firms to invest so heavily in the absence of specific pressures. These pressures arise most frequently from oligopolistic market structures in which the need for product differentiation has been recognized and where rivalry has been limited to variables other than price. This article puts forward an analytical framework within which these questions may be considered, and also attempts to provide some answers dealing with the experience of the pharmaceutical industry in the United States.

THE GROWTH OF RESEARCH AND DEVELOPMENT

The spectacular growth of the pharmaceutical industry in the postwar period has been founded upon a number of important medical advances and has been associated with some radical changes in the structural and behavioral characteristics of the industry.[3] Prior to 1937 and the introduction of the early sulpha drugs the industry was composed largely of long established firms producing relatively standardized commodities. Unlike as at present, a large proportion of medical prescriptions were compounded by the pharmacist.[4] Barriers to entry were low and a high degree of competition prevailed.

With the introduction of penicillin and streptomycin during and immediately after the Second World War, the nature of the industry changed. As neither of the products was protected by patents,[5] the rapid growth of demand resulting from their introduction was accompanied by the entry of many new suppliers and by the development of active price competition. The price of a standard form of penicillin dropped from $20 for 100,000 units in 1943 to 4½ cents in 1950[6]; the price of streptomycin behaved similarly.[7] Excess capacity was created, and it may well be that prices fell to the vicinity of short-run marginal costs.

Following this experience, it was clear to the leading firms that their profits in the future would depend on the development of more protected market positions to be achieved through some form of product differentiation. This would provide the producer with substantial control over the prices of his products as well as act as a significant barrier to entry into the relevant therapeutic market. With the trend in the new technology towards the compounding of prescriptions by the manufacturer rather than the pharmacist, this development seemed all the more promising. Although increased selling expenditures would be necessary, these were not likely to be sufficient to establish effective differentiation, for the industry faced a relatively informed consuming public in the medical profession, and it would be more difficult to differentiate between products consisting of identical chemical substances. Only through the extensive introduction of new products could significant differentiation be achieved. This would enable individual firms to emphasize in their selling activities the improved quality of new drugs. Moreover, if each of the leading firms followed this course of action, competition in the industry would largely cease to be founded on the sale of standardized commodities.[8]

The accelerated growth of pharmaceutical research and development expenditures during the post-war years[9] was due largely to the desire to promote the

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[3] In this study the pharmaceutical industry is defined to include those firms which produce ethical drugs, as opposed to proprietaries, and which distribute these products in dosage-form. Pharmaceuticals are, thereby, marketed and sold only through the medical profession and require, for the most part, a written medical prescription.

[4] In 1961 prescriptions compounded by pharmacists accounted for only 3.6 per cent of all prescriptions in the United States.

[5] While a patent was issued to the inventor of streptomycin, Dr. Selman A. Waksman, it was assigned to the Rutgers Research and Endowment Foundation, and was licensed on a relatively liberal basis.

[6] Federal Trade Commission, *Economic Report on Antibiotics Manufacture*, 1958, p. 230.

[7] See United States Senate, Subcommittee on Antitrust and Monopoly, *Report of the Study on Administered Prices in the Drug Industry*, 87th Congress, 1st Session, 1961, pp. 81–8.

[8] In this context it is instructive to note the statement made by an industry spokesman in 1950. When considering the industry's future, he declared: "From a profit point of view . . . the only realistic solution of this problem lies in the development of *new and exclusive antibiotic specialties*. This . . . is an exceedingly costly and vigorous alternative; nevertheless, it is the avenue of approach being most extensively explored by certain antibiotic houses today. This is the approach being followed by Pfizer". Statement by John McKean, President of Chas. Pfizer & Co., quoted in Senate Report, *op. cit.*, pp. 130–31 (italics added).

[9] Between 1951 and 1960, research and development expenditures in the pharmaceutical industry grew from $60.4 million to $206.5 million, an increase of over 200 per cent. (Pharmaceutical Manufacturers' Association, *Yearbook, 1961–62*, p. 168.) These figures are measured in current dollars and are derived from surveys of P.M.A. member firms.