The Theory of Sales: A Simple Model of Equilibrium Price Dispersion with Identical Agents

By S. SALOP AND J. E. STIGLITZ*

A fundamental tenet of neoclassical theory is the law of the single price. The parable of the Walrasian auctioneer is intended to provide us with some insight into the determination of that single price. The object of this paper is to examine equilibrium in a competitive market in which the mythical auctioneer is absent and information is costly to gather. As a result, individuals may not be perfectly informed about the prices (or qualities) of what is being sold. Equilibrium in such markets may differ markedly from the one conventionally studied by neoclassical theory. In particular, the only market equilibrium may be characterized by price dispersion for a homogeneous commodity; the law of the single price does not obtain. We illustrate this with a model in which all individuals are (*ex ante*) identical and in which there is no exogenous source of noise, no external disturbances to the market which have to be equilibrated. Instead, noise is introduced solely by the internal functioning of the market. Thus, the information imperfection is created by the market itself.

In our model, although all individuals have identical preferences and incomes and all firms have identical technologies,[1] some firms charge high prices and others charge low prices. Those customers who (unluckily) arrive at a high-price firm purchase only for their immediate needs and re-enter the market later. Those who (luckily) arrive at a low-price store "economize" by purchasing more than is required for immediate consumption and storing the excess for future consumption. High-price stores earn a larger profit per sale, but make fewer sales. Equilibrium entails equal profits for the two kinds of stores, that is, the lower volume of the high-price stores exactly compensates for the higher profit per sale.

The model we develop is of interest not only for the insight that it provides into the nature of price dispersion in the economy, but also because it provides at least a partial explanation of some aspects of retailing which otherwise would be difficult to explain.

A simplifying assumption employed in the basic model of Section I is that there are no costs to entering the market. When there are costs to entering the market, the *only* possible equilibria in the market involve price dispersion; in those situations where there does not exist an equilibrium price distribution, there does not exist any equilibrium to the market. For in the absence of noise, firms will seek to increase prices to the point where there is no consumers' surplus left, *given* that consumers are already in the market. The existence of some low-price stores provides sufficient (expected) consumers' surplus to induce consumers to pay the fixed costs associated with entering the market. A necessary condition for price dispersion, in turn, is that firms not be able to differentiate perfectly among individuals. Thus, if firms have access to devices, like nonlinear pricing schedules, which allow the firm to differentiate between different groups in the population (here, the young and the

*Georgetown Law School and Princeton University, respectively. An earlier version of this paper was written while Stiglitz held the Oskar Morgenstern Distinguished Fellowship at Mathematica and was visiting professor at the Institute for Advanced Study, Princeton. Financial support from the National Science Foundation is also gratefully acknowledged. An earlier version of this paper was presented at the Bell Laboratories Conference on Monopolistic Competition and Imperfect Information, February, 1978. We are indebted to R. Lindsey, V. Krishna, and D. Abreu for their helpful comments.

[1]The assumptions of identical firms and customers and no exogenous noise are made to show clearly that the kind of price dispersion analyzed here is distinctly different from that analyzed in the earlier models of price dispersion (for example, Salop, 1977, and our 1977 article) where it serves to differentiate among different groups of customers.

old), equilibria with price dispersion cannot exist, and, if it is costly to enter the market, no equilibrium exists.

Although the model we develop in this paper is very simple, the basic qualitative results are robust; in Section II we note a number of directions in which the model may be extended. For instance, the analysis of this paper (and most of the other related literature) assumes rational expectations: consumers' beliefs about the distribution of prices, which affect their decision about where to buy for future needs or to re-enter the market next period, correspond to the price distribution which emerges in equilibrium. We show that price distributions will emerge even in the absence of rational expectations; indeed, there are circumstances in which price distributions are even more likely than with rational expectations.

I. The Theory of Sales

Although the formal model of price dispersion that follows is highly simplified, it captures a general class of phenomena. The price dispersion may be across stores, across brands of the same product, or at a single store over time. The dispersion may be in quality as well as price. One phenomenon is particularly interesting. Robert Steiner (1978) observes that most nationally advertised brands have a common "everyday" price across stores, but different stores offer temporary discounts from time to time, either passing on manufacturer discounts or holding their own advertised and unadvertised sales. The model to follow here analyzes unadvertised specials.[2]

We assume every consumer lives two periods. Each consumer demands one unit of the commodity *each period* at any price no greater than some reservation price u. Thus, a monopolistic producer would choose $p^m = u$. We refer to this as the "monopoly price." In the presence of price dispersion, a consumer who enters the market may either purchase one unit each period, or purchase two units in period 1, consume one unit and store the rest for consumption in period 2. If the consumer purchases for storage, the additional transaction cost c of re-entering the market is saved. However, a storage cost δ must be incurred.[3] The decision to buy-and-store or shop again balances these two considerations.

Suppose consumers know a priori the distribution of prices $f(p)$ charged in the market. In the absence of more detailed information, the consumer randomly selects a store in period 1. Suppose that store quotes a price p. Let $\hat{p}$ denote that "reservation price" which leaves the consumer indifferent between purchasing for storage and purchasing only for present consumption with the intention of re-entering the market next period. In order to focus on these interperiod transactions costs, we assume the consumer is not permitted to reject the price p and select a new store in period 1. We assume, in other words, that the cost of a second search in any period is so great that the individual will never undertake it.[4]

Noting that the consumer will obtain the average price $\bar{p}$ next period and must also pay transactions cost c, $\hat{p}$ is given by[5]

$$\hat{p} + \delta = \bar{p} + c. \tag{1}$$

[2]It is important to emphasize that our model is a highly idealized one, designed to illustrate one aspect of retailing with imperfect information. In particular, individuals may acquire information in a variety of ways, besides actually going to the store. Information may for instance be gathered from personal inspection, experience, product sellers (including advertising), and information sellers.

[3]In this paper, we assume storage costs are proportional to the numbers of units purchased, but do not depend on the price paid. If the "storage costs" consist of interest and spoilage, then they will be proportional to the price. Assuming this does not alter the analysis in any substantial way.

[4]This should be contrasted with most of the search literature which assumes constant costs per search. Our assumption simplifies the analysis, but is not essential. As a conventional in the search literature, we assume consumers know the probability distribution of price. Their prior distribution of price for each store is the same, and hence each store has exactly the same number of customers ready to arrive at its door step.

[5]This assumes risk neutrality on the part of the consumer. In our 1976b paper, we show that this is not a critical assumption. In addition, we require

$$\hat{p} \leq u - \delta. \tag{1$'$}$$

(Otherwise it does not pay the individual to purchase the commodity for storage.) More generally, we write

$$\hat{p} = min\{\bar{p} + c + \delta, u - \delta\}. \tag{1$''$}$$

A. *Characterization of Equilibrium*

We wish to find an equilibrium price distribution $f^*(p)$ with the following properties:

1) *Profit Maximization*: Each small firm chooses a price p to maximize profits given the prices of the other firms.

2) *Equal Profits*: Each firm earns identical (to "normal") profits.

3) *Search Equilibrium*: Each consumer searches optimally given $f^*(p)$.

4) *Entry Equilibrium*: Each consumer enters the market if and only if expected consumer's surplus is nonnegative.

We shall derive conditions under which a nondegenerate equilibrium price distribution exists. To do this, we shall first characterize such an equilibrium (if it exists); we show that it can have only two prices, that the higher price is the monopoly price and the lower price the reservation price. We then derive conditions under which profits at the reservation price and at the monopoly price can be the same.

We first prove

LEMMA 1: *In the equilibrium price distribution, there are at most two prices.*

Suppose there were more than one price below $\hat{p}$, say p_m and p_l and $p_m > p_l$. The p_l and p_m firms would obtain an identical number of customers who purchase for two periods. The profits of the p_m firm would be higher, and no equal profit equilibrium can obtain. Similar reasoning eliminates the possibility of two prices at least as great as $\hat{p}$.

B. *Two-Price Equilibria*

We denote the two prices by p_l and p_h, and the respective fractions of firms charging each in each period by $1-\lambda$ and λ.

LEMMA 2: *Any two-price equilibrium must have the property that the low-price store charges exactly the reservation price*:

$$p_l = \hat{p}. \tag{2}$$

If $p_l > \hat{p}$, consumers at both stores purchase for one period only, but since $p_h > p_l$, profits cannot be the same. If $p_l < \hat{p}$, consumers at the low-price store purchase for two periods. But by raising the price slightly, a low-price store would not lose any customers, but would increase profits; hence the price p_l cannot be profit maximizing.

LEMMA 3: *In any two-price equilibrium, the high price must be the monopoly price, or*

$$p_h = u. \tag{3}$$

Suppose not. Since $\hat{p} < p_h$, the p_h firms sell for only one period. If a p_h firm were to raise its price, it would lose no customers and its profits would rise.

The equal profit condition allows calculation of the fraction of p_h firms, λ, as follows.

There are L consumers and n firms. Each firm attracts L/n young customers and $\lambda L/n$ old customers who were unlucky and selected a p_h store when they were young.[6] Since both unlucky young and old customers purchase one unit each, the sales X_h of each p_h firm are given by

$$X_h = [1+\lambda]L/n. \tag{4}$$

The sales X_l of the p_l firms are higher. Each sells two units to their young customers and one unit to their old customers, or

$$X_l = [2+\lambda]L/n. \tag{5}$$

For simplicity, we assume that the marginal costs of production are zero. Thus equal profits implies

$$p_h X_h = p_l X_l, \tag{6}$$

or, using (3), (4), and (5), we obtain

$$(1+\lambda)u = p_l(2+\lambda). \tag{7}$$

Substituting the definition of $\bar{p}$,

$$\bar{p} = \lambda p_h + (1-\lambda)p_l, \tag{8}$$

[6] We assume all of them re-enter the market the second period. See Section 3 of our 1981 paper, and below.

noting the reservation price equation (1), and using (2), we obtain

$$(9)\quad p_l = \lambda p_h + (1-\lambda)p_l - (\delta - c) = u - (\delta - c)/\lambda.$$

Equations (7) and (9) give us two equations in the unknowns, p_l and λ, which can be solved for the market equilibrium. We can thus establish

THEOREM 1: *If there exists a nondegenerate equilibrium price distribution, it consists of two prices, with*[7]

$$(10)\quad p_l = (u + (\delta - c))/2, p_h = u,$$

and the fraction of firms charging the high price

$$(11)\quad \lambda = 2(\delta - c)/(u - (\delta - c)).$$

In order to ignore the question of whether the individual enters the market, we focus our attention on the case where $c = 0$. (The more general case is discussed in Section II.) We can now establish:

THEOREM 2: *If $c = 0$, a necessary and sufficient condition for the existence of a two-price equilibrium (TPE) is that*

$$(12)\quad \delta < u/3.$$

For (10) and (11) to constitute a two-price equilibrium, clearly $0 < \lambda < 1$ and $p_l + \delta \leqslant u$. The second constraint is required to ensure that an individual who arrives at a low-price store purchases for storage. The constraint $\lambda < 1$ implies $2\delta/(u - \delta) < 1$, or

$$(13)\quad \delta < u/3.$$

The constraint $\lambda > 0$ implies that $\delta < u$ which is clearly implied by (13). The condition $p_l + \delta = (u + 3\delta)/2 < u$ is equivalent to (13).

From a formal point of view, it makes no difference whether a fraction $1-\lambda$ of the stores always charge a low price, or each store charges the low price with probability $1-\lambda$. The latter has the natural interpretation of a sale. (The objection may be raised to the former interpretation that it is not reasonable to assume that, although every one knows the probability distribution of prices, no one has any information about which stores are low price stores.) When all stores use a "mixed strategy" for price determination, no one in fact knows which stores will have a low price in any period. Notice that when all firms use a mixed strategy, in any period, the fraction of firms charging the low price is a random variable with mean $1-\lambda$. If we assume however, that firms cannot observe the actual price distribution at t before deciding on the price at $t+1$, then the fact that the fraction of stores charging a low price is a random variable does not alter the analysis in any significant way. (Otherwise, the equilibrium would entail a mixed strategy, where the low price and the probability of charging that price would depend on the proportion of firms charging the low price the previous period.)

C. *Single Price Equilibria*

Lemma 1 established that there were at most two prices in equilibrium. In the previous subsection we considered two-price equilibria. We now consider single price equilibria (*SPE*). We shall show

THEOREM 3: *If $c = 0$, $p = u$ is the only possible single price equilibrium. $p = u$ is a single price equilibrium if and only if $\delta \geqslant u/3$ and $c = 0$. If $c > 0$, there is no single price equilibrium.*

The first statement follows directly from our earlier analysis showing that $p < u$ can be a *SPE* only if consumers store. But, if $c = 0$ (and $\delta > 0$), it never pays anyone to store.

The proof of the second statement is straightforward. If $c > 0$, and $p = u$, it will

[7]Note that the nature of the two-price equilibrium (*TPE*), if it exists, depends only on second-period search costs. Thus, if c_t is the cost to entering the market the tth period,

$$p_l = \frac{u + (\delta - c_2)}{2}, \lambda = \frac{2(\delta - c_2)}{u - (\delta - c_2)}$$

not pay individuals to enter the market. If $c=0$, $p=u$ is an equilibrium if and only if it does not pay a firm to lower its price to the "reservation level" and sell for storage. The reservation price when all firms charge $p=u$ is $u-\delta$.

If this is an equilibrium, profits must fall if the firm lowers its price, even though sales are increased, that is, since half of its customers are young and half old,[8] sales are increased by 50 percent and we require $\frac{3}{2}(u-\delta)<u$ or $\delta \geqslant u/3$.[9]

This result, together with Theorems 1 and 2, implies that if $c=0$, there is a *SPE* with $p=u$ if $\delta>u/3$, a *TPE* if $\delta<u/3$. Whether there exists a price dispersion or a single price equilibrium depends simply on the magnitude of storage costs. If they are low (relative to the reservation price u), the only equilibrium in the market entails price dispersion.

If it pays firms to have "sales" to induce individuals to purchase for future consumption, storage costs cannot be too great. And if the storage costs are not too great, it always pays to have sales.

To see that if $c>0$, there cannot exist a *SPE*, recall that we have already established that if $c>0$, we cannot have a *SPE* with $p=u$. For $p<u$ to be a *SPE*, there must be storage. It is easy to show, using the reservation price equation, that if individuals store in a *SPE*, $c>\delta$; moreover, profit maximization requires $p=u=\delta$ (individuals are just indifferent to storing). Hence the consumer's surplus obtained by an individual is $2u-2p-\delta-c=\delta-c<0$. No one will enter the market, a contradiction.[10]

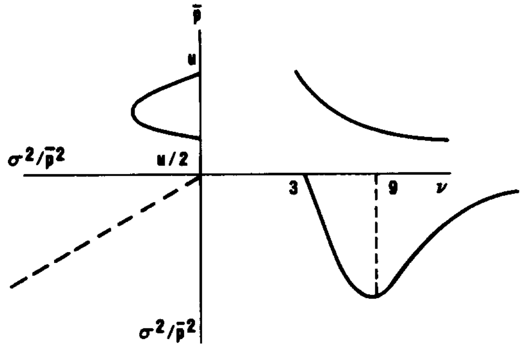

FIGURE 1. MEAN AND VARIANCE OF PRICE DISTRIBUTION AS A FUNCTION OF $u/(\delta-c)\equiv\nu$

D. *Comparative Statics and Welfare*

In the two-price equilibrium, the relative magnitude of price dispersion is simply a function of $u/(\delta-c)$. Letting $u/(\delta-c)=\nu$, we have from (10), (11), and (8),

$$\lambda=2/(\nu-1); \tag{14}$$

$$p_l=(\delta-c)(\nu+1)/2, \qquad p_h=u; \tag{15}$$

$$\bar{p}=u(\nu+3)/2\nu. \tag{16}$$

Hence,

$$\sigma_p^2=\lambda(u-\bar{p})^2+(1-\lambda)(p_l-\bar{p})^2 = u^2(\nu-3)/2\nu^2; \tag{17}$$

$$\sigma_p^2/\bar{p}^2=2(\nu-3)/(\nu+3)^2 \tag{18}$$

Figure 1 depicts the relationship of the equilibrium to values of ν. Notice that an increase in storage costs always raises mean price—sales become less attractive—but it may either increase or decrease price dispersion, as measured by the coefficient of variation.

Our consumers have been modeled as being risk neutral. Their welfare is thus simply

[8]Recall that the individual purchased at a low-price store for storage for *two* reasons: it reduced his total transactions cost and he was uncertain about whether the store he sampled next period would have a low price. In the case of $c=0$, only the latter effect is relevant, but this, by itself, is sufficient to give rise to an equilibrium price distribution.

[9]If $c_1=0$ (search costs for the first period are zero) but $c_2>0$, no one will shop the second period. Hence sales are increased by 100 percent if prices are lowered to $u-\delta$ (since there are only young customers, at a price $u-\delta$, they all buy for storage). Then a single price equilibrium at $p=u$ requires $2(u-\delta)<u$, or $\delta>u/2$.

[10]If $c_1=0$, $c_2>0$, there is a *SPE* at $u-\delta$, provided $\delta<min[u/2,\ c_2]$. The condition $\delta<c_2$ ensures that individuals do not search second period. The condition $\delta<u/2$ ensures that firms do not raise their prices to u (i.e., $u/2<u-\delta$).

measured by the average price plus average storage and search costs.

$$\begin{aligned} -W &= \lambda[u+\bar{p}+c]+(1-\lambda)[2p_l+\delta] \\ &\quad +\text{constant} \\ &= \lambda[u+\bar{p}+c]+(1-\lambda)(p_l+\bar{p}+c) \\ &\quad +\text{constant (using (1))} \\ &= 2\bar{p}+c+\text{constant (using (8))} \\ &= 3(\delta-c)+u+c+\text{constant} \\ &\qquad\qquad \text{(using (1), (2), and (10))} \\ &= 3\delta-2c+u+\text{constant} \end{aligned}$$

Thus, an increase in storage costs always makes individuals worse off, but the general equilibrium effect—through the effect on mean price—is much greater than the partial equilibrium effect. Thus, lowering storage costs (for example, by lowering interest rates for purchases of consumer goods) may have significant beneficial welfare effects. On the other hand, the general equilibrium impact of a reduction in search costs is to make individuals worse off. Lower search costs makes sales less attractive.

II. Robustness of the Model

The model formulated in the preceding section has several special features to it on which we have not commented so far:

(a) The demand (utility) function has a special form;
(b) There are only two periods;
(c) Storage costs are proportional to the number of units purchased;
(d) All individuals are identical;
(e) Firms use only a linear price system;
(f) Individuals know the probability distribution of prices;
(g) There are no costs to entering the market;
(h) Firms cannot distinguish between young and old individuals.

All of these may be generalized without altering the basic results, the possibility of the existence of an equilibrium with price dispersion and the possibility that the only equilibrium involves price dispersion.

Altering the first four assumptions ((a)–(d)) complicates the analysis but does not change it in a fundamental way. In our 1976b paper, we showed how the model can be extended to the more usual case of a downward-sloping demand curve. In Stiglitz (1979), the results were extended to a model in which individuals' search costs differ. The extension to the case where individuals live (purchase) for more than two periods is straightforward; this adds the possibility of an equilibrium with more than two prices. In our 1981 paper, we show how the results can be extended to other storage cost functions.

The remaining four assumptions ((e)–(h)) require brief comment.

A. *Costly Search, Noise, and the Existence of Equilibrium*

In the previous section, we assumed the cost of entering the market (the first search) was zero. We now show that if it is positive, then, for those parameter values for which there does not exist an equilibrium price distribution, there does not exist any equilibrium: *the only possible equilibria entail price distributions.*

When search is costly, individuals must decide whether to enter the market. We shall show that when there is no price distribution and $c>0$, no one in fact will enter the market.

The intuition behind our result is seen most clearly for the limiting case where storage is prohibitively expensive ($\delta=\infty$). Under these circumstances, each firm is obviously a pure monopolist; once a consumer arrives at a store, he is perfectly captive, since he may not search again. Hence, the only possible equilibrium is the single price equilibrium at the monopoly price u. However, at that price, no consumer will enter the market, correctly realizing that he would attain a negative consumer surplus from doing so.[11,12]

[11]Formally, although a price equal to $u-c$ is required to induce the consumer to enter, any small firm —believing it has a negligible effect on average price— has an incentive to raise its price to u; for once the

The argument for finite δ is similar. Indeed, the last part of Theorem 3 established that if $c>0$, there does not exist a *SPE*, because it will not pay anyone to enter the market.[13]

Hence, whenever there does not exist an equilibrium with price dispersion, no equilibrium exists. *Ruthless competition with a small degree of monopoly power destroys the market equilibrium.*

This problem may be alleviated by the existence of a price distribution, a form of noise created by the market itself.[14] Noise ensures that there is some chance that the individual will get a good buy; it is this hope which induces him to enter the market.

We can extend the arguments of Theorem 2 to establish

THEOREM 4: *Necessary and sufficient conditions for the existence of an equilibrium are that $u \geqslant 3\delta - c$ and $\delta > c$. When an equilibrium exists, it is characterized by the two-price equilibrium described in Theorem* 1.

From (11) for $0<\lambda<1$, $\delta>c$ and $u>3(\delta-c)$. This will clearly be satisfied if $u \geqslant 3\delta - c$. For the unlucky young to reenter the market when they are old $\bar{p}+c=p_l+\delta \leqslant u$. But using (10), this implies that $(u+\delta-c)/2+\delta \leqslant u$, or $u \geqslant 3\delta - c$. If it pays the unlucky young to enter the market when they are old, it certainly pays the young to enter the market in the first period.

B. *Nonexistence of Equilibrium with a Discriminating Monopolist*

The assumption that the firm could not tell who was a young purchaser, or who an old, was essential to our earlier analysis. If the firm could perfectly discriminate, then it would charge each enough to eliminate all consumers' surplus, given that the individual had already arrived at the store. (For old individuals, this would entail $p=u$, for young, this would entail selling two units, for a total amount of $2u-\delta$.) But then, if $c_1>0$ (where c_1 is the cost of entering the market the first period), it would not pay any individual to enter the market: there exists no equilibrium.[15]

If firms can employ a nonlinear pricing schedule, they will always be able to identify who is young.[16] Only the young will be willing to purchase two units; all that the firm needs to do is to allow a sufficiently large quantity discount that the individual prefers to store rather than to enter the market the next period.[17] As a result, it can be shown that if search is costly, no equilibrium exists.

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consumer (unluckily) arrives at the store, he is captive and will pay up to u (bygones are bygones: he regrets having gone to the store, but he puts the regret aside as he makes the best of a bad situation).

[12] The assumption of $\delta=\infty$ eliminates any intertemporal linkage present and allows a static view of the market. Note that Peter Diamond's (1971) model can be viewed as the special case of our model with $\delta=\infty$. Diamond failed to check whether it would, in fact, pay an individual to enter the market. Our analysis (with the admittedly special utility and search cost functions) has shown that it never will. Elsewhere, we have established that if firms can use nonlinear price schedules, then regardless of the utility functions of consumers, so long as they have strictly positive search costs, there will never exist an equilibrium.

[13] If first period search, c_1, is less costly than second, c_2, then there exists a single price equilibrium with $p=u-\delta$ provided $min(u/2, c_2)>\delta>c_1$ and provided that firms cannot price discriminate. (This result generalizes that of fn. 10.)

[14] This result parallels those of Grossman and Stiglitz (1980); in their analysis of the capital market, noise was essential in ensuring the existence of equilibrium when information was costly. In contrast to the model presented here, however, the noise was completely exogenous.

[15] To establish this result, we first show that individuals never enter the market the second period. Assume an individual re-entered the market the second period. He would have had to have purchased only one unit the first period. Assume $\hat{p}$ is the reservation price for purchasing a second unit. Clearly, provided $\hat{p}>0$, it would have paid the store to have offered to sell the individual a second unit at a price $\hat{p}$. Thus, the first store could not have been maximizing profits. Thus, the only possible equilibria entail individuals purchasing two units the first period. But if all individuals purchase two units the first period, the only possible equilibria entail firms charging $2u-\delta$ for the two units, consumers' surplus is again negative. (This follows immediately from the fact that any firm selling to the old would charge a price equal to u.)

[16] The use of nonlinear price schedules as devices by which a monopolist can partially discriminate among various customers is discussed in Salop (1977), Stiglitz (1977), and M. Katz (1981).

[17] The form of the price schedule is simple to calculate. Let $R(Q)$ be the required payments by an individ-

C. *Rational Expectations*

We have assumed that although individuals do not know the price charged at any store, they do know the price distribution. This is a kind of "rational expectations" assumption, and it is employed not so much because of its realism as because it is difficult to know what alternative expectations hypothesis to use.

It should be apparent, however, that expectations are critical. For individuals' expectations about what prices they will have to pay next period if they re-enter the market determine whether they buy for storage, or only for current consumption. There is no persuasive reason to believe that individuals' perceptions of the probability distribution of prices corresponds to the actual probability distribution; indeed, there is a considerable body of literature suggesting that there may be systematic biases in individuals' perceptions of probability distributions, particularly of events (like sales) which occur infrequently. (See Amos Tversky and D. Kahneman, 1974.)

What induces firms to charge prices below the monopoly level is that, if they lower them enough, consumers will purchase for future consumption. In an economy with price dispersion, in a two-price equilibrium we require

$$\hat{p}(2+\lambda)=u(1+\lambda). \tag{19}$$

Consumers' reservation price, $\hat{p}$, depends on their beliefs concerning the price distribution:

$$\hat{p}=\bar{p}^e+c-\delta, \tag{20}$$

where the superscript e on $\bar{p}$ is to remind us that what is critical is the consumers' perceptions of the mean price.

These perceptions affect the profitability of sales, and hence the frequency with which sales occur. But this, in turn, affects the mean price, which in turn may affect the perceived price.

Assume individuals believe there are bargains, even when there are not any. Then the only equilibrium may entail a price distribution. Assume for instance that individuals' expected price is greater than the true mean, $\bar{p}^e=\beta(\bar{p})\bar{p}$, $\beta>1$, and for $\bar{p}=u$, $2\bar{p}/3<\beta(\bar{p})\bar{p}+(c-\delta)$. Even under the stringent conditions where, with rational expectations, there existed a single price equilibrium, now there does not. For assume there did; as before, assume $c=0$ and $\delta>u/3$, so there is a *SPE* with $p=u$. If $p=u$, any store that reduced its price to $\hat{p}=\beta(u)u+c-\delta$ would increase its sales by 50 percent. Thus if at $\bar{p}=u$, $\{\beta(\bar{p})\bar{p}+c-\delta\}3/2>u$, it pays a firm to lower its price. (Clearly, the inequalities $u/3<\delta<(\beta-2/3)u$ can both be satisfied, if $\beta>1$.)

So long as individuals are reasonably pessimistic about prices, there must, in equilibrium, in fact be some bargains.

III. Concluding Remarks

For certain markets, the mythical auctioneer of traditional economic analysis may provide the basis of a good description of the working of the market; but for others, the equilibrium is vastly different from that which would obtain were there an auctioneer. This paper has shown exactly how different the two may be in the simplest of possible contexts where there is costly information gathering.

The basic structure of our model is simple. Firms set their *prices*; because of costly information, firms face downward-sloping demand schedules. The demand schedules which they face depend, in turn, on prices being charged by other firms. We can thus write the profits of the ith firm as a function of the vector of prices:

$$\pi_i=\pi_i(p_1,\ldots,p_N).$$

ual to obtain quantity Q of the output. Clearly, $R(2)\geqslant R(1)$. Moreover, $R(1)\geqslant u$. (Suppose $R(1)<u$. Then, raising $R(1)$ to u could only entail a loss of young customers who choose to buy two units at $R(2)$. But, since $R(2)\geqslant R(1)$, this is no loss.) Notice that $R(2)\geqslant R(1)\geqslant u$, regardless of what schedules other firms offer; the schedules of all firms must satisfy these properties. But, since $R(1)\geqslant u$ in both periods of the individual's life, if $R(2)=2u-\delta$, the individual who arrives at the store will (just) be willing to buy two units. This is the profit-maximizing value of $R(2)$. With this revenue function, there is no consumers' surplus, and, hence, no one would enter the market if it is costly to do so.

A Nash-Cournot equilibrium is characterized by the following two sets of conditions: (a) All existing firms choose a price to maximize profits. (b) For all existing firms, profits are nonnegative, and for any potential nonexisting firm, profits are nonpositive at all potential prices.

If all firms are identical, and the number of firms is large, then if equilibrium is characterized by price dispersion, the profit function (as a function of price) must peak at every price charged and at each peak profits must be identical.[18] There are two broad categories of mechanisms which allow firms to have the same profits although they charge different prices. First, stores which charge a low price have larger sales, just compensating for the lower price. There are a number of reasons why this might occur. Sales might be larger because more individuals shop there, because more individuals who arrive there are willing to purchase, or because those individuals who arrive purchase more units. In this paper, this latter possibility was explored in some detail. Secondly, if firms must recruit customers, for example, by advertising, then high-price stores may have higher recruitment costs per customer, exactly offsetting the higher revenue.[19]

In our analysis, we identified three cases, all very different from the equilibrium of traditional competitive analysis (even though we allow free entry):

(a) There may exist equilibria with price dispersion; the price one pays depends simply on the luck of the draw; the model has an immediate application not only in terms of the dispersion in prices one sees at any one time (there being high- and low-price stores), but also in terms of sales (unannounced specials). The variations in price with which we are concerned relate also to variations in quality, including durability; that is, what is important is price per effective unit of the commodity;

(b) There may exist equilibrium with a single price, but the price is above the competitive equilibrium price;

(c) There may exist no equilibrium; this will always be the case if stores are allowed to give quantity discounts.

Competition is usually thought to be in the consumers' interest; although we would not disagree with this general presumption, there is another side to this that must be borne in mind: with costly search, competition may take the form of attempting to find better ways of exploiting the small but finite degree of monopoly power associated with costly search and information. (More successful firms may not be more efficient firms, but more effective discriminators.) Although a perfectly discriminating monopolist without transaction costs is known to be Pareto optimal, perfect discrimination with transactions costs will result in the nonexistence of competitive equilibrium markets; no one will have the desire to enter the market.

The simple model of this paper has another important moral: the kinds of comparisons that have been made in comparative systems, comparing mythical market economies with mythical socialist economies are likely, with costly information, to be of only limited relevance; and the results obtained so far, for example, the basic equivalence theorems, are likely to be seriously misleading. We have constructed a model in which the market economy creates the "noise" which, because of costly information, it is unable to eliminate; although we have not presented a fully articulated model of either the competitive economy or a planned economy, it is clear that the two might look markedly different.

[18]If the number of firms is small, then the nature of the equilibrium depends on the beliefs of the potential entrant concerning the consequences of his entry (Salop, 1979). Similarly, any producing firm must form conjectures about the consequences of changing his price (see our 1977 article).

[19]See Gerard Butters (1977). Similar arguments apply to variations in quality. High-quality stores will have more repeat customers, and have a lower consumer recruitment cost per customer.

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