veterans and their families. From 1924 until 1938, when the Nazis pressured him to resign, he worked on the implementation of a body of laws concerning the unemployment insurance system. During that period he published seventeen articles, nine about how to assist unemployed workers. From 1939 until 1948 he lived in England, where he was introduced to the teachings of Lord Keynes and worked at the Oxford Institute of Economics and Statistics, where he pursued empirical economic research about labor economics, particularly labor disputes. This research led to five articles in the *Oxford Bulletin*, the *Quarterly Journal of Economics*, and the *Oxford Economic Papers*. The lifelong interest of Forchheimer was the improvement of the lot of labor, which he tried to facilitate by helping to implement a modern social policy in Austria. Since he believed that Keynesian economics would guarantee full employment, he tried to disseminate Keynes's ideas in Austria. Upon his return to Vienna he worked on his third monograph, an introduction to Keynesian economics, which was published in 1952 by the *Arbeiterkammer*. Nine years before he died at the age of 79, the Austrian government honored him with the highest title an Austrian government official can receive.
4. The translation in the present paper is based on the original article and are by Christoph Schenzler. An English translation of Forchheimer's article by W.E. Kuhn appeared in the *Nebraska Journal of Economics and Business* [1983, 65-77].
5. Ely, writing in 1900, did not analyze the market for a dominant firm or partial monopoly, but he did give a brief definition (in italics in the original) as follows: "We have a partial monopoly where there is a unified control over a considerable portion of the industrial field, but not over a sufficient portion to give complete domination of the whole field" [1900, 32]. Later he added that the "partial monopoly" is able to restrain competition and secure some of the advantages of monopoly; so that the conditions determining price and other conditions are appreciably different from what they would be under free competition" [1900, 77]. This appears to be the first use of the term "partial monopoly."
6. That Forchheimer "works either explicitly or implicitly with net profit functions" has been pointed out by Reid [1979, 304], in his brief summary of Forchheimer's 1908 article.
7. Forchheimer began his analysis of incomplete monopoly by stating that he was aware of only one prior attempt to delve, analytically, into the complexity of a market structure between competition and absolute monopoly. In passing, he mentioned Cournot's analysis as "unrealistic" and so unsatisfactory. Nevertheless, in his first model of incomplete monopoly, where the output of the fringe firms is fixed, Forchheimer used a model remarkably similar to Cournot's [1838, 84-85], which describes a market consisting of n symmetric firms producing a homogeneous good at no cost and other firms who together produce a fixed

quantity, Δ , 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 Forchheimer's first model, Cournot's n firms acting as one become a cartel acting as a price setter faced with competing firms producing at capacity a fixed output of 400 units, so that Cournot's Δ becomes 400. It appears that Forchheimer borrowed Cournot's model to analyze his first case of the dominant firm market and, to borrow a phrase from Joan Robinson, mentioned the name of the explorer whom he "found already at the Pole when [he] arrived there" [1969, xv], although citing Cournot in an unappreciative way.

8. In Gaskins' dynamic optimal control model, a dominant firm with no cost advantage maximizes its long-run profits by setting price above the price necessary to limit entry, earning monopoly profits while it can, and letting its market share steadily erode.
9. Shackle [1967], in his chapter on "Marginal Revenue," summarized the early history of the marginal revenue concept. The earliest attempts by Cournot [1838] and Marshall [1890] were not sufficient to credit them for having "invented marginal revenue" [1967, 22]. The earliest "printed occurrence of the phrase marginal gross revenue," he reported, appeared in an apparently very little read article by T. O. Yntema entitled "The Influence of Dumping on Monopoly Price" [1928, 686-698] [1967, 23]. Although Zeuthen cited both Cournot and Marshall, there is no reference to Yntema.
10. A. C. Hoffman in a 1939 Harvard University Ph.D. thesis [1940, 82] cited Stigler's 1937 article and presented an almost correct Viner-type diagram as described verbally by Stigler. However he used the average costs of the competing firms rather than their marginal costs even though Stigler had explicitly stated: "From the demand or average revenue curve of the industry is subtracted the marginal cost (and hence short-run supply) curve of the minor firms, leaving the demand curve for the dominant firm" [717]. We owe this reference to our colleague, Professor Fred Westfield, who found it in Nicholls [1941, 1].

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