Equilibrium in Product Markets with Imperfect Information

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This paper is concerned with the relationship between information and market equilibrium: with the effect of information on the effective degree of competition, on the level of prices and their dispersion, on the variety and character of products produced by markets, on the one hand; and with the demand for information by consumers and the supply of information by producers, on the other. I shall argue not only that taking appropriate account of the costs of information provides an explanation of many phenomena which otherwise could not be explained, but that it also casts considerable doubt on a number of presumptions of traditional economics, for example, the efficiency of competition, and the policy prescriptions derived from those presumptions.

Traditional models of competition with perfect information obviously cannot explain the widely observed phenomena of price distributions, which seem sufficiently persistent that they cannot simply be dismissed as a disequilibrium phenomenon; nor can they explain advertising; nor can they explain why markets in which there are only a few large firms often seem more competitive than markets with many small firms. The work I am about to describe, which attempts to characterize equilibrium in product markets in which information is costly, provides considerable insight into these phenomena. At the same time, examining markets with costly information raises several important conundrums for competitive equilibrium theory: in the simplest of models formulated, no market equilibrium exists. The resolution of this paradox provides one of the foci of this paper.

It is important to recognize that market structure is itself an endogenous variable, a result (at least in many cases) of natural barriers to entry and incentives to agglomerate, some of which are related in an essential way to the cost of information. In this paper, I shall not have time to explore this set of relationships; throughout, it shall be assumed that the only barrier to entry is the fixed cost of establishing a new firm and that these are sufficiently small that markets will be characterized by a large number of firms.

I. Imperfect Information and Monopoly Power

A. *Competitive Markets with Monopoly Price*

It has long been recognized that imperfect information would result in firms having some degree of monopoly power. But it was presumed that a market equilibrium with "small" costs of search would be "very similar" to one with zero search costs; I suspect this belief is based on the presumption of continuity which seems to have been ingrained in economists at least since Alfred Marshall's famous dictum.

As Tibor Scitovsky and Peter Diamond have shown, this is not necessary; even with infinitesimal search costs and a very large number of firms, in market equilibrium *the price is the monopoly price.* To see this, assume all individuals have the same demand curve, all firms have the same cost functions, and also all charge the same price. Then if price is below the monopoly price, it would pay any firm to raise its price by an amount less than the magnitude of search costs for the individual with the lowest search cost, for it would then not pay any customer to leave the given store and go to another. But this, in turn, implies that all firms will raise their

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prices until marginal revenue equals marginal costs.

So far, nothing has been said about the determination of the number of stores. If we allow free, competitive entry, we obtain a result of considerable importance: *all the monopoly profits are dissipated in excess entry; competition is socially wasteful. Monopoly is Pareto superior to free competition.*[1]

This is not the only presumption of conventional economic theory which needs to be reversed. In market equilibrium, if there are a large number of firms, no single firm has any effect on the search behavior of individuals. But if a group of firms can get together, they can, by lowering their price, induce individuals to search to find one of the members of the "low-price chain." Thus a reduction in the number of competing firms may result in more *effective* competition and lower prices to the consumer.

B. *Nonexistence of Equilibrium: Gresham's Law Revived?*

Among businessmen, there is some belief in the converse proposition, that excessive competition may actually destroy markets in which there is costly information. This can occur even in the simplest of search models. For instance, assume that individuals always purchase one unit of the good (if they purchase it), and that the dollar value of the utility they derive from it is equal to u. Hence, when consumers arrive at a store, they purchase if and only if the price p is less than u. In this context, the monopoly price is u, and hence each firm will raise its price p to u. But if it is costly to go to the market, then the utility from entering the market itself is $u - p - c = -c < 0$, where c is the cost of search. Thus, no consumer will enter the market. In their ruthless attempts to exploit the hapless consumer who has entered the market, firms continue to raise the price to the point where the marginal individual who has entered the market is just indifferent to purchasing or not purchasing; but if all of his consumer's surplus is eliminated, then he will have no incentive to enter the market at all. But since each firm is small, it perceives itself to have no effect on the individual's decision to enter the market.[2] Hence, if all individuals have *positive search costs* (no matter how small), *there never exists a competitive market equilibrium with uniform prices for homogeneous commodities.* This result seems a quite general and disturbing paradox. Three possible resolutions are addressed in Sections II, III, and IV.

II. Equilibrium Price Distributions

Market equilibrium may be characterized by a price distribution. Although the existence of price distributions provides one of the main motivations for market search (see George Stigler), it initially apeared difficult to formulate a consistent model in which price dispersion persisted. To do so, as I pointed out in my forthcoming paper, it is necessary to explain (a) why individuals do not eventually learn about the prices charged in any particular store; and (b) why different stores charge different prices. There are some simple, if not completely convincing, explanations for both of these phenomena. A flow of ignorance can be maintained either by entry of new firms or new individuals. If firms differ with respect to their cost functions, then the price they set will differ, and the market will give rise to a price distribution (see Salop, 1973). Alternatively, if spatially separated markets are subjected to random shocks and are imperfectly arbitraged, there will also be a price distribution (see, for example, Dale Mortensen).

More interesting, however, are situations where firms have identical cost functions. Then it must be the case that the profits

[1]It is important to emphasize that these considerations have to be balanced off against other, probably more important, advantages of competition, which are not well captured by the traditional analyses of competitive markets. See the author (1978a).

[2]The result (see the author, 1977a) is general: individuals may have conventional downward-sloping demand curves which may differ from individual to individual; search costs may differ from individual to individual, etc. In these situations, the firm will employ non-linear price schedules. (See the author 1977b.)

generated at one price must be the same as those at another price. Not only must profits as a function of price have several peaks but those peaks must be of exactly the same height. This seems remarkable, until it is recognized that the shape of the profit function is itself a function of the price distribution.

In particular, high-price stores may have higher average costs, either because they spend more to acquire customers or because they have fewer sales (with U-shaped average cost curves); the differences in costs exactly offsetting the difference in price. Several such models have been constructed.

A. *Bargains and Ripoffs: Markets Exploit High-Search-Cost Individuals*

Salop and I (1977) have investigated a model in which the low-price stores have higher sales because individuals with low-search cost seek them out. Only high-search-cost individuals go to high-price stores. This model with costly information establishes the existence of market equilibrium with price dispersion, and illustrates several further general principles.

First, *the market itself gives rise to the imperfection of information.* In a "planned" economy, all firms would charge the same price, and hence there would be perfect information. Second, *the widespread belief that all that is required for markets to work well is that there be some individuals who are informed and who thus arbitrage the market is not valid,* at least within this context. The informed convey only a limited positive externality on the uninformed, in the sense that without them there would be fewer stores charging the competitive price. However if there are enough informed individuals, the market may act competitively. On the other hand, an increase in the number of uninformed creates a negative externality: there will now be a larger proportion of high-price stores, and the expected welfare of all the uninformed is decreased.

Indeed, the *market equilibrium in which all individuals have costly information must be characterized either by firms charging the monopoly price or by price dispersion.* For it pays individuals to undertake information acquisition only if there is price dispersion, that is, the market is not fully arbitraged: so if there is no price dispersion, all individuals remain uninformed, and the firms can then exercise their monopoly power.

B. *The Theory of Sales*

In the model just described differences in individuals' information costs give rise to the price distribution. Salop and I also considered a "Theory of Sales," in which all individuals and all firms are identical and still, the only equilibrium may be a price distribution (1976). This model recognizes that firms can increase sales both by attracting the more informed, and by selling more to those who arrive, for example, by inducing them, "in a sale," to purchase for future consumption (storage). If all stores charged the same price, it would pay some firm to lower its price to induce those who are planning to consume the good next period as well to purchase for their future needs. They lower their price just to the point necessary to induce purchase for storage. Equilibrium is established where the extra sales just compensate for the lower price on each sale.

It is important to observe that in these cases, where firm profits from charging a high price or a low price are the same, there is an alternative interpretation of the equilibrium:[3] each store randomizes its price between the high price and the low price. In that case, even if there were no entrants into the market, or new firms, individuals would remain imperfectly informed.[4]

Although it is now apparent that the existence of markets may, even in equilibrium, be characterized by price dispersion, this does not fully resolve the paradox of nonexistence for two reasons. First, in the sequential search model (where at each search individuals only

[3]Since the profits at the two prices are the same, the firm is indifferent which price it charges. Equilibrium is thus characterized by a mixed strategy. This interpretation is only persuasive if the *ex post* cost function is the same as the *ex ante* cost function.

[4]For a similar model with mixed strategy equilibrium, see Y. Shilony.

find about the store they have visited) if all firms are identical, then such markets can never be characterized by price dispersion. For clearly, if there were a price distribution, the reservation price (the price above which the individual does not buy) must be slightly above the lowest price within the distribution. It would thus pay that store to raise its price, provided that the price were below the monopoly price. Secondly, even if firms and individuals differ, by the same kind of reasoning as employed earlier, it will always pay all stores to raise their prices to the point where the marginal entrant into the market (the individual who is just indifferent to purchasing or not) is indifferent to purchasing (given that he has already entered). But then, he will not want to enter the market. Hence, there cannot exist a "marginal" entrant, and hence there cannot exist a market.

III. Product Heterogeneity

A. *Quality Dispersion*

The second possible resolution to the nonexistence paradox is that markets are characterized by product heterogeneity. Of course some product heterogeneity is really nothing more than disguised price dispersion. A good x which lasts twice as long as a good y (if the interest rate is zero) is just equal to two units of y. There is, however, one important difference between price and quality dispersion: even after arriving at the store, the individual may not know what the true price of the commodity is. Only after purchasing the commodity does he find out the effective (true) price.

Obviously, this lack of knowledge provides an incentive for firms to "cheat," to lower their quality, thereby raising their effective price. This is limited by two considerations: firms can establish a reputation if the commodity is repeatedly purchased. Then "good" firms will have "repeat customers" and thus larger sales. Secondly, firms can provide guarantees, which both reduce the risk borne by the customer (see Geoffrey Heal) and serve as a "signal" (a self-selection device) by the firm concerning its quality.

Even if firms are risk neutral, the use of guarantees is limited by both moral hazard and adverse selection problems—a 100 percent guarantee will result in the purchaser abusing the product (if he can), and if use cannot be monitored, will lead to purchase by those individuals who are "hardest" on the commodity. Moreover, guarantees have to be guaranteed, and the enforcement of such contracts may be costly.

Individuals can attempt to infer something about the product (or the seller) not only on the basis of the guarantee provided but also on the basis of the price charged. George Akerlof, in his classic theory of lemons considered a particular variant of this problem. He assumed that the average quality z of a commodity offered on the market was an increasing function of the price $z(p)$, while demand was a function of price and average quality. Since quality decreases with price, it is possible that the "effective price," the price per unit quality p/z, actually increases as the nominal price decreases. In Akerlof's model, the only possible equilibrium in which demand equaled supply was where price was zero: quality was zero, so demand was zero, and supply was zero.

Subsequently, the author (1976), Salop (1979), the author and Andrew Weiss, and Charles Wilson have argued that, at least in some contexts, this is an inappropriate equilibrium concept. When individuals know that quality is affected by price either because of screening or incentive effects, they will use price to affect the expected quality of the commodity purchased. For instance, in the labor market, a firm will choose the wage to minimize expected labor costs, that is, minimize the wage per effective labor unit; in the capital market, a lender will choose the interest rate to maximize the expected return obtained from the loan; and in the product market, with which we are concerned here, the buyer will choose p to minimize the "quality adjusted price."

In this case, competitive market equilibrium does not necessarily entail market clearing. The law of supply and demand has been

repealed. Assume that at the value of p at which the quality adjusted price p/z is minimized, there is some individual willing to supply a good. Conventional theory has it that he undercuts his rivals; price is thus bid down until the market is cleared. But here, if an individual offers the commodity for sale at a lower price, then the buyer infers that it is probably of a lower quality, sufficiently lower in fact not to compensate for the lower price. The existence of non-market-clearing equilibria has important implications for macroeconomic analysis (see Salop, 1979; the author, 1978b).

B. *Product Variety*

In the discussion so far, all individuals agree on the desirable characteristics of a commodity. But in many situations, different individuals place different relative evaluations on the different goods offered in the market, that is, there is some element of matching individuals to commodities (or jobs). Assume, for instance two kinds of widgets, blue widgets and red widgets. Each store can only sell one kind. Some individuals prefer blue widgets, some red. Store owners cannot discriminate between blue widget lovers and red widget lovers. Then, market equilibrium may be characterized by a price dispersion, with low-price stores selling to those who like their commodity *and* those who would prefer the other color, but, given the low price, are willing to stop searching, while the high-price stores sell only to those who are "properly matched." More importantly for our purposes here, there may exist a market equilibrium: an individual who goes to a low-price store which sells the commodity which he loves enjoys some consumer's surplus: it is the possibility of capturing this consumer's surplus which induces individuals to bear the costs of entering the market.

Although this leads to the result that market equilibrium will be characterized by some product variety, there is no presumption that the market will have the correct amount of variety. Even with perfect information, of course, markets will not, in general, have the correct amount of product differentiation. (See Michael Spence, Avinash Dixit, and the author, 1977a.) But the existence of costly information changes both the social and private returns to variety. Those who sample the new commodity and don't like it are worse off, since they now have to search more than they otherwise would. The potential beneficiaries of the new commodity are those for whom there is now a commodity more to their liking, but because of costly search, only a fraction of these individuals actually get the new commodity.

At the same time, the existence of product variety may have an important effect on the returns to improved information. For improved information may affect the elasticity of demand facing any firm; if it increases the degree of monopoly power of each firm, it may lead to higher prices and lower welfare. If it lowers the degree of monopoly power, not only will there be better matching of individuals and goods, but markets may be more competitive and prices lower.

C. *Kinked Demand Curves Arising from Imperfect Information*

The models formulated so far are basically static, but one important implication of the natural dynamic extension is that demand curves are kinked. To see this, assume a market in equilibrium, with the only individuals searching for the lowest price (or the commodity most to their liking) being new entrants. Then a firm which raised its price would induce the marginal individuals purchasing it to begin searching again, and it thus loses customers; but when it lowers its price, since individuals at other stores do not know about its lower price, it does not gain a corresponding number of new customers. It should be noted that this argument for the kinked demand curve is distinctly different from the traditional oligopoly argument, which postulates (not completely convincingly) asymmetric responses on the part of rivals (assumed to be few in number—here there may be a large number of firms) to price increases and decreases. The fact that

demand curves (and by a similar argument, labor supply curves) are kinked has important implications for macro-economic equilibrium (see Salop and the author, 1976; the author, 1978b).

IV. Advertising

The third resolution of the nonexistence paradox is that individuals can obtain information by means other than sequential search.[5] Earlier, we described one such method, where individuals purchased a newspaper, obtaining complete information. Some individuals hear about "good stores" by word of mouth and this too may lead to a price distribution (see Salop and the author, 1976). In both cases, the existence of some low-price stores with high sales provides an incentive for some individuals to enter the market. But firms can attempt to provide information to their customers as well, through advertising.

This, however, gives rise to a new advertising paradox. Assume a set of firms advertise a price p. Then, it always pays any firm to advertise at a slightly lower price, for it will obtain all the customers. This means that advertised prices continue to be cut, until they reach the minimum average cost. But then, firms must be making a loss, since they are breaking even on their sales, but paying advertising costs.

Gerard Butters provided an ingenious resolution of the advertising paradox: he showed that there existed a continuous equilibrium price distribution. Stores randomly send out advertisements informing customers of their price. The individual goes to the cheapest store from which he receives an advertisement. Thus, most of the advertisements of high-price stores are ineffective; while all the advertisements of the lowest-price store are effective. The higher sales of the lower-price store exactly compensates for the lower sales of the higher-priced stores.

[5]Equivalently, it may be assumed that there is a mass of individuals with zero search costs. This ensures that at least some stores charge the competitive price; if there is a distribution of individuals by search costs, a price distribution may then be generated. See Peter von zur Muehlen.

Although there are some markets in which high-priced commodities have a higher expenditure on advertising, in other markets (discount department stores), the low-priced stores have larger advertising budgets.

There is an alternative resolution of the "advertising paradox." Assume, as I did earlier, that markets are characterized by product and consumer heterogeneity. Then a store can actually advertise and raise its price, since individuals who like the given commodity would rather buy there than attempt the random lottery of the market. Equilibrium of such markets will in general have price dispersion; low-price stores may advertise a great deal, but will make up for both the lower price and the higher advertising costs with the larger sales arising from the wider market area they serve.

V. Concluding Remarks

Although space prohibits pursuing all the implications of imperfect information for equilibrium in product markets, I hope I have convincingly shown that the traditional paradigms of competitive markets, with perfect information and markets equilibrated by the mythical Walrasian auctioneer, are not only not directly applicable, but may be seriously misleading. For instance, attempts to promote competition by increasing the number of firms by removing barriers to entry may actually reduce effective competition, increase prices, and lead to lower efficiency. Similarly, although clearly the traditional presumption of caveat emptor has no basis within welfare economics when information is costly, the full implications of various attempts at consumer protection need to be examined carefully within a well-articulated model of product market equilibrium of the kind I have attempted to formulate here before their desirability can be correctly assessed.

Finally, the kinds of models I have developed here do seem to provide, at last, a micro-economic foundation for many important macro-economic phenomena: not only have I shown how they can give rise to rigidities in adjustment but I have also shown

how there may be equilibria in which markets do not clear.

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