Chapter 13

IMPERFECT INFORMATION IN THE PRODUCT MARKET

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Contents

*Financial support from the National Science Foundation, The John M. Olin Foundation, and the Hoover Institution is gratefully acknowledged. This chapter is not intended as a comprehensive survey of what has become a voluminous literature. Rather, it is my objective to present a simple exposition of some of the major underlying themes. For a survey of the search literature, see, for instance, Lippman and McCall (1976). Several of the specific models presented here have not been published elsewhere, while the presentation of other models, in particular, the Salop–Stiglitz "Bargains and Ripoffs" (1977) model differs substantially from the published version. I am deeply indebted to Steve Salop with whom I have worked closely on the questions under discussion here. His influence should be apparent.

Handbook of Industrial Organization, Volume I, Edited by R. Schmalensee and R.D. Willig

PART I

1. Introduction and overview

In traditional competitive theory, each firm is a price taker. Each firm (and its customers) has perfect information concerning prices: if it attempts to charge more than the market price, it will lose all of its customers. Similarly, its customers have precise information concerning the nature of the commodities which it sells: if it attempts to cheat them by lowering the quality by even a little bit, it is immediately caught.

The theory describing the processes by which market prices are reached is much less well developed than the theory describing what the equilibrium prices are. Most commonly, reference is made to the Walrasian auctioneer, who calls off prices, with customers and producers passively responding with their demands and supplies.

In most markets, there is no Walrasian auctioneer, nor anyone who even vaguely resembles him. Firms set their prices. Yet this fact is not, in itself, necessarily a telling criticism: markets may act as if firms were price takers, and adjustments to disturbances might well occur as they would if there were a Walrasian auctioneer. Indeed, the Walrasian auctioneer has long been thought of as a convenient fiction.

It is our contention that in many instances, this traditional view is fundamentally incomplete, incorrect and misleading. It is incomplete, in the sense that there are many aspects of the market which it simply fails to explain; it is incorrect, in that its predictions concerning the behavior of the market are often wrong; and it is misleading, in that it often leads to policy prescriptions of dubious validity.

Among the predictions of the traditional theory are that a given commodity is sold at the same price by all stores (the Law of the Single Price); that price differences for "similar" commodities simply reflect differences in qualities (including difficult to measure differences in service qualities); and that cost increases (such as those associated with a specific tax) are passed along to consumers.[1] These, as well as the underlying assumption that firms face horizontal demand curves for their products are empirically testable propositions. Do firms believe that they face a horizontal demand schedule? Do consumers believe that price differences simply reflect differences in qualities, that there are no bargains to be had? Do prices respond quickly to cost changes in the way predicted by the theory? This chapter is not concerned with the literature attempting to test these propositions; rather, it begins with the presumption that

[1]Assuming a constant returns to scale technology (horizontal supply curve). In other cases, they are partially passed along.

these empirical predictions of the theory are not true.[2] We trace the disparity between the traditional paradigm's predictions and what is observed to that paradigm's failure to recognize that information is imperfect and costly. Though all would recognize that there are some costs of information, believers in the traditional paradigm argue that the market works in the manner described by that paradigm, provided only that there are enough individuals who are well informed. These well-informed individuals engage in arbitrage activities, ensuring that all stores charge the same prices for the same commodities, and that the price they charge is the competitive price (the marginal cost of production).[3]

We show here that the above view is not well founded. We show that the presence of imperfect and costly information gives firms market power; that well-informed individuals (individuals who have low costs of information acquisition) may indeed confer some externality on others, by ensuring that there are some low price stores, but that there will remain high price stores attempting to take advantage of the ill-informed consumer. In such situations, the theory of perfect competition is no longer relevant; some variant of a theory of monopolistic competition is required.

On the other hand, one simply cannot borrow the traditional theories of imperfect competition to analyze markets where the cause of the limitations on competition is costly information. For instance, changes in the number of firms (what might be thought of as an increase in the degree of competition) may have markedly different effects than those predicted by traditional theories of imperfect competition. If there are many firms, if any single firm lowers its price, it will not induce much search, and thus it may have limited incentives for lowering its price. On the other hand, if there are very few firms, if any one of them lowers its price, it may induce a considerable amount of search. This suggests that markets with duopolies or with a limited number of firms may be more competitive than markets with a large number of firms. The validity of this intuition turns out to be somewhat sensitive to the precise specification of the information or search structure of the model; although at least in some simple models this intuitive argument is not quite correct, it should at least serve to remind us that the relationship between the number of firms and the degree of competition is far more subtle and complicated than suggested, for instance, by Cournot's earlier analysis.

Not only does imperfect information result in firms having market power, with the degree of market power related to the number of firms in a possibly quite complicated way: we show further that under a variety of circumstances, the market will be characterized by a price distribution. The Law of the Single Price is repealed.

[2]See Pratt, Weiss and Zeckhauser (1979) and Scitovsky (1976) for a discussion of some of the evidence on price distributions.

[3]Thus, these "arbitrageurs" ensure that the market acts *as if* everyone were perfectly informed.

Furthermore, we argue that the Walrasian auctioneer provides an inappropriate model of adjustment.[4] We show that imperfect information gives rise to price rigidities, so that under certain circumstances markets simply fail to respond to certain kinds of disturbances (which would, under the conventional theory, lead to marked price changes). This aspect of the theory may play a role in explaining the price rigidities which are central to understanding certain macro-economic phenomena.

Imperfect information in product markets has further consequences on the qualities and varieties of commodities produced. Firms must have an incentive for producting high quality products, for not cheating their customers; in many (most) cases, individuals do not observe the quality of what they purchase until after they have purchased it. An examination of the consequences of this – including the mechanisms by which quality is assured – is one of the subjects surveyed in this chapter, as are the consequences for the variety of commodities produced.

Consumers obtain information in a variety of ways. Most of this chapter is concerned with information that individuals obtain through deliberate activities to become more informed, through search. Some of the information is obtained as a by-product of other activities – the dissemination of information through social contact – and we discuss this too. Finally, some of the information they obtain is the result of deliberate activities on the part of firms to inform consumers, through advertising. Advertising is an important economic activity, with over 2 percent of GNP being spent on it in recent years. Yet, I would argue that most of this expenditure does not fit neatly within the economists' model, neither that which assumes fully informed individuals with well defined tastes, nor the one (with which we shall be concerned here) which assumes uninformed consumers (with well-defined tastes.) Advertising may have more to say about economists' approach to the theory of consumers' behavior than economists have to say about advertising! These are issues to which we turn in Part II.

1.1. Methodological remarks

As is so often the case in economics, our analysis is partly an enquiry into how economic models work, and partly an enquiry into how the economy functions. In the preceding paragraph, we have suggested that the traditional competitive paradigm, with fully informed consumers, should be rejected because it generates empirical predictions of dubious validity. Another criterion by which a theory is to be judged is its robustness. Thus, one of our objectives is to explore how robust the standard competitive paradigm is to the introduction of imperfect information: we show that it is in fact not very robust; slight modifications of the

[4] This is perhaps an unfair criticism: no one probably took the tantamount process seriously.

standard model result in the non-existence of the market equilibrium; alternative modifications result in the market equilibrium price being the monopoly price or in market equilibrium being characterized by a price dispersion.

Though we may not fully believe some of these conclusions – is the market equilibrium price the monopoly price, even with arbitrarily small search costs? – they convey an important message: market prices may well be significantly above marginal costs, even when there are a large number of firms; and an examination of the assumptions underlying these results may provide us with considerable insights, not only into the workings of the model, but also into the workings of the economy.

Skeptics may ask: Are not the issues we are raising here second order refinements of the basic theory? Is it not still true that if demand increases, price will increase? If costs increase, price will increase? Are not the basic lessons of economics, of, say, the law of supply and demand still valid? I hope to persuade the reader that the concerns raised here are not in fact second order refinements but first order effects. Not only is the traditional theory unable to explain certain important phenomena (such as the central role of price discrimination – which in the standard perfectly competitive paradigm can play no role at all – or the persistence of price distributions); but changes in parameters (e.g. costs of production) may have markedly different effects than those predicted by the perfectly competitive paradigm. Moreover, the welfare consequences may differ markedly. Markets with imperfect information are, in general, not even constrained Pareto efficient, that is they are not efficient even when we take into account the costs of information.[5] Unfortunately, we cannot pursue these welfare questions (and the associated questions of the appropriate policy interventions) in this chapter. The theory developed here does, however, provide the basis of a Theory of Consumer Protection.

1.2. On the use of derived demand curves

Information is exchanged between consumers and firms in a variety of ways. Individual consumers find out about prices, qualities, and locations where products can be obtained both through systematic search activities (by visiting stores and shopping centers, by reading newspapers, etc.) and as a by-product of other activities (talking to their friends). Stores try to convey information to potential customers by a variety of advertising media. For most of this chapter, we focus on models in which information is obtained as a result of customers' activities, not through firm advertising.

[5]See Greenwald and Stiglitz (1986).

Even within this more narrowly defined range of information acquisition processes, a large number of alternatives remain – with often different consequences. We begin by reviewing several simple models and then attempt to synthesize from these models the general lessons to be learned. In each case, we ask how the presence of imperfect information affects the demand curves facing the firm. Thus, while the traditional model may not be appropriate for analyzing most markets for consumer goods, it provides us with an indispensable tool for interpreting what is going on in the market.

When imperfect information results in the demand curve becoming less than infinitely elastic, it implies that imperfect information confers a degree of monopoly power on the stores [Figure 13.1(a)].. When a store raises its price a little, it does not lose all of its customers; when it lowers it a little, it does not get the entire market. When, by lowering the price a little, the store recruits no additional customers, then the equilibrium price will be the monopoly price [Figure 13.11(b)]. When, under the hypothesis that all firms charge the same price, there is a kink in the demand curve, as depicted in Figure 13.1(c) (where the elasticity with respect to price decreases exceeds that with respect to price increases), then there cannot exist an equilibrium in which all firms charge the same price. For assume there were a zero profit (Nash) equilibrium. As should be apparent, firm profits would then be increased either by lowering or raising prices. Such kinks should not come as a surprise: there is a natural asymmetry of information – the consumer knows the price of the store that he is at; he does not know the prices of stores that he is not at. Contrast the effects of a single store deviating from an equilibrium in which all stores charge the same price, either by raising or by lowering its price. When a single store raises its price, the costs of finding one of the multitude of low price stores for an individual who has the bad fortune of arriving at the high price store is relatively low, and hence it is plausible that the firm faces a relatively elastic response to price increases. On the other hand, if a firm lowers its price, the cost of finding that one low price firm – the needle in the haystack – may be relatively high. But while relatively few individuals at each of the rival stores may be induced to search, there are many stores from which the firm which has lowered its price can recruit customers. Thus, it is possible that the increase in demand to a price decrease be either greater or less than the decrease in demand to a price increase. Figure 13.1(c) illustrates the case where the elasticity of demand with respect to price decreases exceeds that with respect to price increases.

By contrast, Figure 13.1(d) illustrates the case where, under the hypothesis that all firms charge the same price, there is a kink in the demand curve, with the elasticity with respect to price decreases being less than that with respect to price increases. It is under these circumstances that the market will exhibit the kind of price rigidity, with its important macro-economic implications, to which I alluded earlier. Since there is a discontinuity in the marginal revenue schedule, small

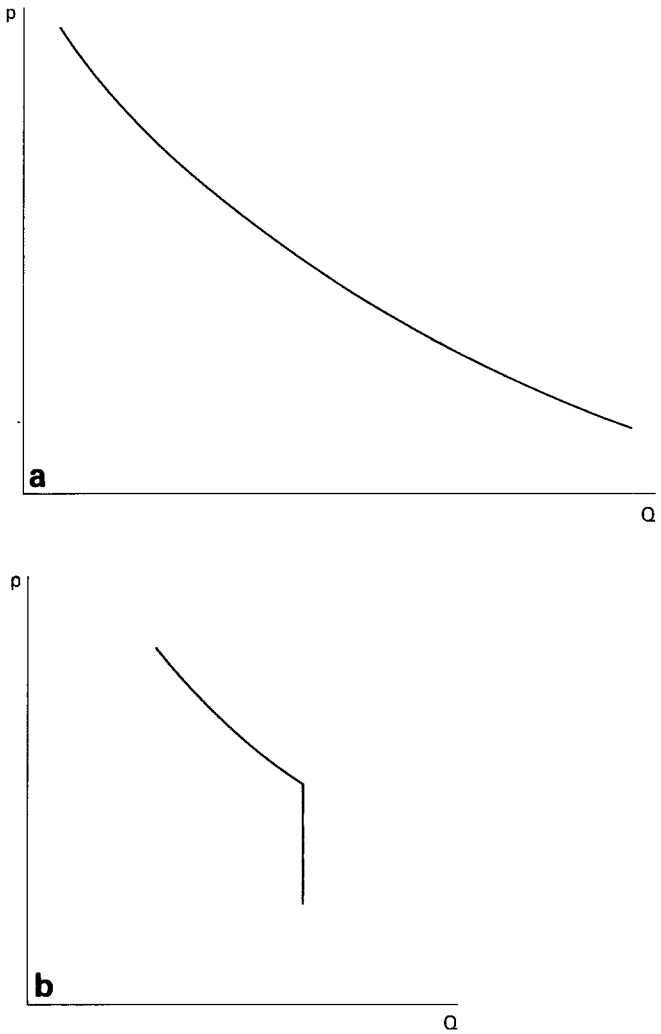

Figure 13.1. (a) Imperfect information may reduce the demand elasticity facing a firm. It no longer perceives itself as facing a horizontal demand curve, as in the standard competitive paradigm. (b) In some limiting cases, the firm recruits no new customers when it lowers its price. (c) In some cases, when all firms charge the same price, the demand curve facing any firm has a kink, with the elasticity of demand for price decreases exceeding that for price increases. It is clear that, under these circumstances, there cannot exist a zero profit single price equilibrium. Profits would be increased if any firm either increased or decreased its price. (d) In some cases, when all firms charge the same price, the demand curve facing any firm may have a kink, with the elasticity of demand for price increases exceeding that for price decreases. (e) In some cases, when all firms charge the same price, the demand curve facing any firm may have a discontinuity. Again, under these circumstances, there cannot exist a zero profit single price (Nash) equilibrium, except at a price equal to minimum average cost.

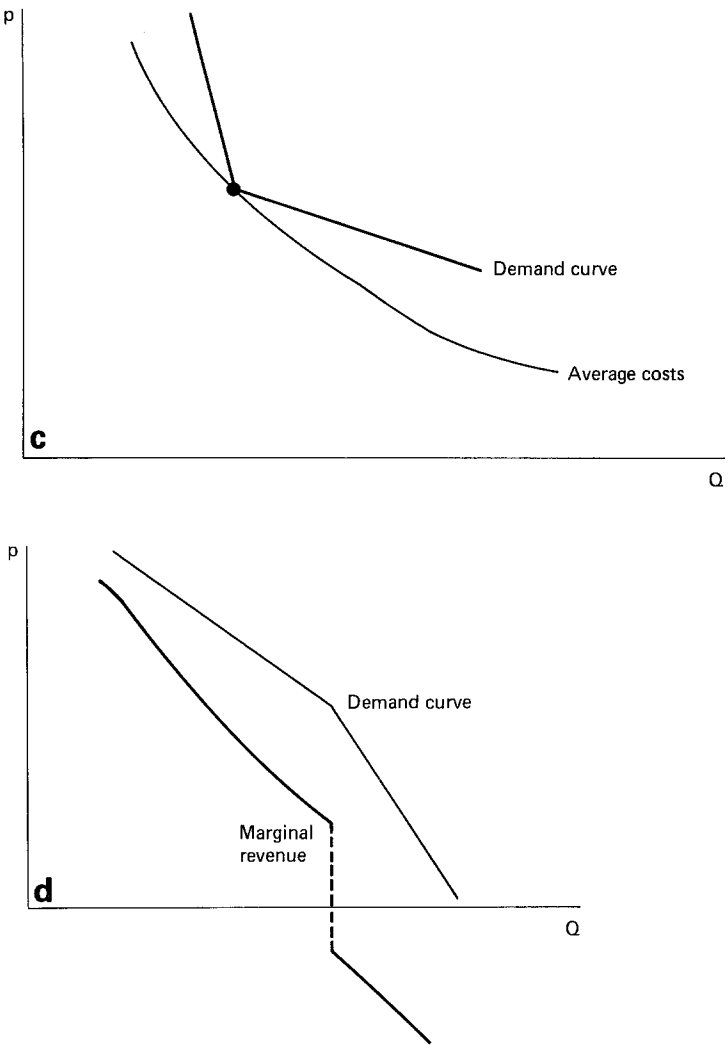

Figure 13.1. *Continued.*

changes in the marginal cost of production will give rise to no changes in output or price.

If there is a discontinuity in the demand curve [Figure 13.1(e)] – if all other firms charge the same price and it lowers its price, its demand increases discretely – then the only single price equilibrium must be at a price equal to the minimum average cost.

One of our objectives then is to ascertain the conditions under which demand curves of each of these forms is generated. Most of the analysis of this chapter

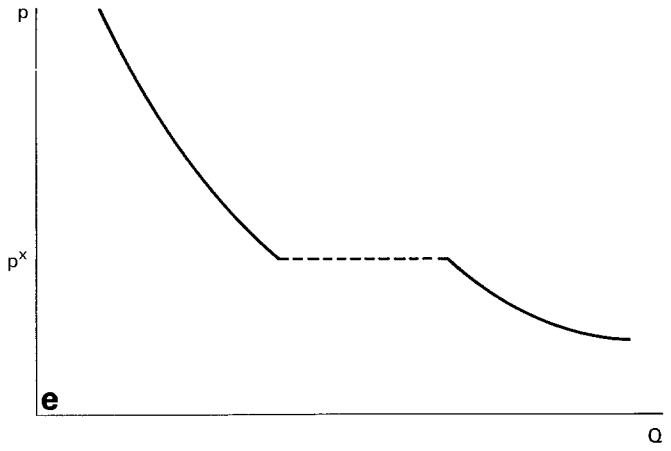

Figure 13.1. *Continued.*

can be thought of as applying to consumer manufactured goods, goods which individuals purchase with sufficient infrequency that they are often uninformed concerning the prices, qualities, and locations of the available goods. These goods are often marked by considerable heterogeneity. Nonetheless, I begin the analysis by analyzing a market for homogeneous goods, in order to focus attention on one information problem – the absence of price information. In Part II, I turn to the more general problem where there is uncertainty about both prices and qualities. Since the demand curve facing manufacturers is a derived demand curve – derived from the underlying demand curves of the stores which purchase goods from it – many of the results obtained here apply equally to manufacturers. Thus, in those cases in which we argue that there are price rigidities, this may be true both at the retail and manufacturing level. On the other hand, I am not sure how important these considerations are for the inputs into manufacturing. One might be tempted to argue that for such enterprises, search costs are small relative to their expenditures. But many of the results of our analysis remain valid even if search costs are very small indeed. (It is precisely in this sense that the standard paradigm is not robust.)

The existence of imperfect information gives rise to a demand for information. There are important economies of scale in the production of information. Thus, imperfect information may give rise to firms which specialize in the production and dissemination of information. But this does not resolve our problem: consumers have to make judgments about the quality of the information provided; and they have to become informed concerning the prices charged by these information gathering services. Furthermore, in heterogeneous markets, it is often

difficult for any information gathering service to convey fully the requisite information about product characteristics, especially in the presence of rapidly changing technologies – as most readers of Consumers' Report will testify. These information intermediaries face further problems: because of the public good nature of information,[6] they may have difficulty appropriating the returns to the information that they produce. A good report on a product will be quickly disseminated by the producer. Individuals can obtain the information from neighbors or from the public library. In spite of the problems facing information intermediaries, they exist. Indeed, one can view wholesalers, or even retailers as being largely information intermediaries. I do not develop here a theory of information intermediaries, but it should be apparent from the previous discussion that the central issues with which we are concerned here would be unaffected by their presence.

2. Three paradoxes

We begin our analysis with a discussion of three paradoxes which serve to illustrate how sensitive the conclusions of the traditional paradigm are to its assumptions concerning information. We show that under a seemingly plausible modification of the standard competitive paradigm,

(i) if all individuals have strictly positive search costs, no matter how small, at least for all searches after the first, if an equilibrium exists, the equilibrium cannot be characterized by a price distribution;

(ii) the unique price is the monopoly price, but

(iii) if all individuals face strictly positive search costs for all searches, including the first, then no equilibrium exists.[7]

Thus, the presence of even small costs of information dramatically changes the standard results: equilibrium may fail to exist, and when it does, it looks very different; even with free entry, prices rise from the competitive level to the monopoly level; all that free entry does is dissipate the resulting profits by excessive expenditures on fixed costs.

We establish these results in a simple model; the arguments can easily be extended to more general cases. We postulate a market for a homogeneous commodity, in which consumers can only obtain information about the price being charged by a store by actually going to the store. We wish to capture the conventional notion of competitive markets. Accordingly, we assume that there is an arbitrarily large number of identical firms, and that each of the large number

[6] For a fuller discussion of these issues, see Stiglitz (1989).

[7] The first two results are generally attributed to Diamond (1971) and the last result to Salop and Stiglitz (1977a, 1982).

of individuals is equally likely to go to each of these stores. Furthermore, we assume that each firm assumes that it has no effect on consumers' search behavior, and each consumer believes that he has no effect on producer pricing strategies. The tth search costs the jth individual s_t^j. We assume that $s_t^j > 0$ for $t > 1$. The results are most easily seen in the case where[8] demand curves are of the form:

$$q = 1, \quad \text{if } p < u, \tag{1a}$$

$$0 \leq q \leq 1, \quad \text{if } p = u$$

$$q = 0, \quad \text{if } p > u. \tag{1b}$$

The individual demands 1 unit of the commodity, provided the price is less than the reservation price u. In this case, u is the monopoly price; the monopolist would charge a price of u, regardless of the costs of production (provided they are less than u). If he decreases the price, he does not gain any sales, but if he increases the price beyond u, he loses all of his customers (see Figure 13.2).[9]

We assume the individual is risk neutral. We first establish the impossibility of a price distribution by contradiction: assume there were a price distribution. Consider the firm with the lowest price, $p_{\min} < u$. Let $s_{\min}$ denote the minimum value of s_j^t, for $t > 1$ and all j; by assumption $s_{\min} > 0$. If the firm with the lowest price were to raise its price by any amount less than $s_{\min}$ (keeping $p \leq u$), it would obviously not pay any of its current customers to leave to search for a better deal. But that means that that firm could not have been maximizing its profits.

Indeed, the same argument shows that the unique single price equilibrium is u, the monopoly price. For the lowest price store will always increase its profits by raising its price slightly, so long as its price is less than u. Since no firm will charge more than u, the only possible equilibrium is one in which all stores charge u.

But now, it is easy to show that if $s_1^j > 0$ for all j, there cannot exist any equilibrium. For the individual has to decide whether to enter the market or not.

[8] We drop the superscript j when there is no confusion.

[9] This demand function can be derived from the utility function:

$$U = uq + Q_0, \quad \text{for } 0 < q < 1,$$

$$U = u + Q_0, \quad \text{for } q \geq 1,$$

where q is the quantity of the good being sold by the store consumed, and Q_0 is the quantity of other goods consumed:

$$Q_0 = I_0 - pq,$$

where I_0 is the individual's income, and p is the price.

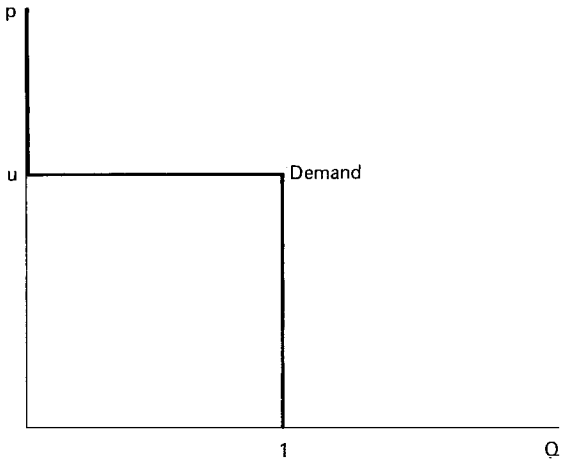

Figure 13.2. Simplified demand structure: individuals demand 1 unit provided price is less than or equal to u; zero if price exceeds u.

If he enters the market, his utility is

$$U = u - p + I_0 - s_1^j = I_0 - s_1^j;$$

while if he does not, his utility is

$$U = I_0.$$

It is clear he will not enter the market. But if no one enters the market, it is clear that there cannot exist any firm (let alone a large number of firms). But if there were no firms in the market, it would pay a single firm to enter, charging a price somewhat less than u (the optimal price would be somewhere between u minus the maximum value of s_1^j and u minus the minimum value of s_1^j.) Thus, there cannot exist any (Nash) equilibrium to the market.

In effect, the excessive greed of the store owners destroys the market. Each store ignores the effect of its actions on the number of shoppers. Each store thus tries to extract the last ounce of surplus out of the marginal shopper; but if it does this (and any store can do this under the conditions stipulated), then the marginal shopper drops out of the market; and as soon as he drops out of the market, the greedy stores raise their prices to try to extract the last bit of surplus out of the shopper who is now marginal. The process continues until there are no shoppers: the market has been destroyed.

It is clear that this argument holds even if different individuals have different reservation prices (u). Indeed, it holds even if individuals have general utility functions, so long as the stores can use non-linear price schedules[10] to extract surplus from their customers.[11]

2.1. *The resolution of the paradoxes*

Markets do exist. Something must, therefore, be missing from the simple analysis presented above. That analysis does show how sensitive the conventional model is to a slight perturbation in information assumptions: even a slight cost of search leads either to a monopoly price or to the non-existence of a competitive equilibrium. There are several possible resolutions to the paradox – each entailing dropping one of the assumptions of the previous analysis. One approach is to drop the assumption of competitive markets, so that each firm believes that its actions affect whether individuals enter the market. If there are a few firms (as there are in many markets) then this is a plausible hypothesis.[12]

[10] The main reason that stores cannot use non-linear price schedules, the possibility of arbitrage, may not be relevant, precisely because of the costs of shopping and marketing which are of concern here.

[11] We can easily show that there cannot exist an equilibrium with a single non-linear price function. In that case, everyone will purchase at the first store at which they arrive. The price function must be such that at least some individual enjoys zero surplus, given that he has arrived at the store; for assume that all individuals enjoy some strictly positive surplus (given that they have already spent s_1^j to enter the market). Then, if the store increases the fixed charge for shopping at the store by an amount which is less than or equal to $\min[s_2^j, V^j]$, where V^j is the surplus enjoyed by the jth individual, then no individual will leave the store, and the store's profits will be increased. But, by exactly the same reasoning as given above, any individual who enjoys zero surplus, given that he has arrived at a store, will not enter the market, if it is costly to do so. Hence, no one enters the market. Thus, if an equilibrium is to exist, it must entail different stores employing different price functions. But this is not possible, if all individuals are identical, or if they are "similar" enough. Assume, in particular, that we can order individuals, so that $i > j$ implies that if $V^j(R, q) > V^j(0, 0)$, where $V^j(R, q)$ is the utility of the jth individual when he pays R dollars for q units of output, then $V^i(R, q) > V^i(0, 0)$, while if $V^i(R, q) < V^i(0, 0)$, $V^j(R, q) < V^j(0, 0)$ – that is, i gets some consumer surplus out of the transaction if j does; and if i does not, neither does j; i unambiguously has a stronger preference for the good than j. Then, each store will set its price function so that the marginal individual buying at its store will enjoy no surplus. Given that, the individual with the lowest preference for the commodity (which by our assumption is well defined) will either not buy at any store at which he arrives or will enjoy a zero surplus if he does buy. Thus, he does not enter the market.

[12] Our earlier analysis showed that there could not exist a Nash equilibrium. This argument holds whether there are a finite or infinite number of firms. But with a finite number of firms, it becomes less convincing that Nash is the appropriate equilibrium concept. An equilibrium, in which firms take as given consumers' search *strategies*, but in which each firm takes the prices of other firms as given, may be more convincing. It is easy to show that there can exist such equilibria, with or without price distributions. In the analysis below we show that with a finite number of firms there can exist Nash equilibria with price distributions.

Alternatively, there may exist equilibria in which different firms charge different prices or sell commodities with different qualities. There is, in other words, noise in the market:[13] There must be some chance that the marginal individual who enters the market does not have all of his surplus extracted. This may be because there is a price distribution, with the lowest price in the price distribution being below $u - s_1^j$, so the individual gets some surplus; or it may be because the individual who is marginal at one store is not marginal at another, because more than one commodity is sold on the same market, with firms unable to distinguish who likes which commodity. Individuals who happen to arrive at the store which sells their most favored commodity will then enjoy some surplus.

In the sections below, we construct several simple models with price dispersion and commodity heterogeneity. These models differ from the simple example just presented in one of two ways:[14]

(a) *The specification of the information technology*. The model just presented assumed that there was a cost associated with acquiring each additional piece of information, and that in the absence of search, individuals had no information. A more general information acquisition technology may be written:

$$S^j = S^j(T), \tag{2}$$

where T is the number of stores sampled (about which price information is obtained). Thus, in the previous model,

$$S^j(1) > 0, \quad \text{for all } j.$$

The standard sequential search a model postulates that each search costs the same amount, so that S takes on the form:

$$S^j(T) = s^j T. \tag{2a}$$

In the model presented in the next section, the information acquisition technology takes on the simple form:

$$S^j(T) = S^j, \quad \text{for all } T \geq 1, \tag{2b}$$

[13] There is one other possibility to which we do not attach much importance: If there are enough individuals with zero search costs, competition for these individuals may be sufficiently keen to keep prices low enough so that the marginal individual is not deterred from entering the market. Even then, however, we normally expect that equilibrium will be characterized by price dispersion. We consider this possibility below.

[14] Most of the models differ from those presented above in a third way: there are only a finite number of firms. But while focusing on the case where there are a fixed number of firms helps to clarify what is going on, the assumption is not critical for most of the results, as we shall see.

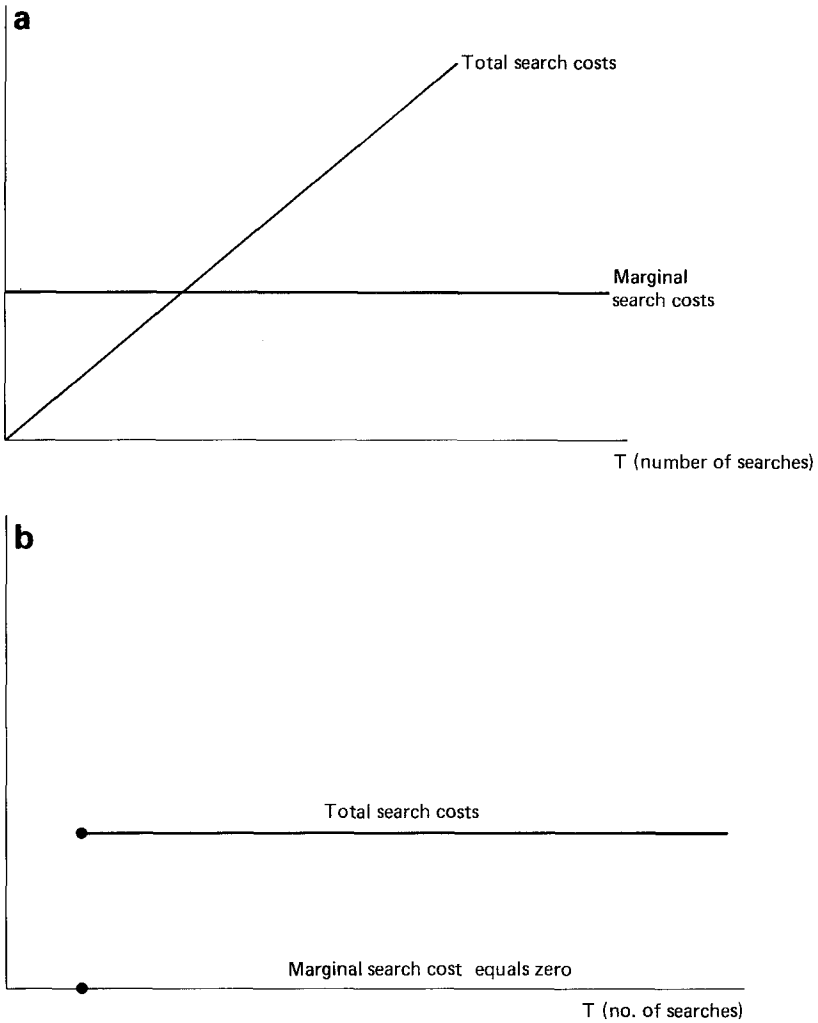

Figure 13.3. (a) Standard sequential search technology: each search costs the same amount. (b) "Newspaper technology": individual acquires complete information by paying a fixed cost. (c) More general convex search technology. (d) Concave search technology: successive searches cost an increasing amount. (e) Limiting case: more than two searches are prohibitively expensive.

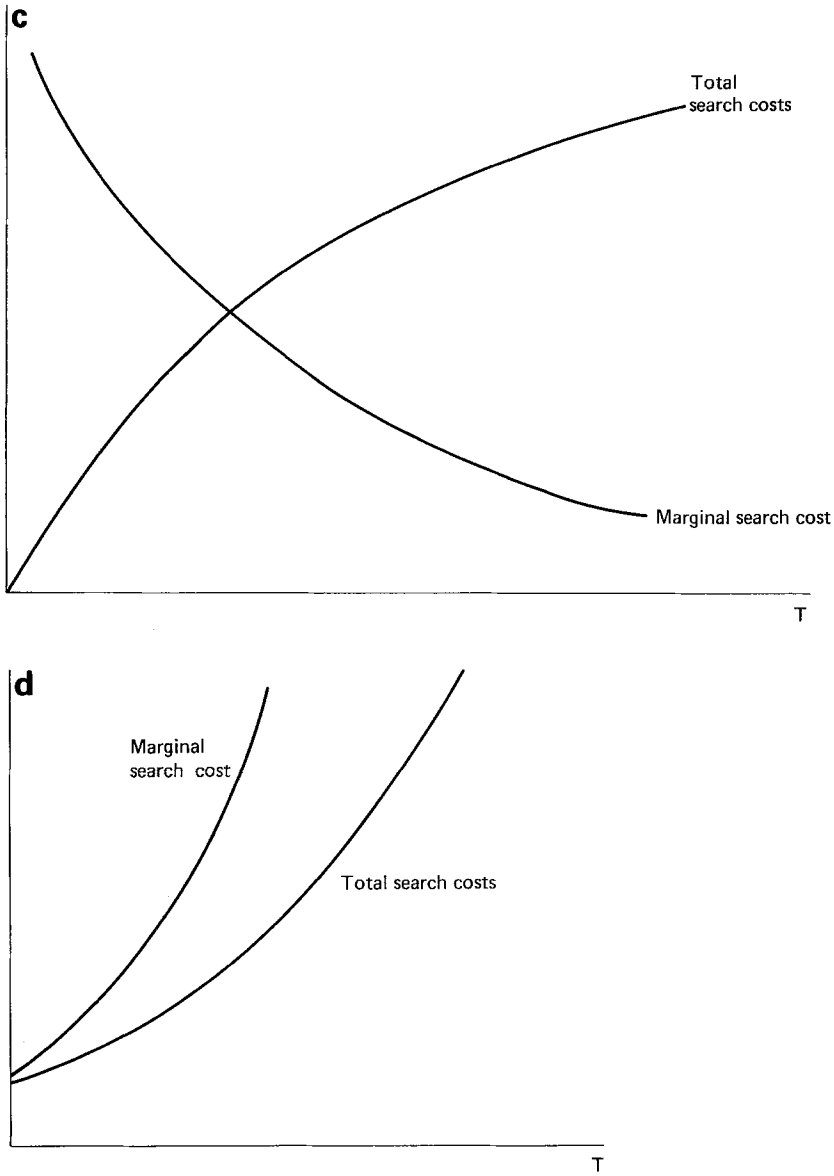

Figure 13.3. *Continued.*

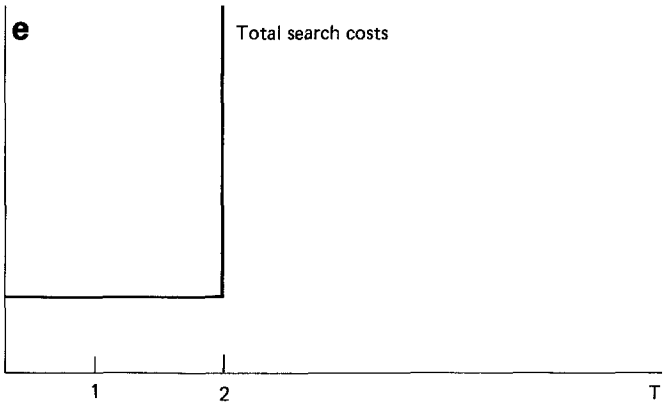

Figure 13.3. *Continued.*

that is, there is a fixed cost associated with obtaining complete information about all stores. That is the case where an individual can buy a newspaper which describes the prices charged by all stores (and the costs of reading the newspaper are essentially zero). Still another interesting technology is that which arises when stores are clustered in shopping areas. Then there is a fixed cost of going to the shopping area, but a very low cost of going from one store to the next within the shopping area. As a limiting case, we could assume that

$$S^j(T) = S^j, \quad \text{for } 1 \leq T \leq k, \tag{2c}$$

$$S^j(T) = 2S^j, \quad \text{for } k+1 \leq T \leq 2k, \tag{2d}$$

etc. (In this case, there are k stores in each shopping area, and there is a fixed cost of S^j of going to a shopping area.) The various information acquisition technologies are illustrated in Figure 13.3.

Another variant of the "shopping-information acquisition technology" which we will discuss below is one in which the individual can store commodities when he finds a good deal. (Implicitly, the example given earlier involved a market for a non-storable commodity, like strawberries.) Still another information acquisition technology which will be modeled is that where individuals acquire information through social contacts.[15]

(b) *Market heterogeneity.* The model presented in the previous section assumed, as we have already noted, that only a single homogeneous commodity was sold on the market. It is not obvious how modern retailing should be interpreted in terms of "markets". What is clear is that if one goes shopping for a sweater, the set of items one finds in different stores may differ markedly. The market for

[15]Advertising represents a quite different kind of information acquisition/dissemination technology, which we will discuss below.

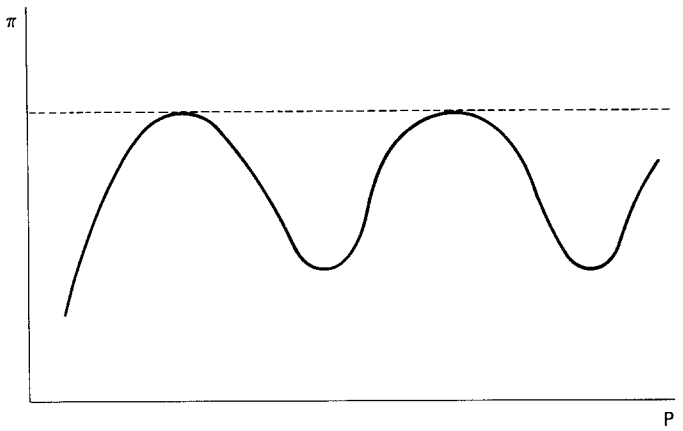

Figure 13.4. Profits as a function of price. For there to be an equilibrium price distribution, the profit function must not only have multiple peaks, but the value of profits at each observed peak must be the same.

sweaters involves selling heterogeneous commodities. This has important implications for the nature of the market equilibrium, which we spell out later.

PART II. Equilibrium price distributions, monopoly power, and price rigidities: Homogeneous goods

3. Constructing models with price distributions

In the following sections we present several alternative models which may generate price distributions. At first blush, it might appear difficult to construct such models. In Figure 13.4 we have plotted the profits of the firm as a function of the price charged. For there to be a price distribution not only must this profit function have multiple peaks, but also the peaks must be at precisely the same level of profits. This seems like an implausible condition to be satisfied, for an arbitrarily specified production and information acquisition technology. But in fact, it turns out easier to construct examples of equilibrium price distributions than at first might seem to be the case.[16]

The earliest investigations of price distributions [see, for example, Stigler (1961)] turned out to be inconsistent: though he considered the consequences of

[16]Had we not been able to construct equilibrium price distributions, we would have faced a dilemma: in Part I we suggested that it was easy to construct models in which, under the hypothesis that all firms charge the same price, the demand curve facing any firm has a kink because of information asymmetries; if this kink is such that the elasticity of demand with respect to price decreases exceeds that for price increases, as well may be the case, then there cannot exist a single price equilibrium.

price distributions for consumer behavior, given the derived demand curves all firms with the same technology would have charged the same price.

With different firms facing different marginal costs, it is easy to construct equilibrium price distributions. Indeed, even when they face the same demand curve (which, because of imperfect information, is downward sloping), the price at which marginal revenue equals marginal costs is different if marginal costs differ.[17]

But there may exist price distributions even when all firms have the same technology.[18] The profit function facing any firm depends critically on the prices charged by other firms; and that dependence takes on a form which easily allows construction of profit functions of the shape depicted in Figure 13.4.

Firms that charge high prices make high profits per sale, but have a low level of sales; firms that charge low prices make low profits per sale, but have a high level of sales. The level of sales at, for instance, low price stores depends on the number of high price stores (and the prices which they charge). There is a set of proportions (of high and low price stores) such that profits at the high and low price stores are exactly the same. There are several ways of modelling the trade-offs between price and quantity sold (the demand curve facing the firm), some of which we describe briefly in the following sections.[19]

The general structure of these price distribution models can be represented simply. Consider first a two-price distribution. The quantity sold by a high price store is a function of the number of low price stores, the number of high price stores, and the price at the low and high price stores; similarly for the low price store. Thus we write:

$$Q^{\mathrm{H}} = D^{\mathrm{H}}(p^{\mathrm{H}}, p^{\mathrm{L}}, N^{\mathrm{H}}, N^{\mathrm{L}}),$$
$$Q^{\mathrm{L}} = D^{\mathrm{L}}(p^{\mathrm{H}}, p^{\mathrm{L}}, N^{\mathrm{H}}, N^{\mathrm{L}}).$$

From this, we can immediately derive the revenue functions (pQ), the profit functions, π, and the marginal revenue functions (MR). Equilibrium is the

[17]There is still a problem in constructing a price distribution: because the demand curve facing a firm will depend on the price distribution, the prices charged (where marginal revenue equals marginal cost) will depend on the price distribution. We need to find a "fixed point" where the hypothesized price distribution, given the distribution of costs, generates the hypothesized price distribution. See Reinganum (1979) and Stiglitz (1974). [Stiglitz' paper is set in the context of the labor market, but the trade-offs are precisely the same. Although in the simpler version of Stiglitz' model, firms with high training costs paid higher wages to minimize total labor costs (raising wages lowers turnover costs), in other versions all firms had the same technological opportunity set; in equilibrium, some firms chose to pay high wages and to employ a technology involving high training costs; while others chose to pay low wages and to employ a technology involving low training costs. The observed differences in technology were thus endogenous. Stiglitz shows that there are in fact multiple equilibrium price distributions.]

[18]This is not the only problem associated with constructing models with equilibrium price distributions. One needs to explain why price information does not eventually get disseminated. See below.

[19]Similarly, if firms "recruit" customers by advertising, some stores will have a high profit per sale, offset by a high recruitment cost per customer.

solution to the four equations:

$$\pi_i = \pi_i(p^{\mathrm{H}}, p^{\mathrm{L}}, N^{\mathrm{H}}, N^{\mathrm{L}}) = 0, \quad i = \mathrm{H}, \mathrm{L}, \tag{3}$$

$$MR^i = MR^i(p^{\mathrm{H}}, p^{\mathrm{L}}, N^{\mathrm{H}}, N^{\mathrm{L}}) = MC, \quad i = \mathrm{H}, \mathrm{L}, \tag{4}$$

where MC is the marginal cost of production. The first set of equations are the zero profit equations, the second the profit maximizing equations. Graphically, the solution is represented by the tangency of two demand curves to the average cost curves; one is the demand curve given the prices charged by the low price stores and all other high price stores; the other is the demand curve given the prices charged by the high price stores and all other low price stores (see Figure 13.5).

It is straightforward to extend this structure to the case of a multi-price distribution; for each additional price, we add two extra equations (the zero profit and the profit maximizing equation), and two additional unknowns, the price, and the number of stores charging that price. It is not enough, of course, simply to write down these equations, and to assert that there is a solution. In each case, one must be able to show that there exist meaningful solutions to the relevant equations (e.g. involving positive prices and quantities). In the models below, we do this. In some cases, the only possible equilibria involve only two possible prices while in other cases, the price distribution may take on a more general form.

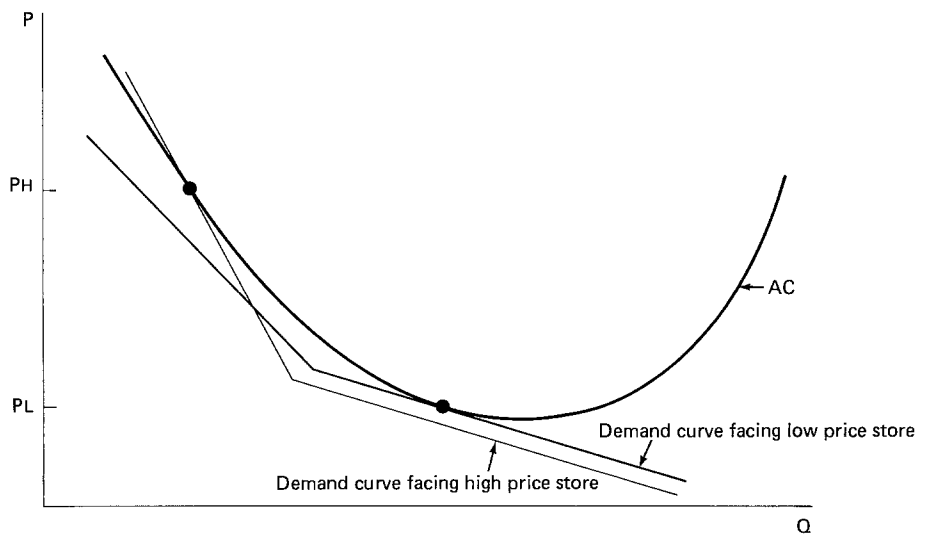

Figure 13.5. With a two-price equilibrium, the low price store has just enough more customers to compensate it for its lower price.

3.1. *Alternative interpretations*

There are two ways of interpreting the price distributions in the models we present below. One is that the same store always charges the same price, some charging low prices, others charging high prices; the other is that each store has a random price, charging a high price a fraction of the time, a low price the remainder of the time. (In terms of game theoretic language, each firm pursues a mixed strategy.)

The difficulty with models in which the same store always charges a low price is that, under most situations, customers will come to learn of the low price store. The one exception is when new individuals are continually entering the market, e.g. in tourist industries. (Of course, in markets for new commodities, price dispersions may persist for an extended period of time.)

Nonetheless, for most (but not all)[20] of the models we present below, our analysis applies precisely only to the case where some stores always charge a high price, others only a low price. This greatly simplifies the calculations, but it should be clear that the models can easily be extended to the "random price" interpretation.[21] The difference between the two interpretations arises from the fact that when each store randomly charges a low price, the fraction of stores charging a low price will be a random variable. This has two consequences. The average value of the average cost will not be the same as the value of the average cost at the average output, and the equilibrium price distribution must take this into account. Furthermore, we show that in the case we focus on, equilibrium is characterized by a price distribution with only two prices. This is true even if a strictly positive fraction of consumers have zero search costs. But this cannot be the case when firms use mixed strategies. For there is some probability that all stores will charge the high price. In that case, any store consistently charging just epsilon less than the high price will have strictly greater profits than the firms charging the high price, for it will garner, for itself, all of the zero search cost individuals. More generally, there cannot be a mass point in the distribution at the highest price. (We omit the details of the proof, as well as the calculation of the price distribution.)

4. Bargains and ripoffs

When individuals differ in their costs of acquiring information, those who can easily obtain information can find the low price stores; thus high price stores sell only to those facing high costs of information acquisition. Low price stores sell to

[20] The model presented in Section 6 is couched explicitly in the vocabulary of "sales", i.e. stores randomly lowering their prices.

[21] Varian (1980) does this for the "bargains and ripoffs" model presented below.

those with low costs of information acquisition and to those with high costs who are lucky enough to arrive on their doorsteps. The market equilibrium prices thus serve to discriminate (imperfectly) among individuals with different search costs. Low search cost individuals confer an externality on high search cost individuals. But there are enough high search cost individuals that small stores charging high prices, exploiting the hapless consumers with high search costs who do arrive at their doorstep and who cannot afford to continue looking for a bargain, survive. [This section represents an extension of work done jointly with Steve Salop (1977b). We consider here the case where there is a continuum of types of individuals. The earlier paper considered the case with two types only.]

To see this, assume that individuals can, at a cost s, obtain complete information concerning the price distribution. Individuals differ though in the magnitude of s; the fraction of the population with search costs less than s is given by $F(s)$. We continue with our assumption concerning individuals' utility function, so that the individual purchases one unit of the commodity, provided the price is less than u.

An equilibrium price distribution must satisfy the following properties:

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

(2) *Firm entry equilibrium*: Each firm earns zero profits.

(3) *Search equilibrium*: Each consumer searches optimally given his search costs and the price distribution.

(4) *Consumer entry equilibrium*: Each consumer enters the market if and only if expected consumer's surplus is non-negative.

We shall derive conditions under which a non-degenerate equilibrium price distribution exists. To do this, we shall first characterize such an equilibrium (if it exists).

There will, in equilibrium, be two types of individuals, those who purchase information (with $s \leq s^*$), and those who do not, with $s > s^*$. We refer to the former as the informed, the latter as the uninformed. The informed only purchase at the lowest available price, which we denote by $p_{\min}$. The uninformed simply purchase at the first store at which they arrive. (Implicitly, we assume that sequential search is prohibitively expensive.) Thus, the expected price which they pay is $\bar{p}$, the average price on the market.[22]

The demand curve facing any firm is depicted in Figure 13.6: At any price above $p_{\min}$ (but below u) the store only sells to the uninformed who happen to arrive; for prices above u, the store sells nothing. For prices at $p_{\min}$ the store gets its pro-rata share of the informed, plus the uninformed who happen to arrive

[22] Uninformed individuals are assumed to have no information concerning the price charged at any store. Hence, they are equally likely to go to any store.

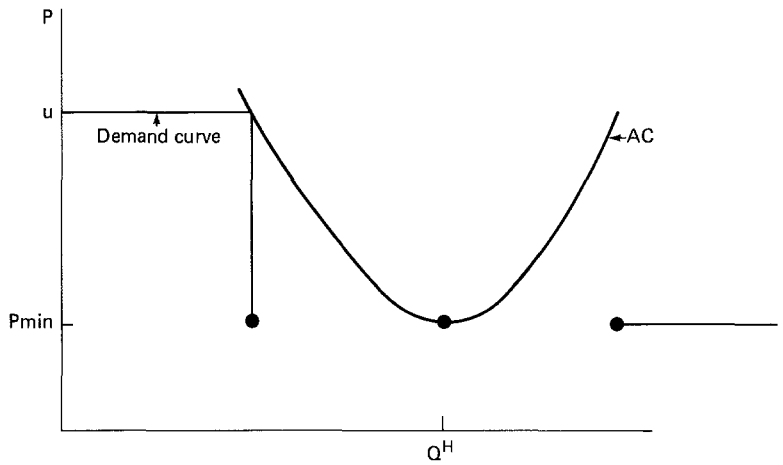

Figure 13.6. "Bargains and Ripoffs". At any price below $p_{\min}$, the firm acquires all informed individuals as customers. Accordingly, the only possible equilibrium "low price" must be at minimum average cost. (At $p = p_{\min}$, the firm acquires a pro-rata share of the informed.)

there. At prices below $p_{\min}$, the store gets all customers. It should be immediately clear that:

(1) the high price store (catering only to the uninformed) must charge a price of u, the monopoly price; while

(2) the low price store must charge a price of a, the minimum average cost (see Figure 13.6):

$$a = \min\{A(X)\}, \tag{5}$$

where $A(X)$ is the average cost associated with producing a quantity X. For if $p_{\min}$ were at any price above a, it would pay any store to reduce its price by epsilon, garnering for itself the entire market of informed consumers.[23]

Clearly, the low price store makes zero profit. For the high price store to make zero profits, it must have sufficient sales that its average costs equal u. Thus, denoting the sales of the high price store by Q^H, and that of the low price store by Q^L, we have:

$$u = A(Q^H) \tag{6a}$$

[23] This assumes that the firm has the option of turning down excess demand.

or

$$Q^{H*} = A^{-1}(u). \tag{6b}$$

Since

$$a = p_{\min} = A(Q^{L}), \tag{7a}$$

by inverting we have:

$$Q^{L*} = A^{-1}(a). \tag{7b}$$

Finally, we can solve for the equilibrium number of stores and the fraction, λ, charging the low price, given s^*, and the search cost of the individual with the highest s who searches (so that the fraction of the population searching is $F(s^*)$):

$$Q^{L*} = \frac{L[1 - F(s^*)]}{M} + \frac{LF(s^*)}{\lambda M} = Q^{H*} + \frac{LF(s^*)}{\lambda M}, \tag{8a}$$

$$Q^{H*} = \frac{L[1 - F(s^*)]}{M^*}, \tag{8b}$$

where M = number of stores and L = number of individuals.

We can also easily solve for the fraction of the population that decides to become informed. For the marginal individual who becomes informed, the cost of becoming informed, s^*, is just equal to his expected gain,

$$\bar{p} - p_{\min}.$$

But the average price is calculated as

$$\bar{p} = \lambda a + (1 - \lambda)u.$$

Thus, s^* is the solution to the equation:

$$s^* = \lambda a + (1 - \lambda)u - a = (1 - \lambda)(u - a). \tag{9}$$

Thus, (8a) and (9) provide two equations in the two unknowns, s^* and λ. The solution may be more easily seen if we rewrite (8a) as [using (8b)]:

$$\lambda = \frac{F(s^*)}{(1 - F(s^*))} \frac{Q^{H*}}{Q^{L*} - Q^{H*}} \equiv \phi(s^*). \tag{10}$$

It is clear that ϕ is a monotonically increasing function of s^*, from which it immediately follows that there is a unique equilibrium. It can take one of three forms:

(a) If $s_{\min}$, the minimum cost of acquiring information, exceeds $u - a$, then the unique equilibrium entails $\lambda = 0$, i.e. there is a single price equilibrium at the monopoly level: it does not pay anyone to acquire information;

(b) If

$$\frac{F(0)}{(1 - F(0))} \frac{Q^{H*}}{(Q^{L*} - Q^{H*})} > 1,$$

then there are so many individuals with zero search costs that the unique equilibrium is at the competitive level, $p = a$.

(c) Otherwise, there is a price distribution, with $0 < \lambda < 1$.

It is easy to use Figure 13.7 to see how changes in the critical parameters affect the nature of the price distribution.

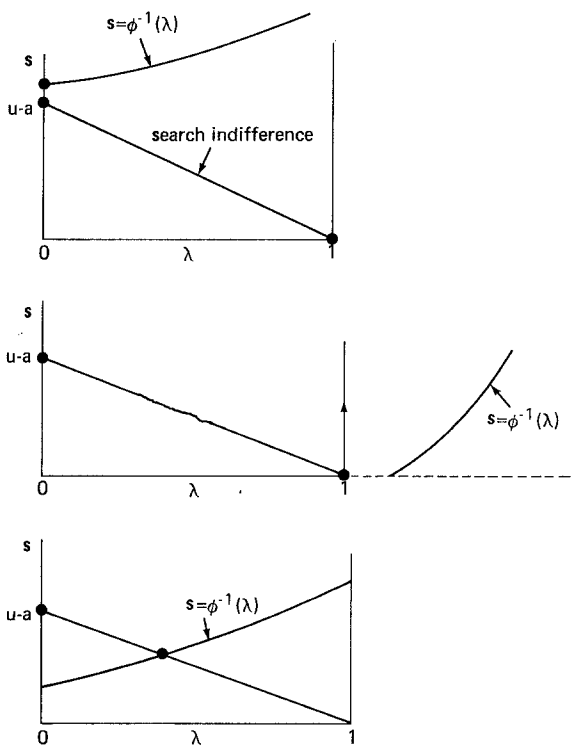

Figure 13.7. "Bargains and ripoffs". (a) With high search costs, the unique equilibrium is the monopoly price. (b) With many low search cost individuals, the unique equilibrium is the competitive price. (c) More generally, the unique equilibrium entails a price distribution.

5. A general theory of equilibrium pricing with search

The essential argument for why market equilibrium may be characterized by a price distribution should now be clear. The information technology of bargains and ripoffs has the property that when the price at any store is lowered enough, the store becomes the low price store, and thus garners for itself all of the informed individuals. Its demand curve, at low prices, is extremely elastic, as typified by Figure 13.1(c). On the other hand, because of the presence of uninformed individuals, when it raises its price, it loses relatively few sales. Thus, the demand elasticity at high prices is relatively low. The shape of the demand curve facing any firm is thus (for a wide range of parameter values) inconsistent with there being a single price equilibrium.

We can ask: Are there other conditions, circumstances, or assumptions under which the demand curves have the property that at low prices, demand elasticities are high, relative to their values at high prices? In this and the next section, we explore two such situations. In this section, we consider more general search technologies. In the next, we introduce storage.

The essential property of the search-information technology that we employed was that the marginal cost of search was decreasing. Assume, for instance, that the search cost technology is convex, as in Figure 13.3(c), and that all firms charge the same price, p^*. Assume some store raises its price by 1 percent, but customers believe that all other stores have kept their prices constant. Then all those with low search costs will leave; in particular, since all individuals know that it will take precisely one search, all those for whom[24]

$$S(1) \leq \Delta p,$$

where now

$$\Delta p = p - p^*,$$

the difference between the price charged by the store and the price charged by all other stores, p^*, will leave. In the symmetric equilibrium, if there are L consumers, each consumer consumes 1 unit, and there are M stores, then sales in equilibrium are L/M; while if the store increases its price, sales are $[(1 - F^*)L]/M$, where $F(S(1))$ is the distribution of individuals by search costs, and $F^* = F(\Delta p)$, i.e. the store loses all of its low search cost individuals. If $f(S^*(1))$ is the density function ($f = \partial F/\partial S(1)$), and we denote by ε^+ the elasticity of demand with respect to price increases, then

$$\varepsilon^+ = f(0)p^*. \tag{11}$$

[24] Where it will be recalled that $S(T)$ is the total search costs associated with T searches. We assume that the first sample costs zero. T refers to the number of *additional* searches.

On the other hand, if any store were to lower its price (and it was known that some store had lowered its price, but not which one), all those with low search costs who were at other stores would leave. If S^e is the expected search cost, then the firm would recruit, from each store, all those for whom expected search costs were less than or equal to Δp.[25] Total sales would be:

$$\hat{F}(\Delta p)L + \frac{(1 - \hat{F}(\Delta p))L}{M}, \tag{12}$$

where $\hat{F}(S^e)$ is the fraction of individuals with expected search costs (to find the one low price store) less than or equal to S^e. Accordingly, the elasticity of demand is:

$$\varepsilon^- = \hat{f}(0)p^*(M - 1), \tag{13}$$

where $\hat{f} = \partial\hat{F}/\partial S^e$. Thus, the elasticity of demand with respect to price decreases exceeds that with respect to price increases – there cannot be a single price equilibrium – if

$$\hat{f}(M - 1) > f. \tag{14}$$

If each search costs the same amount, and search is conducted without replacement (that is, when an individual samples a store, he remembers where it is, and does not return), then the expected number of searches (for a consumer who initially arrived at a high price store) is $M/2$. (If there are three stores, there is a 50 percent chance he will find the low price store on the first search, and a 50 percent chance he will find it on the second.) Thus, expected search costs are $sM/2$. Thus,

$$\hat{F}(x) = F(2x/M),$$

and accordingly,

$$\hat{f}(0) = \frac{2f(0)}{M}.$$

Thus, condition (14) is satisfied if

$$2(M - 1) > M$$

[25] We continue to assume risk neutrality. With risk aversion, ε^- will be decreased.

or

$$M > 2.$$

If there are more than two stores, then with constant search costs and search without replacement, there cannot exist a single price equilibrium. The reason for this is that with search without replacement, the effective search costs are convex: it becomes increasingly less expensive to find the low price store.

5.1. Search with replacement[26]

When there is search with replacement, when a store raises its price, there is a probability of $(M-1)/M$ of finding the low price store on each sample. Hence, the expected number of searches is $M/(M-1)$, and with constant search costs, expected search costs are $s[M/(M-1)]$. It then follows that

$$\varepsilon^{+} = f(0)p\frac{M-1}{M}. \tag{15}$$

Conversely, if one store lowers its price, the probability of finding that low price store, on any search, is $1/M$. Thus, the expected number of searches is M and

$$\varepsilon^{-} = f(0)p\frac{M-1}{M} = \varepsilon^{+}. \tag{16}$$

There is no kink in the demand curve. Equations (15) and (16) generate the standard result that *as the number of firms increases, the elasticity of demand facing any firm increases, and hence the equilibrium price will fall.* Notice how this result contrasts with our earlier result that with fixed search costs, no matter how small, the equilibrium prices will be the monopoly price.

The earlier analysis, while recognizing that as the number of firms increases it becomes increasingly difficult to locate a low price store, ignored the fact that there were a correspondingly larger number of stores from which to draw customers. In the central case of constant search costs, these two effects exactly cancel each other.

Even in this case, equilibrium may be characterized by a price distribution, when there is a continuum of firms. Lower price stores sell to more individuals.

[26]Search with replacement means that individuals do not remember where they previously sampled; the probability of sampling any store is $1/M$. If stores are pursuing mixed strategies with respect to pricing (with no serial correlation), it is clear that the appropriate model is one of search with replacement. In other cases, it is not obvious which provides a better description of individual behavior.

There is a distribution of stores by prices (given the distribution of individuals by search costs) such that at each price, expected sales at each store are such that price equals (expected) average cost.[27]

Furthermore, if we now postulate that search costs are a convex function of the number of searches, since the probability distribution for the number of searches to find the (one) low price store is (first order) stochastically dominated by the probability distribution for the number of searches to find one of the $M-1$ stores who have not raised their prices, there is always a kink in the demand curve: market equilibrium is always characterized by a price distribution.

5.2. *Price rigidities*

By precisely the same argument, we can show that when there is search with replacement, and search costs are concave, then there is a kink in the demand curve: the elasticity of demand for price decreases is always less than for price increases. Accordingly, there is a discontinuity in the marginal revenue schedules: prices will not adjust to small changes in marginal costs.

In this case, we can show that as the number of stores increases, the maximum mark-up increases – to the monopoly price; while the minimum price decreases. That is, *it is possible that as the number of firms increases, prices actually rise*. The reason for this, as we have suggested, is that as the number of stores increases, it is increasingly difficult to recruit customers – it is difficult for them to find the store that has lowered its price. This intuition is even more compelling in the case of markets with heterogeneous commodities, particularly when different individuals have different preferences for different commodities. It then becomes increasingly difficult for individuals to find out about other relevant vendors, even from "neighborly communication". To put the matter somewhat heuristically, in atomistic markets, firms may believe that by lowering their prices, they recruit no customers, and hence they act as monopolists; in markets with fewer firms, they believe that lowering prices will be more effective in increasing sales. Moreover, if individuals communicate with their neighbors (as in Subsection 7.2 below), if there are relatively few stores, it is more likely that any individual will have a neighbor who shops at the low price store. Information that a store has lowered its price may spread more rapidly. Again, increasing the number of stores may have an anti-competitive effect. Pauly and Satterthwaite (1981) have constructed

[27]Note the difference here between the interpretations of the model when there is a continuum of firms, and when there are, say two firms, each pursuing a mixed strategy. With mixed strategies, there can only be a mass point at a price equal to minimum average cost; for if one firm had a mass point at, say, $\hat{p}$, it would never pay the other firm to have a mass point at the same price, for by undercutting by ε it discretely increases the probability that it will recruit more customers, at an arbitrarily small cost.

a model (designed to explore the market for doctors) showing that increasing the number of firms need not lead to lower prices under these circumstances.[28]

6. Theory of sales

In the previous section[29] we showed how there could exist an equilibrium price distribution, in a competitive (or should I say, monopolistically competitive) situation, where the only source of market power was that resulting from imperfect information. Firms were able to price discriminate, to take advantage of differences in search costs, by charging, on average, a higher price to those with high search costs than to those with low search costs.[30]

Now we consider a case where individuals are, ex ante, identical. Like the previous models, 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,[31] 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.

As in the earlier model, there are two interpretations of this price dispersion: we can think of there being dispersion across stores, or as stores engaged in random pricing. The latter interpretation seems particularly congenial with this particular model, especially as it provides an explanation of unadvertised spe-

[28]It should be noted, however, that product heterogeneity is essential to their argument. With a larger number of firms it becomes increasingly unlikely that you and your neighbor prefer the same subset of firms, so that the information conveyed to you by your neighbor becomes increasingly irrelevant.

[29]This section is based on joint work with Steve Salop. For a more extended version, see Salop and Stiglitz (1982). A still more extensive treatment is provided in the working paper of the same title, Princeton University mimeo, 1981.

[30]The idea of using price distributions as discriminating devices was first developed by Salop (1977) in the context of markets dominated by a single monopolist.

[31]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 other models of price dispersion [for example, Salop (1977), and Salop and Stiglitz (1977b)] where price dispersion serves to differentiate among different groups of customers; where it is generated by costly arbitrage; or where it arises from differences in technology [Reinganum (1979), Stiglitz (1974)].

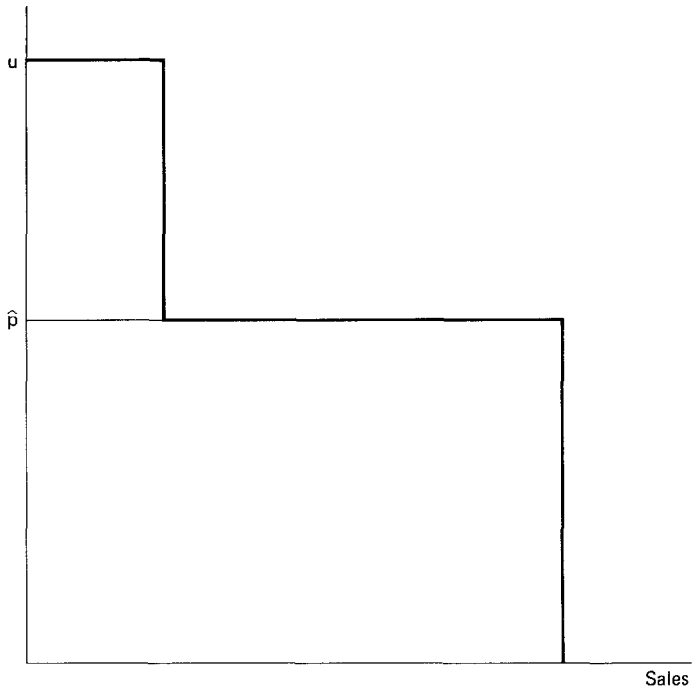

Figure 13.8. Theory of Sales: demand curves with single price equilibrium. If all firms charged the same price, say the monopoly price, then any store lowering its price below $\hat{p}$ would discretely increase its sales. For the monopoly price to be an equilibrium, the increase in sales must not be enough to compensate for the decrease in price.

cials. Here, not only does the expectation of such unadvertised specials serve to draw customers to the store, but they also led to increased sales to those who do arrive: once the individual is in the store, he is more likely to buy several units of the good, more than he needs for his current consumption. He purchases, in other words, for future consumption.[32]

The reason that this model gives rise to price dispersion can easily be seen. If all stores charged the same price, then any store that lowered its price enough would find (under certain conditions to be derived below) that it faced a much higher demand, as some individuals who arrived at it would purchase for future consumption. Thus, the demand curve appears as in Figure 13.8.

Interest in this model is motivated not only by its ability to provide an explanation for sales. It has been conjectured that with storage, markets might behave more competitively. Even if individuals can only engage in limited search

[32]See Steiner (1978).

each period, the relevant market embraces many periods, and thus search costs become relatively less significant. Though there are some limiting cases in which this is true [see Dow (1987)], our analysis below shows that as long as there is storage as well as search costs, the market equilibrium may deviate significantly from that of the conventional competitive paradigm.

6.1. The model

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 $p = p^m = u$. 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.[33] The decision to buy-and-store or shop again balances these two considerations.

Suppose consumers know a priori the distribution of prices 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.[34]

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:[35]

$$\hat{p} + \delta = \bar{p} + c. \tag{17}$$

In addition, we require:

$$\hat{p} \leq u - \delta.$$

[33] Here, we assume storage costs are proportional to the number 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.

[34] Our assumption simplifies the analysis, but is not essential. It represents the extreme assumption concerning concavity of the search cost function, an assumption which normally serves to make price dispersion less likely. As is 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 doorstep.

[35] This assumes risk neutrality on the part of the consumer. This is not a critical assumption.

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

$$\hat{p} = \min[\bar{p} + c - \delta, u - \delta]. \tag{18}$$

6.2. *Characterization of equilibrium*

As in our earlier model of bargains and ripoffs, an equilibrium price distribution must satisfy the properties of Firm Equilibrium (Profit Maximization, Firm Entry Equilibrium) and Consumer Equilibrium (Search Equilibrium, Consumer Entry Equilibrium).

We shall derive conditions under which a non-degenerate equilibrium price distribution exists. To do this, we shall first characterize such an equilibrium (if it exists).

As in our previous model, there are at most two prices. The reason for this is simple: stores that cater to those who do not store will simply charge the monopoly price. Lowering the price a little gains them no new sales. If the store lowers the price enough, to the reservation level, at which individuals purchase for future consumption, sales increase discretely. Further reductions in price do not (in this model) increase sales any further. The demand curve thus appears as in Figure 13.9. Thus, we have not only established that there can be at most two prices, but we have also shown that:

$$p^{\mathrm{H}} = u, \tag{19a}$$

$$p^{\mathrm{L}} = \hat{p}. \tag{19b}$$

As before, we denote the fraction of the firms charging the high price by $1 - \lambda$ and the fraction charging the low price by λ. Then the mean price is:

$$\bar{p} = (1 - \lambda)p^{\mathrm{H}} + \lambda p^{\mathrm{L}}. \tag{20}$$

Substituting (20) into the reservation price equation (17), we obtain:

$$\hat{p} = p^{\mathrm{L}} = (1 - \lambda)p^{\mathrm{H}} + \lambda p^{\mathrm{L}} - (\delta - c), \tag{21}$$

or, upon using (19), we have:

$$p^{\mathrm{L}} = u - \frac{\delta - c}{1 - \lambda}. \tag{22}$$

If $\delta > c$, p^{L} is a declining function of λ, as depicted in Figure 13.10. Equilibrium also requires that profits at the high price and low price stores be the same. The equal profit condition allows calculation of the fraction of low price firms, λ, as follows.

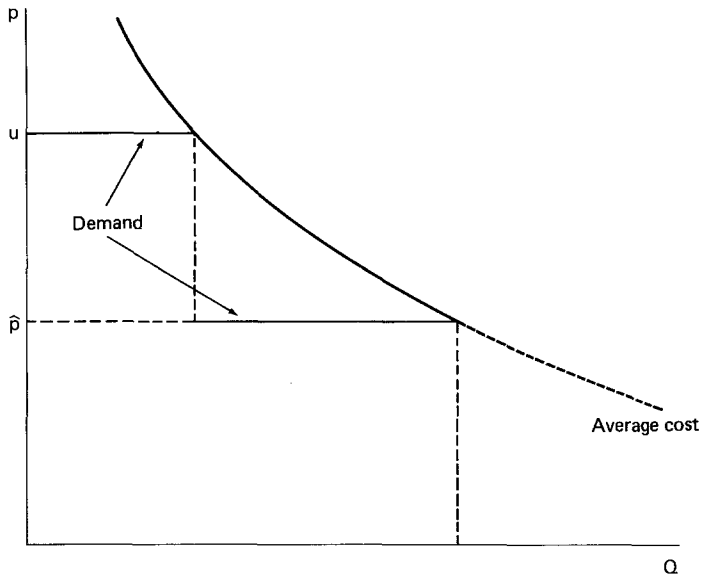

Figure 13.9. Theory of sales: demand curves with price dispersion. If some firms charge the monopoly price u and others the price $\hat{p}$, then the increased sales from lowering price to $\hat{p}$ must exactly compensate for the decreased price.

There are L consumers of each generation and M firms. Each firm attracts L/M young customers and $[(1-\lambda)L]/M$ old customers who were unlucky and selected a high price store when they were young.[36] Since both unlucky young and old customers purchase one unit each, sales Q^{H} of each p^{H} firm are given by:

$$Q^{\mathrm{H}} = \frac{(1+1-\lambda)L}{M}.$$

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

$$Q^{\mathrm{L}} = \frac{(2+1-\lambda)L}{M}.$$

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

[36] We assume all of them re-enter the market the second period.

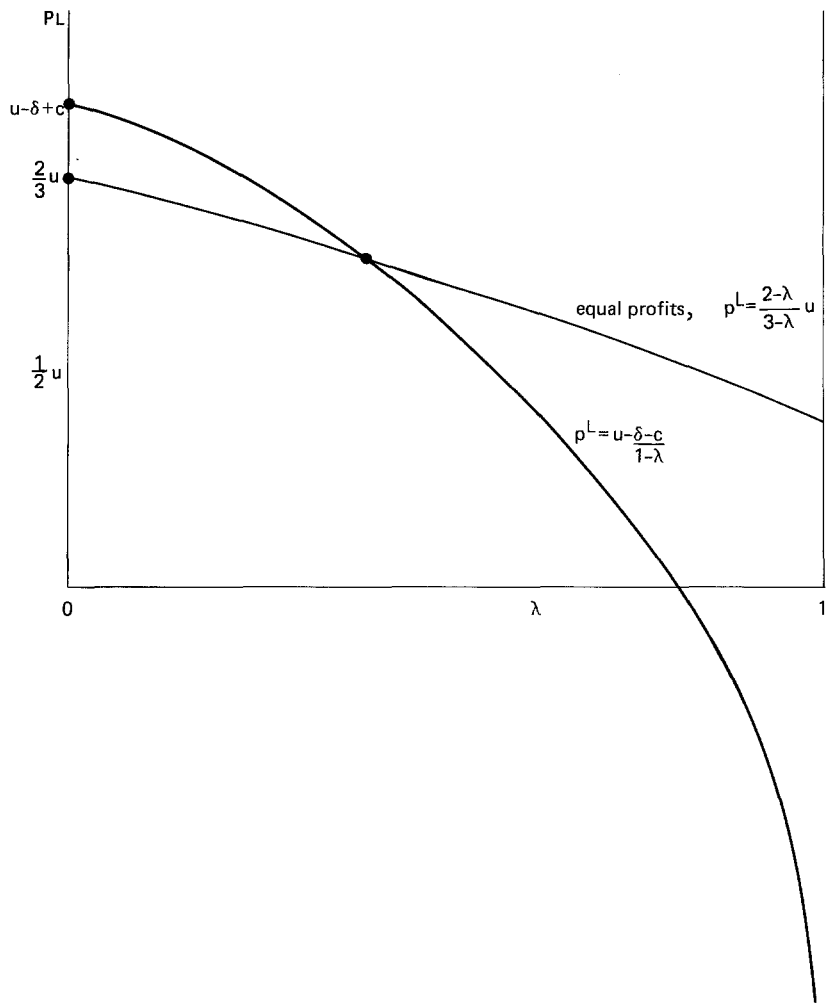

Figure 13.10. Theory of sales: the equilibrium values of p^L and λ which satisfy the equal profit and profit maximizing conditions.

equal profits implies:

$$p^H Q^H = p^L Q^L.$$

Using the three preceding equations, we obtain:

$$(2 - \lambda)u = p^L(3 - \lambda).$$

The relationship between p^L and λ, entailing equal profits, is plotted in Figure

13.10. It is easy to see that there is a unique intersection, characterized by:

$$p^{L} = \frac{u + (\delta - c)}{2}, \qquad p^{H} = u,$$

and the fraction of firms charging the high price:

$$1 - \lambda = \frac{2(\delta - c)}{u - (\delta - c)}.$$

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 below.) For a two-price equilibrium to exist, clearly $0 < \lambda < 1$. We can thus show that if $c = 0$, *a necessary and sufficient condition for the existence of a two-price equilibrium (TPE) is that*

$$\delta < u/3.$$

6.3. Single price equilibria

We established earlier 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 can show:

$p = u$ is a single price equilibrium if and only if $\delta > u/3$ and $c = 0$. If c is greater than 0, there is no single price equilibrium.

If c is greater than 0, and $p = u$, it will 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 (for storage)" 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,[37] sales are increased by 50 percent and we require $3(u - \delta)/2 < u$ or $\delta > u/3$.[38]

[37]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.

[38]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 $\delta > u/2$.

This result, together with our earlier results, implies that if $c = 0$, there is a SPE with $p = u$ if $\delta > u/3$, and 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 market equilibrium 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).[39] Hence, the consumer surplus obtained by an individual is $2u - 2p - \delta - c = \delta - c < 0$. No one will enter the market, a contradiction.[40]

Hence, if $c > 0$, 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.*

The problem may be alleviated by the existence of a price distribution, a form of noise created by the market itself.[41] 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.

Thus,

Necessary and sufficient conditions for the existence of an equilibrium when $c > 0$ are that $u > 3(\delta - c)$ and $\delta > c$. When an equilibrium exists, it is characterized by the two-price equilibrium described earlier.[42]

[39] If $p < (u - \delta)$, any firm could increase its price by δ and lose no sales.

[40] 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. $u/2 < u - \delta$).

[41] 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.

[42] The analysis has been couched in terms of different firms charging different prices, rather than each firm having a random price policy. The analysis is completely unaffected, however, if firms choose a low price p^L a fraction λ of the time, and a high price p^H the remainder of the time, provided firms do not know the actual proportion of firms which have charged a low price in the previous period (and provided firms are risk neutral.) Individual's decisions concerning whether to buy for storage or not are based on the expected price which they must pay next period; and accordingly, firm's sales at any price are based on the expected number of young versus old customers, and on the firm's beliefs about the reservation price (for storage) of the young.

6.4. Non-existence of equilibrium with discriminating firms

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.[43]

If firms can employ a non-linear pricing schedule, they will always be able to identify who is young.[44] Only the young will be willing to purchase two units; all that the firms need 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. As a result, it can be shown that if search is costly, no equilibrium exists. The welfare consequences of allowing price discrimination may indeed be far worse than envisioned in traditional price theory.

7. Alternative theories of price distributions

The simple models we have constructed may be extended in a number of directions; these extensions suggest that our model is reasonably robust to alterations in the assumptions. The one result that is not robust[45] is that concerning the high price: the high price will not, in general, be the monopoly price. The reason for this is that, in general, there is an *extensive* margin of sales: as the firm raises its price, it loses some customers; as it lowers its price it gains some customers. Different models may differ in the reasons for which this

[43] 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 individuals a second unit at a price $\hat{p}$. Thus, the first store could not have been maximizing profits. Thus, the only possible equilibrium entails individuals purchasing two units the first period. But if all individuals purchase two units the first period, the only possible equilibrium entails firms charging $2u - \delta$ for the two units, and 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.)

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

[45] The other result that is not robust is that equilibrium will be characterized by a two-price price distribution. It is easy to construct examples with many prices, and in many of the examples, there are price distributions involving a continuum of prices, rather than a finite number of prices.

happens, and the extent to which it happens, but it is only in certain limiting cases that there is no extensive margin.

In the following subsections, we briefly sketch three of these generalizations. In the first, we assume that the individual, when he acquires information, finds out about a subset of the stores, rather than all of the stores, as in "Bargains and Ripoffs", or rather than only one store, as in the conventional sequential search model.

In the second, we assume that individuals find out about the prices charged at other stores by talking to their neighbors. These two extensions are important, because to the extent that the individual can make simultaneous price comparisons across stores, competition will be more effective. The stores can be thought of as engaging in a bidding war for the customers who happen to have found out about them. Again, although in certain limiting cases, competitive outcomes obtain [see, in particular, Dow (1987) and Perloff and Salop (1985)] in the general case, equilibrium is characterized by a price distribution, with high prices possibly considerably in excess of the competitive price.

In our third example, we replace information costs by transportation costs. Even in those cases where information costs are not significant, transportation costs may be, and these alone are enough to generate price distributions.

These examples illustrate two of the important reasons for the existence of an extensive margin. When some individuals have some information about prices at some stores, an increase in price may induce some of those individuals to switch to a less expensive store. Similarly, when there are differences in stores (here represented by differences in locations) there are likely to be individuals who are essentially indifferent between buying at one store and another; again an increase in price will induce a switch. In all of these models, individuals have rational expectations about the distribution of prices charged by different stores; but the existence of an extensive margin does not depend on that; so long as there are some individuals whose beliefs are such that, when the store at which they are at increases its price, they are induced to search, there will be an extensive margin. Indeed, since, particularly in changing environments, different individuals are likely to have different information about the prices charged at different stores (simply from the randomness associated with search), there are likely to be differences in beliefs about the value of further search. Thus, models in which individuals do not know the probability distribution of prices, but come to have views concerning that probability distribution from observations,[46] while they may easily generate equilibrium price distributions, are likely to have price distributions in which the maximum price is less than the monopoly price.

[46]It makes little difference here whether those probability judgments are formed in accordance with Bayesian procedures.

7.1. Search with limited information

An unrealistic aspect of the "Bargains and Ripoffs" analysis is that when individuals obtain information, they obtain perfect information about all stores. Now we assume, somewhat more realistically, that each individual finds out the prices at a subset of all the stores, but that they each find out about different stores. Assume, in particular, that they find out only about n stores, where n is less than M, the total number of stores. For n small enough, there is some possibility that the individual who has purchased information only finds out about the high price stores; this means that if any high price store were to lower its price, it would gain a few customers, those who purchased information, but were unlucky enough simply to obtain information about high price stores. This gives some elasticity to the demand curve. Indeed, if there are some individuals who have only obtained information about high price stores, if one of these stores lowers his price by an epsilon, he gains all such individuals as customers; this discontinuity in his demand curve means that there cannot be a two-price equilibrium, or indeed any price distribution with a mass point other than at the lowest price (the minimum average cost a). The calculation of the equilibrium price distribution may be done most easily for the case where the individual obtains information about only two stores. We simplify further by assuming a constant marginal cost of production m and a fixed cost C. Let $P(p)$ be the distribution of stores by prices; for convenience, define

$$G(p) = 1 - P(p).$$

When all individuals find out about precisely two firms, the profits (gross of fixed costs) at a firm which charges a price p equal

$$(p - m)[(1 - F^*) + F^*G(p)]\frac{L}{M}, \tag{23}$$

where $F^* = F(s^*)$ is the fraction of individuals who purchase information (the remainder are uninformed and purchase at the first store at which they arrive). Then the zero profit condition becomes:

$$(p - m)[(1 - F^*) + F^*G(p)]\frac{L}{M} = C. \tag{24}$$

Equation (24) can be solved for $G(p)$ as a function of F^*:

$$G(p) = \frac{\dfrac{CM}{L(p - m)} - (1 - F^*)}{F^*}. \tag{25}$$

To complete the analysis, we need to specify the boundary conditions: clearly u is the maximum price, and there can be no mass points at u, so

$$G(u) = 0. \tag{26}$$

This means that we can solve (25) for M/L, given F^*:

$$\frac{M}{L} = \frac{(u - m)(1 - F^*)}{C}. \tag{27}$$

Substituting (27) into (25) we obtain:

$$G(p) = \frac{u - p}{p - m} \frac{1 - F^*}{F^*}. \tag{28}$$

Figure 13.11 shows the solution for different values of F^*.

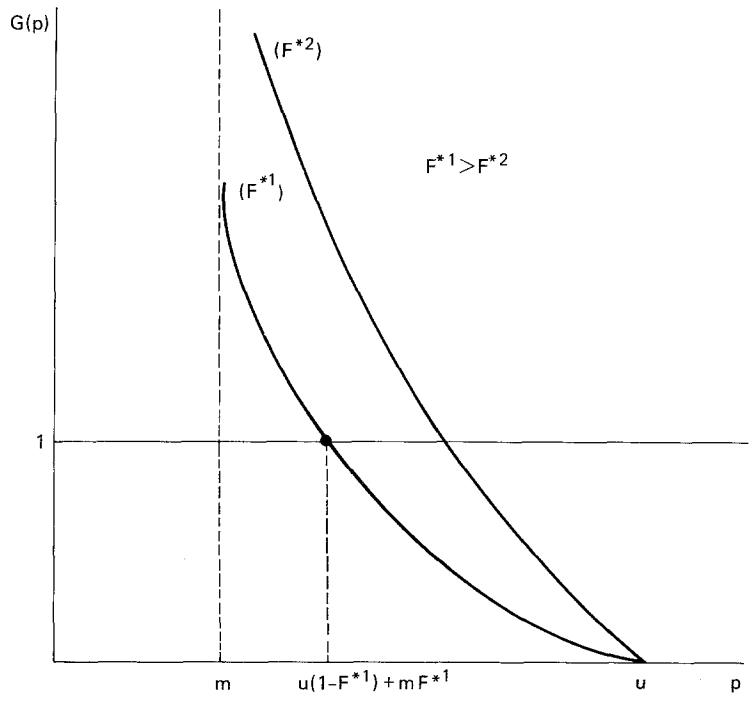

Figure 13.11. As F^*, the fraction of informed individuals increases, more stores charge lower prices.

Equation (28) reveals two important properties of the equilibrium price distribution: the more informed individuals there are, the lower prices will be; but while the minimum price [where $G(p)$ equals 1] exceeds marginal costs so long as there are some uninformed individuals,[47] the maximum price remains at u, the monopoly price.

The fraction becoming informed, F^*, now needs to be determined. The marginal individual is indifferent between acquiring information and not. If he does not, his expected price is:

$$\bar{p} = \int_{\underline{p}}^{u} p \, dP(p), \tag{29}$$

where $\underline{p} = p_{\min}$, the price at which $G(p) = 1$, i.e.

$$p_{\min} = F^* m + (1 - F^*)u. \tag{30}$$

If he does, the probability that he pays a price in excess of $\hat{p}$ is equal to the probability that both pieces of information yield prices in excess of $\hat{p}$, i.e.[48]

$$H(\hat{p}) = G^2(\hat{p}). \tag{31}$$

Thus, his expected price is:

$$p^* = \int_{\underline{p}}^{u} p \, d[1 - H(p)]. \tag{32}$$

An individual for whom the costs of acquiring the information is s^* will be indifferent, where

$$s^* = \bar{p} - p^*. \tag{33}$$

If, as before, $F(s)$ is the fraction of individuals with search costs less than s, then the fraction acquiring information is just

$$F(s^*) = F^*. \tag{34}$$

We are now in a position to characterize the equilibrium. Note that in (28) if F^* increases, the price distribution unambiguously moves to lower prices so the mean price is lowered. But what is crucial for determining whether to purchase

[47]Our analysis requires that $F^* < 1$, for otherwise at $p = u$, $G(p) = CM/L(u - m) > 0$. But there cannot be a masspoint at $p = u$; for it would then pay any firm to shave its price by ε.

[48]Assuming independent draws.

information is the difference in mean price one obtains if one searches once (that is, does not acquire information) or twice (acquires information). Denoting this difference by Δ, we have:

$$\Delta = \int_{\underline{p}}^{u} p[\mathrm{d}H - \mathrm{d}G]. \tag{35}$$

Integrating by parts, we obtain [using the facts that $H(p_{\min}) = G(p_{\min}) = 1$ and $G(u) = H(u) = 0$]:

$$\Delta = \int_{\underline{p}}^{u} [G - H]\,\mathrm{d}p$$

$$= \int_{\underline{p}}^{u} G(1 - G)\,\mathrm{d}p. \tag{36}$$

Clearly, Δ is simply a function of F^*, which is a function of Δ. Equilibrium is the solution to

$$F(\Delta(F^*)) = F^*. \tag{37}$$

The solution is depicted diagrammatically in Figure 13.12. For low values of F^*, Δ is negative.[49]

Up to some point the return to searching increases the larger the number of informed individuals (since this increases the number of low price stores). And, of course, the larger the return to searching, the larger the number of individuals searching. Hence, there may be multiple equilibria.

[49]Actually, of course, Δ cannot be negative; what is negative is the right-hand side of (36), where we have substituted (28) into (36). Upon rewriting, we obtain:

$$\Delta = \frac{1 - F^*}{F^{*2}} \int_{\underline{p}}^{u} \frac{u - p}{[p - m]^2} [(u - m)F - (u - p)]\,\mathrm{d}p.$$

Differentiating with respect to F^*, we obtain:

$$-\frac{2 - F}{F(1 - F)}\Delta + \frac{1 - F^*}{F^{*2}} \int_{\underline{p}}^{u} \frac{u - p}{(p - m)}(u - m)\,\mathrm{d}p. \tag{38}$$

Note that at $\Delta = 0$ and $F < 1$, this is positive, but after a critical value, it becomes negative, so that Δ reaches zero again when $F^* = 1$. Thus, the Δ function has the shape depicted.

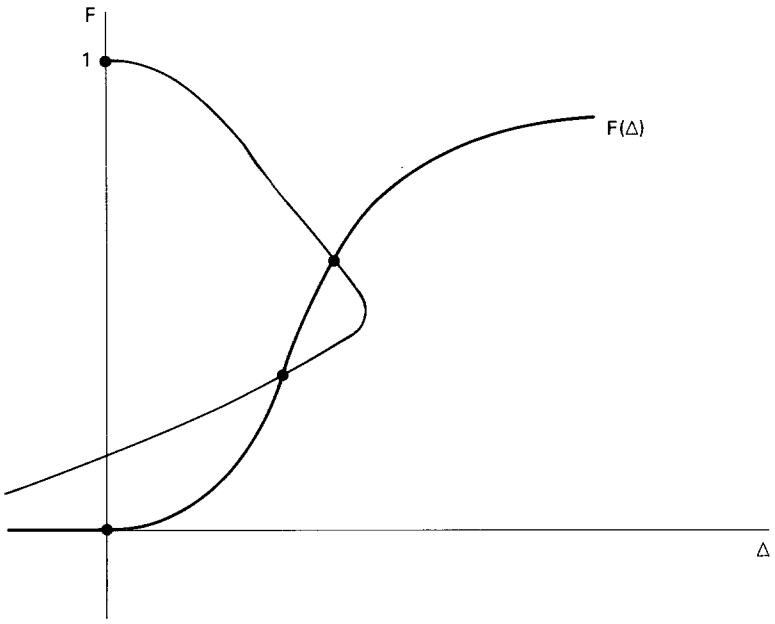

Figure 13.12. Equilibrium price distributions with limited information: individuals find out about two stores.

7.2. Equilibrium with a limited number of stores

In the preceding models we have assumed that the number of stores was endogenously determined, and that the fixed costs of entry were sufficiently low that there were a large number of stores. We now ask: What happens either if entry is limited, or costs of entry are increased, so that the equilibrium number of firms is reduced? We show that in these models, reducing the number of firms may actually lower the average price paid by consumers.

Assume in particular that the number of stores is very limited, but each store pursues a mixed strategy, that is a random pricing policy. Again, there will be some price elasticity: by lowering one's price, one obtains (probabilistically) more customers. We can characterize the symmetric equilibrium. For simplicity, we assume the fraction of informed individuals, F^*, is fixed. We assume, as in "Bargains and Ripoffs", that informed individuals become fully informed about the price distribution, so that they all purchase at the lowest price store; while uninformed individuals purchase randomly. Thus, if all M stores pursue a mixed strategy characterized by $G(p)$, the probability that a store that charges $\hat{p}$ will be the lowest price store, and thus recruit all of the informed, is just the probability

that all other $M-1$ stores choose a price in excess of $\hat{p}$, i.e. $G(\hat{p})^{M-1}$. Thus, assuming for simplicity that $m=0$, the firm's profits from charging a price $\hat{p}$ is:

$$\frac{\hat{p}(1-F^*)L}{M}+\hat{p}G(\hat{p})^{M-1}F^*L=K,$$

for all $\hat{p}$ in the distribution, i.e.

$$G(p;K)=\left[\frac{K-\dfrac{p(1-F^*)L}{M}}{pF^*L}\right]^{[1/(M-1)]}$$

First, note that there are multiple equilibria. We simply require that

$$K\leq\frac{u(1-F^*)L}{M},$$

so that $G(p;K)=0$ at some $p\leq u$. This in turn implies that, as before, F^* must be less than unity, that is, there must be some uninformed individuals.

Secondly, even when K is set to equal the fixed costs of entry, C, there are multiple equilibrium: any value of M for which

$$M\leq\frac{u(1-F^*)L}{C},$$

generates an equilibrium.

Thirdly, the expected price paid, both by the informed and the uninformed, increases with the number of firms. The expected price paid by the uninformed is just $\int p\,\mathrm{d}G(p)$. But since

$$\frac{\partial\ln G(p)}{\partial M}=-\frac{1}{(M-1)}\ln G+\frac{1-F}{F(M-1)G^{M-1}M^2}>0,$$

it is clear that the probability distribution of the prices they pay unambiguously worsens as M increases.

Similarly, the probability that an informed individual pays a price equal to or greater than p is just the probability that all M stores charge an amount equal to or greater than p, that is, it is just equal to $G(p)^M$. Straightforward differentia-

tion establishes that

$$\frac{\partial \ln G(p)^M}{\partial M} = -\frac{1}{(M-1)}\ln G + \frac{M(1-F)}{F(M-1)G^{M-1}M^2} > 0,$$

so that the informed are unambiguously worse off as well.

The results of this[50] and preceding sections should be contrasted with the limiting case where individuals obtain information about only one store when they search. As long as the process of search yields information about more than one store, there is some price elasticity, some effective competition. It is only in the limiting case that the paradoxes described earlier arise. The information which results in price distributions may, of course, be obtained in other ways, as the following subsection illustrates.

7.3. Price distributions with friendly neighbors

Neighborly communication gives rise to price distributions of very much the same form as described in the previous subsection. Assume, for instance, that each individual goes to one store, and a fraction F^* talk to one neighbor. Thus, a fraction F^* of individuals have information about two, and only two, stores. The model is precisely the one described above, which gives rise to a price distribution.

7.4. Price distributions in models with transportation costs

One can easily construct models with price distributions, with known price differences, where individuals differ in their transportation costs per unit distance, s.[51] Consider, for instance, the standard model in which individuals are uniformly arrayed along a line of infinite length (with total density of one per unit length). The fraction of those at any location with transportation costs less

[50]See also Perloff and Salop (1985) for a model where individuals simultaneously find out about several stores before making their purchasing decisions.

[51]Thus, this section differs from the remainder of the chapter in assuming perfect information. Information, like transportation costs, can be viewed as a form of transactions costs. The point of this section is to show some of the formal similarities between the two, in particular for their consequences for the nature of market equilibrium. In Section 11, we consider product variety. One standard way of representing product variety is by a locational model of the form presented in this section. Papers combining spatial location models, representing product diversity, and imperfect information, include Wolinsky (1986) and Salop and Stiglitz (1987).

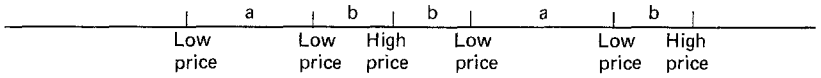

Figure 13.13. Equilibrium price distribution with transport costs: store configuration.

than or equal to s is given by $F(s)$.[52] There is a fixed cost C of establishing a new store, and a marginal cost of production of m. Figure 13.13 illustrates a possible configuration of stores, with every high price store surrounded by two low price stores, and every low price store with one high price and one low price store as neighbors. The distance between adjacent low price stores is a, between a low price and a high price store, b, with $a > b$. Low price stores have larger market areas. Indeed, an individual located near a high price store might actually travel some distance to the low price store, if his transportation costs are small enough. An individual located a distance v from the high price store will be indifferent to going to the low price store if

$$p^{\mathrm{H}} + sv = p^{\mathrm{L}} + s(b - v). \tag{39}$$

Denote this marginal individual by $\hat{s}^{\mathrm{H}}(v; p^{\mathrm{H}}, p^{\mathrm{L}})$. It is clear that:

$$\frac{\partial \hat{s}^{\mathrm{H}}}{\partial p^{\mathrm{H}}} = \frac{1}{b - 2v}. \tag{40}$$

As the high price store raises its price, more individuals at any location decide to travel to the low price store. Conversely, as the low price store raises its price.

Similarly, an individual located a distance v from one low price store, in the direction of another low price store, will be indifferent to going to the first store if the first store charges a price p and his transportation costs are such that

$$p + sv = p^{\mathrm{L}} + s(a - v). \tag{41}$$

We denote this marginal individual by $\hat{s}^{\mathrm{L}}(v; p, p^{\mathrm{L}})$. From this, we can calculate the demand at the high price and low price store:

$$Q^{\mathrm{H}} = 2\int_0^b \left[1 - F\left(\hat{s}^{\mathrm{H}}(v; p^{\mathrm{L}}, p^{\mathrm{H}})\right)\right] \mathrm{d}v = Q^{\mathrm{H}}(p^{\mathrm{H}}, p^{\mathrm{L}}, b), \tag{42a}$$

$$Q^{\mathrm{L}} = \int_0^b F\left(\hat{s}^{\mathrm{H}}(v; p^{\mathrm{L}}, p^{\mathrm{H}})\right) \mathrm{d}v + \int_0^a F\left(\hat{s}^{\mathrm{L}}(v; p, p^{\mathrm{L}})\right) \mathrm{d}v$$

$$= Q^{\mathrm{L}}(p, p^{\mathrm{L}}, p^{\mathrm{H}}, a, b). \tag{42b}$$

[52] In the discussion below, we ignore the standard problems of existence of equilibrium, which arise for instance if all individuals have the same transportation costs. In that case, a store, by lowering its price enough, can capture all of its neighbor's store market, so demand curves are discontinuous. There are other ways of addressing this problem besides that undertaken here (for instance, assume non-linear transport costs), with similar results.

Of course, in equilibrium, the second term of (42b) is just $a/2$, and the first term is just $b - (Q^H/2)$. (That is, the two low price stores charge the same price, and hence split the area between them; and all those who do not purchase at the high price store must go to the low price store.) From this, we can easily calculate the marginal revenue schedules, and the total revenue schedules. Equilibrium is characterized by p^H, p^L, a, b such that marginal revenue MR equals marginal cost, m (profit maximization):

$$MR^i = m, \quad i = H, L,$$

and entry occurs until profits are driven down to zero:

$$(p^i - m)Q^i = C, \quad i = H, L.$$

These equations are precisely of the form of equations (3) and (4) introduced earlier: market equilibrium may well be characterized by a price distribution.[53]

8. Concluding remarks

This part of the chapter has considered models exploring four properties of markets *for homogeneous commodities* in which it is costly to obtain information:

(1) Equilibrium may not exist.

(2) When equilibrium exists, prices in such markets may be considerably in excess of the competitive level (marginal costs); and an increase in the number of firms may not result in a lowering of prices.

(3) Alternatively, equilibrium may be characterized by a price distribution.

(4) Demand curves may be kinked.

One general result emerges from the analysis: *the results of the standard competitive model, in which it is assumed that there is perfect information, are not robust. Slight modifications in the assumptions – even assuming* ε *search costs – affect both the existence and nature of equilibrium.* Though this result seriously calls into question the credence that should be given to the standard Walrasian model, it also raises questions concerning the robustness of our results, particularly to alterations in the specific nature of the informational assumptions. That is precisely why we have explored so many variants of the basic model. The results we have obtained do appear to be robust.

In the end, the question that we need to ask is: To what extent do these models help us to understand the functioning of product markets?

[53] Note that much of the literature on monopolistic competition has focused on the case of symmetric equilibria, where all firms charge the same price.

Any attempt to understand the functioning of product markets must take into account two aspects of these markets which we have, until now, ignored; the rich variety of goods produced and the difficulties of ascertaining quality. In Part III of this chapter we address those issues. Still, bearing in mind this limitation, it is useful to summarize what may be learned from the analysis of markets with homogeneous commodities. The essential lesson is simple: markets (for homogeneous commodities) are likely to be characterized by price distributions and to be *imperfectly* competitive.[54]

8.1. Monopoly power

Costly information gives rise to monopoly power; firms are able to charge more than the competitive price, even when there are some individuals for whom search is costless. Even with relatively small search costs, prices may be well in excess of the marginal cost of production. Free entry simply results in the dissipation of the rents conferred on firms by their monopoly power in excessive entry costs. The result that prices will equal the monopoly price is clearly a polar case: it assumes that there is no extensive margin (that is, that the firm assumes that by lowering its price, it gains no additional customers, or that by raising its price slightly, it loses no customers). If individuals obtain information about several stores simultaneously (say from talking with their neighbors, or because they purchase newspapers, or because they visit shopping centers, where they can glean information about the prices at several stores at almost zero marginal cost, or because they follow what might appear to be non-optimal non-sequential search strategies, obtaining information about several stores before they make any purchase), if individuals have different beliefs concerning the prices to be found in different stores, or if there are some individuals with very low search costs, or if there is product heterogeneity and individuals have different tastes, then there will be some extensive margin. Markets are more aptly described by a model of *monopolistic* competition than either by a model of perfect competition or monopoly.

A natural question to raise at this juncture is: Are there not means by which the inefficiencies arising from the fact that price exceeds marginal cost could be eliminated? Surely, the large discrepancy between price and marginal costs should induce *some* action on the part of some firm to capture these potential profits!

[54] The analysis of the first issue, that of existence, provides more a commentary on economic theory than on economics: the assumption that firms are able to extract all of the consumer surplus of the marginal consumer is clearly not true, for reasons that we discuss below.

The most obvious mechanism is advertising: firms expend resources to recruit customers. Advertising is not costless, but it does put a bound on the size of the discrepancy between price and marginal cost. Still, advertising raises problems not unlike those posed by search costs [Butters (1977b)]. Assume the cost of reaching a customer is fixed at a. If the marginal cost of production is m, a store which advertised that its price was $m + a + \varepsilon$ would find itself undercut by a firm advertising a price of $m + a + \varepsilon'$, with $\varepsilon' < \varepsilon$. Hence the only possible uniform price is $m + a$. Moreover, in the absence of coordination among firms sending out messages to recruit customers, there can be only one firm sending out messages. (Otherwise, there would be some unproductive messages, one individual receiving two messages that the price is $m + a$. But then one firm would lose money.) But if there is only one firm sending out messages, the market clearly is not perfectly competitive. The resolution of this problem provided by Butters is that equilibrium is described by a price distribution; firms that advertise a high price only recruit customers who are badly informed – who have received no messages advertising a lower price. Thus, the lower sales offset their higher prices. There is a particular distribution of prices where these two effects are just offsetting. Thus, market equilibrium may be described by price equaling marginal costs plus recruiting costs, but because there are many firms attempting to recruit, the total recruiting costs may be considerably in excess of the cost of sending one message. Indeed, the greater the number of stores, the more duplicative messages there are likely to be, and hence the higher prices are likely to be. Now, in effect, excess profits are dissipated in advertising costs rather than entry costs; but prices remain above marginal costs.

Again, the natural question is: Are there not still more efficient methods of conveying information? One possibility, which we discuss briefly in Part III of the chapter, is a reputation mechanism. Some stores establish a reputation for being low priced sellers. As we show there, to maintain any reputation requires price in excess of marginal costs, but the price–marginal cost margin may be far smaller than would be suggested by models without reputation. We suspect that this mechanism has been particularly effective in keeping retail prices of mass produced consumer goods low. For such goods, Sears and K Mart have established a reputation for low price/effective quality ratio. But these stores do not sell many more "specialized" goods, and the markets for these goods may well be described by the models of this chapter. (Though some economists might claim that the observed differences between the prices of these goods and the mass produced goods can be accounted for by quality differences, we suspect that most of the difference is not accounted for by differences in production costs, but in differences in marketing costs; and these differences in marketing costs are, at least partly, attributable to the information theoretic concerns of this chapter.)

The fact that firms have monopoly power has, in turn, several important consequences. 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 the more efficient firms, but rather those which are more effective in discrimination.[55] Although a perfectly discriminating monopolist without transaction costs is known to be Pareto efficient, perfect discrimination with transactions costs in a competitive environment will result in the non-existence of competitive equilibrium markets; no one will have the desire to enter the market; and imperfect discrimination results in a wide variety of distortions.

Although in our simpler models we showed that there were circumstances in which firms exercise their monopoly power so ruthlessly that they destroy the market, we suspect that the informational assumptions required to do so (to identify the characteristics of the marginal consumer), and the competitive assumptions (that there are so many firms that any given firm is unconcerned with the effect of what it does on whether individuals enter the market) are sufficiently rarely satisfied that this is not a problem.

On the other hand, the result that monopoly power may increase with the number of firms – as consumers find it increasingly difficult to find low price firms, and as firms, knowing this, find attempts to recruit customers by lowering prices, increasingly ineffective – may be relevant, particularly for markets with heterogeneous individuals and products, a subject to which we shall turn in Part III.

8.2. Price dispersion

The Law of the Single Price has long been enshrined as one of the central tenets of classical economic theory. Our interest in price dispersion, though, is motivated by more than simply dethroning such a long standing tenet; it is motivated more by the result that without some price dispersion, under a variety of circumstances, no equilibrium will exist: it is only the chance of obtaining a bargain that induces individuals to enter the market. As we suggested above, price dispersions (sales, unadvertised specials) are phenomena that need to be explained.

Though differences in locations, qualities, and dates make it difficult to ascertain precisely the magnitude of the price dispersion, there is little doubt about its presence. Moreover, to the extent that these aspects of product quality are viewed to be important, they call further into question the standard model's assumption of "thick" markets with homogeneous commodities. If the commod-

[55] There are some who claim that the success of several of the more profitable insurance companies in recent years has not been a result of inventing a better insurance policy, but rather of devising a set of insurance policies that more effectively exploited consumer ignorance concerning the actuarial probabilities of various events.

ity sold by each store is treated as a different commodity, what sense can we make of the competitive model's assumption of a large number of sellers of identical commodities?

Our models show not only that there may exist equilibria with price dispersion, but also that under some circumstances, the only possible equilibria are characterized by price dispersion. And this price dispersion is a reflection not only of the costs of arbitraging among firms charging different prices. The market creates the very noise which enables stores to take advantage of the monopoly power resulting from search costs. In some cases (such as "Bargains and Ripoffs"), the noise enables the market to discriminate between high and low search cost individuals; in other cases ("Theory of Sales") the market simply creates lucky and unlucky individuals.

There are two other reasons besides those upon which we have focused here that, with imperfect and costly information, market equilibrium may be characterized by price distributions. First, when different submarkets face different demand or supply shocks with costly information, the resulting price differences will not be fully arbitraged away. There will exist an "equilibrium amount of disequilibrium". With costly arbitrage, some price differences must persist, or else arbitragers will have no incentive to obtain the information required for them to detect price differences. By contrast, in the models we have focused on here, there is no exogenous source of noise; the market creates the noise.

Salop (1977) has discussed a second reason for price distributions: monopolists may use differences in search costs as a screening device, enabling the monopolist to price discriminate. High search cost individuals are forced to pay the average price, low search cost individuals are able to pay the minimum price that the monopolist charges. The models we have discussed here are, by contrast, competitive – at least in the sense that we allow free entry and that we assume there are many firms. In fully competitive models, of course, firms cannot discriminate (except to the extent that there are differences in costs of serving different customers). What we have shown is that competitive models with costly information are very much like monopolist models: though no single firm discriminates, the market as a whole effectively does.

8.3. Price rigidities

We also noted that the market demand curves facing firms may exhibit a downward kink, that is, that the elasticity of demand with respect to price decreases may be lower than with respect to price increases. These kinks give rise to a discontinuity in the marginal revenue schedules. This is important for its macro-economic consequences.

Changes in wages may not result in any alteration either in output or price. The location of the kink depends on individuals' beliefs about what different stores are doing (or, more accurately, since what is relevant is the store's perceptions of the demand curve it faces, the location of the kink depends on the store's beliefs about individual's beliefs about the price distribution). Thus, if all (stores believe all) individuals believe that all (other) stores have raised their prices by 5 percent, then the price at the kinked output will move up by 5 percent. The model is thus consistent with nominal or real price rigidities. There are multiple equilibria.

We have not, of course, provided a theory of how (stores' expectations of) individuals' expectations get formed, of how, in other words, certain conventions get established. If, for instance, the costs of inputs of different firms are highly correlated, and all firms in the past have passed on cost differences, then in fact the price at the kink will rise with a rise in the cost of inputs. But if, in the past, prices have not fallen when the cost of inputs has fallen, then one would observe a market equilibrium in which there is an asymmetric response to price increases and price decreases. In any case, the model is consistent with the establishment of a variety of conventions concerning the circumstances under which the industry changes its equilibrium price, and how prices get changed when they do change.

PART III

9. Quality and reputations

Until now, we have focused on the consequences of only two kinds of imperfection of information: concerning price and location of stores. Equally important are the consequences of imperfect information concerning the characteristics of products at the time of purchase.[56] Informational imperfections of this type have an impact both on the *quality* of goods produced and on the *variety*. This section discusses the consequences for product quality, the next for product variety.

There would seem to be an incentive for firms to take advantage of imperfect information concerning product characteristics by selling shoddy commodities which cost less to produce than high quality commodities. What prevents this?

This is, of course, only one of a number of similar situations where one individual is in a position to cheat or otherwise take advantage of another. A

[56] We are thus concerned here with markets in which *pre-purchase* inspection is limited; the characteristics of the commodity cannot be fully verified before purchase. We follow most of the literature in focusing on commodities in which there are repeat purchases. The individual forms his beliefs concerning the qualities of the commodity supplied by the given firm from his own experience. The spread of information from one individual to others is a rather different matter, which may be studied, for instance, by use of contagion models.

worker can shirk on his job, thus in effect cheating his employer of the promised labor services. A borrower can abscond with the lender's money. A Chinese restaurant can reduce the amount of pork contained in a dish called Moo Shi Pork to a barely perceptible level, or, in the absence of government health regulations, substitute dog meat for pork. In all of these situations, there is either no explicit contract (perhaps because to specify completely the nature of the economic transaction in a contract would be prohibitively costly: all menus would need to specify all the actions to be taken by the chef in preparing each dish, as well as detailed descriptions of all the ingredients; since these may vary from day to day, the menu would have to be reprinted every day) or, if there is a contract, it is sufficiently costly to resort to legal processes[57] that that is not viewed to be a viable recourse.[58]

In spite of widespread complaints about the prevalence of cheating, it is perhaps more of a surprise that it does not occur more frequently than it does. Why do "rational" individuals not take advantage of others, when they have the opportunity to do so? Do we need to rely on vague notions of "morality" or "social pressure"?

Economists at this juncture are wont to introduce the notion of *reputations*: firms produce high quality commodities because they fear the loss of reputation will do greater harm than the slight temporary advantage of cheating.[59]

[57]Possibly, because of the costs of verifying whether the terms of the contract were compiled with. Alternatively, there is a contract, but it is sufficiently incomplete that the outcome of a legal process is sufficiently indeterminate to make it not worth while to resort to legal processes.

[58]Note that guarantees do not resolve this problem: the firm may refuse to honor its guarantee, and guarantees seldom cover all possible contingencies. Moreover, there is, again, often sufficient ambiguity in the interpretation of guarantees to make the outcome of a legal process uncertain. Guarantees often call for certain actions on the part of a purchaser. Verifying whether these have or have not occurred is often a difficult and contentious matter. A guarantee can be viewed simply as a contract to deliver a commodity which is more fully specified than one without the guarantee.

[59]Models of reputation focus on goods which the individual purchases repeatedly, on what Nelson (1974) has called "experience goods". There is a vast literature on the economics of reputation. Similar models have been used to analyze reputations in a variety of settings. The basic result that reputation equilibria require price to exceed marginal costs is perhaps due to Klein and Leffler (1981), Allen (1984) and Shapiro (1982, 1983), though similar results can be found elsewhere in the literature [e.g. Becker and Stigler (1974)]. Reputation as a perfect equilibrium was perhaps first analyzed by Eaton and Gersovitz (1981a, 1981b) in the context of credit markets and Dybrig and Spatt (1983), in the context of production markets. More formal developments can be found in Kreps and Wilson (1982) and Kreps, Milgrom, Roberts and Wilson (1982). The problems of reputation equilibrium in firms with finite lives have been analyzed by Eaton (1986) in the context of banking. As we discuss further below, the game theoretic approach to reputations, in which individuals, in effect by introspection, come to figure out what they might reasonably expect as rational behavior from the firms with which they deal, is markedly different from the approaches taken by, for instance, Shapiro (1982, 1983) and von Weizacker (1980), who assume that individuals extrapolate past behavior to make inferences about likely future behavior. In the game theoretic literature, the fact that an individual has behaved badly in the past does not necessarily mean that he will (be believed to) behave badly in the future. To the extent that there are characteristics of the individual which are relevant for determining their future behavior, information about which is gleaned from examining past behavior, the two views may not be inconsistent. A model of this form is presented later.

Constructing an equilibrium theory of reputations in the context of competitive markets is, however, somewhat more difficult than it might seem at first glance. First, one needs to specify what the losses to be had from the loss of reputation are, or conversely what the gains to be had from maintaining it are. Again, this seems obvious: a firm which has lost its reputation will lose future sales. Customers retaliate against the cheater by refusing to deal with him.

It is immediate that if the reputation mechanism is to be effective, firms must make a profit *at the margin* on each sale. Otherwise, they would be indifferent to losing a sale. *Price must exceed marginal cost.* Thus, markets in which the reputation mechanism is used to ensure quality differ fundamentally from conventional markets with perfect information.

Three problems remain: first, to develop a consistent theory, retaliation – refusal to purchase from the firm that has cheated – must be a rational response. If a Chinese restaurant that cheats me by providing an inferior meal (relative to what I had come to expect) has a locational advantage for me, is there any reason I should refuse to go there simply because he has cheated me once? Only if I thought that he was likely to cheat me again. Although collectively, as consumers, we might be interested in "boycotting" firms which cheat, the provision of this kind of incentive for good behavior is a "public good"; any small consumer would wish to be a free rider. He would only join the boycott if he believed that there was persistence in cheating; but the rational consumer might well reason that if others are boycotting the firm, it will be making a special effort to retain what customers are left, and to attract new customers. Hence, the period immediately following being cheated is a particularly good one. A worker who has shirked and been fired may be as likely to work hard on the next job, to re-establish his credential as a good worker, as to shirk again. On a priori grounds, then, it is not obvious that it is in the interest of customers who have been cheated by firms selling shoddy products (employers who have been cheated by shirking workers, etc.) to punish the cheaters. But if they do not punish cheaters, individuals will have no incentive not to cheat, and reputation becomes an ineffective mechanism for enforcing honesty.[60]

There is a second problem in formulating a consistent and economically meaningful theory of reputation. If one constructs a model in which no one ever

[60]Shapiro and Stiglitz (1984) present one resolution to this punishment quandary in the context of labor markets; workers who shirk are fired; the punishment is provided by the period which the worker must subsequently spend in the unemployment pool. Stiglitz and Weiss (1983) present a similar resolution of the punishment quandary in credit markets: a firm which was observed to have an unsuccessful project (even though it might have been, and in equilibrium was, the bad outcome of the correctly chosen project) has his credit terminated; and in equilibrium, no other firm will, under the circumstances, extend credit to him. In both of these situations, there was a cost to the shirker (or potential shirker) associated with the termination of the relationship, but no cost to the firm (bank); there are social costs to these punishments, but they are not borne by the agent directly imposing them.

cheats and sells lousy commodities, then how are individuals to form expectations concerning the relationship between low quality at one date and low quality at subsequent dates? Clearly, if customers assume that cheating is persistent, they will refuse to buy from the firm which cheated them the previous periods, or they will only purchase if the price is low enough relative to prices offered in other stores. But there is no rational justification for this assumption, as we argued earlier. They could as well assume that cheating was an aberration, in which case there would be no punishment. Moreover, firms in deciding whether to cheat must form expectations concerning the consequences of their cheating. To do this, they must guess how consumers will respond. Again, if in equilibrium, no shoddy commodities or no cheating ever occur, they have no basis for forming those expectations.

There is a third problem: since for firms to have an incentive to maintain reputations, price must exceed marginal costs, profits are generated. How can these profits be "reconciled" with standard results on competitive markets, which argue that competition should drive profits to zero?

In this section we present simple models showing how these problems can be resolved. Before turning to these models, we note some important consequences of the analysis.

The fact that prices, in the context of reputations, are performing a function quite different from their usual roles (in supply and demand analysis) has fundamental consequences; *these markets may exhibit price rigidities*. See Allen (1988) and Stiglitz (1987b).

These price rigidities have two very important consequences.[61] First, decreases in demand may not be reflected in decreases in prices; prices fail to perform their conventional role in signalling changes in market conditions. Indeed, it is even possible for prices (relative to marginal costs) to rise in a recession.

Secondly, they serve as a barrier to entry. The standard argument for how a firm that has built a cheaper mousetrap makes a profit is that he lowers prices, inducing others to switch to his mousetrap. The rent he receives, the difference between the new price and the (lower) marginal cost of producing the mousetrap, is the return to his innovative activity. But if customers believe, when he attempts to recruit them by lowering his price a little, that he is really selling a lousier mousetrap, then he will fail to recruit customers: he will be unable to obtain a return to his innovation.[62]

[61] For a more extensive discussion of these issues, see Schmalansee (1982b), Stiglitz (1987a), and Farrell (1986).

[62] He may be able to recruit customers by lowering his price enough. But it pays to do this only if his invention is a sufficiently important one, that is, it has reduced the cost of production by enough. Reputation thus serves as a barrier to *small* innovations. But if it is costly to make innovations, it reduces the incentive to innovate more generally.

9.1. The simplest reputation model

Losing one's reputation entails being thought of as a "bad" firm (individual, etc.). In an economy in which all firms are identical, it thus would seem impossible to lose one's reputation. In the following simple model, even though individuals ex ante are identical, ex post they may differ; those who have been bad in the past may, simply because of that, be believed to be different from those who have not been bad in the past; and these beliefs are consistent: because of these beliefs, they behave differently.

Although we show that there exists a perfect equilibrium in which there are consistent expectations which enforce "good behavior", that is, it is rational in some sense for consumers to sever relationships with those who have cheated, it should be clear that since, in equilibrium, no firm ever cheats, the individual cannot confirm the "rationality" of these beliefs through experience. (The precise sense in which the beliefs which enforce the "good behavior" are rational will be specified below.)

Assume it costs c_g to make a good commodity, c_b to make a shoddy one. Assume that the shoddy commodity can be detected, but only after purchase. Assume that the individual will continue repurchasing, so long as the commodity is good. The firm has to decide, at any date, whether it should cheat. If it does not, it gets $p - c_g$ profits every period from the customer; if r is the discount rate, the present discounted value of its profits is $[(p - c_g)(1 + r)]/r$.

Assume that it believes that if it cheats, it will lose the customer forever. Its profits this period are $p - c_b$. Thus, for it not to cheat, given these beliefs, p must be sufficiently high:

$$\frac{(p - c_g)(1 + r)}{r} > p - c_b$$

or

$$p > c_g + r(c_g - c_b).$$

At very high discount rates, the price must exceed marginal cost by a considerable amount; at low discount rates, price can be very near marginal costs.

9.1.1. Consistency of beliefs

We now confirm that the beliefs that a firm will lose all of its customers if it cheats are consistent. Assume the firm believes that once it has cheated, it will never be able to regain its reputation. It believes that no one will offer any price in excess of the value of a shoddy product, which for simplicity, we shall assume is just c_b, for the commodities which it produces. The only commodities which it therefore pays for the firm to produce are the shoddy commodities.

Similarly, assume that consumers believe that the firm has those beliefs concerning their (i.e. the consumers') beliefs; then clearly, since the firm is going to produce shoddy products, the most that they will pay for the products is c_b. There is a perfect equilibrium in which, given that the firm has cheated, the firm only produces shoddy commodities, and individuals are only willing to pay c_b for its products.

9.1.2. Market equilibrium

The nature of the market equilibrium depends on how reputations are established (and destroyed). In our model, these are established upon an individual-by-individual basis. That is, individuals do not communicate with each other, and do not know whether the firm is selling commodities to other individuals. In a more realistic model individuals would take into account the information which could be gleaned from other individuals (both directly, and indirectly, from their actions).

Market equilibrium is characterized by price exceeding marginal cost. In conventional theory, these profits would give rise to entry, but here, it must be recalled, consumers are naturally skeptical of new entrants: anyone is willing to come along to produce, at low cost, a shoddy commodity and attempt to sell it for a price of p.

The problem is, how to convince potential new customers to buy one's product, to "switch". One way is to offer the commodity at a price below marginal costs. So long as the price exceeds the marginal cost of producing the low quality product, this conveys no information: if we assume there is an infinite supply of producers of shoddy commodities, all stand willing to sell their commodity at any price exceeding their marginal cost of production. However, for a firm to sell its commodities at any price below c_b does convey information: for a bad firm would lose money, not being able to gain anything in a repeat purchase; while a good firm might rationally be willing to sell at below the cost of production, if by doing so, it recruited a loyal customer, who would thereafter be willing to pay a price in excess of marginal cost.

The problem is that there are no contracts between firms and their customers; loyalty is superficial. If some new entrants sell their goods at a price below c_b, all customers, believing that it could only be high quality commodities which are being sold, stand willing to switch.

Thus, assume that a fraction ν of each firm's customers quit each period, to buy at a new entrant who is recruiting new customers by offering prices below c_b. Then, for it to pay a firm to maintain its reputation:

$$p \geq c_g + m(c_g - c_b),$$

where now

$$m = \frac{r + v}{1 - v}.$$

Notice that the less loyalty there is among customers (i.e. the higher is v), the higher the price must be to induce firms not to cheat. The present discounted value of profits are $(1 + m)(c_g - c_b)$, or

$$\frac{1 + r}{1 - v}(c_g - c_b).$$

Thus, provided v is not too large, a new entrant can offer to sell its product at a price below c_b, and entry will still be profitable. Of course, all individuals would prefer to switch.[63]

There is an "introductory offer" price, p_o, such that, if all firms take the quit rate among customers as given, expected profits are just zero. Of course, all individuals would prefer to pay p_o for the high quality good than p, the price that a high price store with a reputation is charging. Thus, there must be rationing. But if there is rationing, any firm that entered with an introductory offer between p_o and c_b would attract customers and make a positive profit. Hence, entry would occur until all customers had "switched". But if there is no customer loyalty, a reputation mechanism simply cannot work.

It is thus apparent that the only possible equilibrium offer entails p_o being just less than c_b. An equilibrium with excess demand can persist, since a firm that raises its introductory offer price will get no customers (since any lousy firm is willing to sell at the price c_b). We can then calculate the value of v for which, at this price, profits are just zero:

$$(p_o - c_g) + (1 + m)(c_g - c_b)\frac{1 - v}{1 + r} = 0$$

or

$$(1 + m)\frac{1 - v}{1 + r} = 1.$$

But direct substitution of the value of m shows that this equation is satisfied for all values of v: higher turnover rates necessitate higher prices, but they generate,

[63] Throughout, we are assuming that at p, the price charged by the high quality firm, the consumer surplus of the individual exceeds that which he could obtain from a low quality commodity sold at a price of c_b.

at any set of prices, lower profits. The two effects are exactly offsetting. Thus, there is a continuum of dynamic equilibria, each associated with a different rate of entry of new firms and different market prices.[64]

Some of these equilibria are unambiguously better (in expected utility terms) than others. (Since expected profits are zero, an equilibrium with higher expected utility is unambiguously Pareto superior.) If individuals have diminishing marginal utility of income, then they prefer the equilibrium in which prices vary the least, that is, the equilibrium with the highest loyalty ($v = 0$).

The model we have constructed thus has solved several of the problems we posed in the introduction to this part: profits are zero, prices convey information, firms have an incentive to maintain quality, and individuals have an incentive to quit firms that have cheated by selling low quality goods.

Several papers have attempted to "solve" the problem of positive profits by means other than introductory offers. One set of studies has firms expending resources on advertising [Kihlstrom and Riordan (1984), Milgrom and Roberts (1986)]. Firms would not advertise if they were suppliers of lousy commodities; for once the customer has tried the low quality commodity, he will not return, and the advertising would prove unprofitable. In most such models, advertising does not convey any information to the customer other than about product quality. In that context, firms who tried to recruit customers by offering introductory offers would succeed in recruiting all the customers; an equilibrium with advertising could not be sustained.

9.2. Reputations with heterogeneous firms

There is still one unsatisfactory aspect of these models: all firms are ex ante identical, and firms never, in fact, lose their reputations. In reality, individuals differ and firms differ. A loss of reputation entails an individual being "grouped" with those of "low reputation" (loose morals, shirkers, unproductive sloths). Customers cannot perfectly screen among firms. They make judgments about the

[64]There are some constraints on the equilibrium value of v. Assume the utility associated with purchasing the good quality commodity is U_g, and that associated with the bad quality is U_b, and assume that there is, for simplicity, constant marginal utility of income; then $U_b - c_b$ must be less than $U_g - p$, or

$$U_g - U_b > (1 + m)(c_g - c_b)$$

or

$$\frac{1 - v}{1 + r} > \frac{c_g - c_b}{U_g - U_b}.$$

quality of the firm on the basis of past performance. Past performance tells them something about the "capabilities" and capacities of the firm. A firm that has produced shoddy products may have a comparative advantage in producing shoddy products. That is why it is more likely to produce shoddy commodities in the future.

Thus, assume that there are two types of firms. The high quality firms, denoted by a superscript 1, have a comparative advantage in producing high quality commodities, relative to the low quality firms, denoted by a superscript 2:

$$c_g^1 - c_b^1 < c_g^2 - c_b^2.$$

More precisely, we assume that at the price at which it pays a type 1 firm to maintain its reputation, it does not pay a type 2 firm, so that

$$c_g^1 + m\left(c_g^1 - c_b^1\right) < c_g^2 + m\left(c_g^2 - c_b^2\right).$$

In the extreme, we could assume that the type 2 firms simply could not produce the high quality commodities.

Assume, moreover, that there is a given probability, ν (the reason for this notation will be apparent in a moment) that a high quality firm loses its hold on quality, that is, it switches from being a high quality firm to being a low quality firm. We assume that ν is less than one-half, so that a firm that is good this period is more than likely to be good next period.

In this model, then, there are firms that find it profitable to "lose" their reputation. Any such firm, were it to continue to produce, would continue to produce the low quality commodities. Past performance has correctly identified the low quality firms. Given our assumption that all individuals prefer the high quality products (at the relevant prices), such firms would exit the market, and there would be a flow of new entrants, offering goods with introductory price offers low enough to dissipate the later profits. Notice, however, that if there are some individuals who prefer low quality firms,[65] the low quality firms could continue to produce in equilibrium.

The model presented in this section provides a resolution to what have, until now, appeared to be two competing approaches to the analysis of reputation. Some models, such as those of Shapiro (1982) and von Weizacker (1980), have provided what may be thought of as descriptive theories, in which individuals form their expectations of future behavior on the basis of past performance (von Weizacker refers to this as the "extrapolation principle"). By contrast, game theorists have formulated "forward looking" theories, where, at each moment,

[65] That is, individuals for whom the difference in utility between the high and low quality firms is insufficient to justify the price differences.

the consumers try to analyze what is reasonable behavior on the part of the firm. They ask: How would it "rationally" behave? In the simplest version (given earlier) past behavior conveys no information about the firm's characteristics: indeed, it is assumed that they are identical. Because firms never cheat, individuals never have an opportunity to test their out-of-equilibrium conjectures.[66]

In the model presented in this subsection, past behavior does convey information; individuals do form rational expectations based on past behavior; and the predictions that they would have made, from examining past behavior, are the same that they would make on the basis of a forward looking analysis of the firms' rational behavior. Differences in behavior are related to real differences in the characteristics of different firms, inferences about which are rationally made on the basis of the firm's previous behavior.[67]

In this model, as in those presented earlier, price conveys information. Price is an unusual signal. The reason that higher levels of education distinguish the more able from the less able is that it is more costly for the less able to obtain more education. If higher prices indicated that the product was a higher quality, or higher wages indicated that individuals were more productive workers, then would not firms simply announce a higher price, workers a higher wage? To be an effective signal, there must be a cost to charging a high price or a high wage, and the cost must differ between high quality and low quality firms.

In reputation models, it is not the high price which is the signal – a new firm entering the market at a high price would not be successful: it is the low introductory price which is the signal. And the net cost to offering a low price is obviously less for the high quality stores than for the low quality stores; for the high quality stores know that they will get repeat customers, to whom they can charge a price higher than their marginal costs.

9.2.1. Cyclical variations in mark-ups

Costs of production and discount factors change over the business cycle. For instance, if marginal costs of producing high and low quality goods remains the same, but the discount factor increases in recessions [as Greenwald and Stiglitz

[66] Indeed, much of the recent work in this area has a certain metaphysical character to it. Results depend upon assumptions concerning behavior in circumstances which the theory predicts will never occur. Since we would have no way of testing which of the alternative assumptions provides the best description of behavior, if the theory were correct, it is obviously hard to choose among these alternative theories. Indeed, the only inference that we should logically make when an out of equilibrium move is observed is that the theory is not correct. Several recent studies by Reny (1988) and Binmore and Brandenburger (1989) have provided more penetrating criticisms of the logical foundations of much of modern game theory.

[67] The model presented here does not completely resolve the difficulties associated with specifying out of equilibrium behavior. Since in equilibrium only two levels of prices are observed, inferences have to be made about quality levels associated with other price levels.

(1988) have argued to be the case], then to induce firms to maintain quality in a recession requires an increase in the mark-up. The ratio of price to marginal cost actually increases in a recession. Thus, these models exhibit a kind of price rigidity.

To see this, we assume that there are two states to the economy, denoted by superscripts 1 (the good state) and 2 (the bad state). Let π^i denote profits in state i. The probability of a change of state is assumed to be $1 - \alpha < 0.5$. The value of the firm, the present discounted value of profits, in state i, is:

$$V^i = \pi^i + \delta^i\big(\alpha V^i + (1 - \alpha)V^j\big),$$

where δ is the discount factor. After considerable manipulation, we can solve for

$$V^2 = \frac{\pi^2(1 - \alpha\delta^1) + \pi^1(1 - \alpha)\delta^2}{1 - \delta^1\delta^2 - \alpha(\delta^1 + \delta^2 - 2\delta^1\delta^2)},$$

with a symmetric expression for V^1. For a firm to maintain quality, in say state 2, the present discounted value of future (expected) profits must exceed the profits it could obtain this period by cheating, i.e.

$$V^2 \geq p^2 - c_b^2,$$

where p^i is the price in state i, and $c_b^i(c_g^i)$ is the cost of producing a bad (good) product in state i. Recalling the definition of

$$\pi^i = p^i - c_g^i,$$

and letting

$$\Delta^i = c_g^i - c_b^i,$$

the difference in costs of production in state i, we obtain, after some rearrangement:

$$\frac{1}{D}\big[\pi^2(\delta^1 + \alpha - 2\alpha\delta^1) + \pi^1(1 - \alpha)\big] \geq \frac{\Delta^2}{\delta^2},$$

where D is the denominator of the expression for V^2 above, with a symmetric expression for state 1. Assuming the prices are the lowest consistent with maintaining incentives (that is, $V^i = p^i - c_b^i$) and subtracting the two, we obtain,

in equilibrium:

$$-\delta^2(\pi^2 - \pi^1)(-1 + \delta^1)(2\alpha - 1)$$

$$+(\delta^2 - \delta^1)(\pi^1\alpha + \pi^2(1 - \alpha)) = \Delta^2 - \Delta^1.$$

Thus, if differences in costs of production do not vary significantly over the cycle, while discount factors do, if we think of state 2 as the recession and $\delta^2 < \delta^1$, then

$$\pi^2 > \pi^1.$$

Profits (per unit sale) must be higher in the recession than in the boom, in order to maintain an incentive for quality.

9.2.2. Alternative theories of price rigidities

In the preceding section, as well as in Part II, we have presented two alternative theories of price rigidities, reasons why the real product wage may not rise in recessions, as Keynes, and most competitive equilibrium theories, predict.

There are alternative explanations, some based on capital market imperfections [Greenwald, Stiglitz and Weiss (1984)] and some based on imperfect competition [see, for example, Hall (1987) and Stiglitz (1984)]. These alternative views are not necessarily inconsistent.[68] There is one view, however, which we should note briefly, that of Carleton (1979), who sees the price contracts among firms much as the implicit contract literature has viewed the wage contract between workers and their employers, as providing an insurance and risk-sharing mechanism. Some of the criticisms which have been leveled against the implicit contract literature seem equally applicable in the product market. Insurance contracts, appropriately specified, represent redistributions; they do not (necessarily) have the kinds of allocative effects that are associated with "true" price or wage rigidities. Thus, so long as there is a spot market for the commodity, and so long as transactions costs are not too high, the fact that some firm has contracted to buy oil on a long-term contract at a high price is of little relevance for the short-run supply or demand for oil. That should be driven by the spot price. The consequences would be little different from those which would arise if the firm had insured itself through a futures contract. Indeed, the transfers associated with the insurance should serve to stabilize the market, not exacerbate its fluctuations. These contractual arrangements do have implications for how we should use statistics

[68] Indeed, the Greenwald, Stiglitz and Weiss analysis is based on some of the same considerations that we have employed in the previous subsection.

concerning the prices at which goods are sold; for purposes of testing, for instance, the Keynesian hypothesis concerning short-term movements in the real product wage, what is relevant is the spot price, not any long-term contractual price.

10. Product variety

We have all had the experience of arriving at a restaurant, and being overwhelmed with a huge menu or wine list that goes on for pages and pages. The restaurant has seemingly provided us with an excessive array of choices. In a world where it is costless to obtain and process information, an increase in product variety would always have a positive benefit. With costly information, this is no longer true. It is apparent that the value of product variety may be significantly affected by costly information. While there is the possibility that one can find a product that is better matched to one's preferences, the costs of finding any particular product are obviously increased.

The interactions between product variety, information costs, and welfare in market economies are complicated.

First, the presence of costly information affects the demand elasticities for different commodities. When it increases the demand elasticities, it leads to lower prices, and less product diversity, When it decreases the demand elasticity, just the opposite occurs. Examples can be constructed where an increase in the cost of information increases the demand elasticity, while there are other instances where it decreases the demand elasticity. We have not yet ascertained general conditions under which each of these occurs.

Consider, for instance, two soft drinks. In the absence of information concerning their distinguishing qualities, they are viewed as perfect substitutes. If now drinkers are informed that one is Coke and one is 7-Up, they become imperfect substitutes: the demand elasticity has decreased.

On the other hand, when search is costly, and there are many commodities on the market, there will be many commodities in any individual's acceptance set. The fraction of customers, therefore, that are just indifferent to buying or continuing searching is smaller than it would be if information were costless. This, in turn, means that if the firm were to raise its price a little, it would lose relatively few customers: costly information leads to a relatively low demand elasticity. Salop and Stiglitz (1987) have constructed a simple model capturing this intuition. See also Wolinsky (1986).

Secondly, the presence of many commodities – and differences in individuals' preferences for different commodities – results in firms being unable to discriminate perfectly. This "noise" in the market enables the existence of an equilibrium, even in the absence of a price dispersion; but it may also result in a price

dispersion, with the high price being the monopoly price, the low price the reservation price of the individual who arrives at a store, is ill-matched, and is just indifferent to going on to search for his more favored commodity. The following subsection presents a simple model illustrating this.

10.1. Product variety, imperfect discrimination, and price dispersions

We construct the simplest model illustrating how, in a market in which there is more than one commodity, stores will be unable to discriminate perfectly. This limited ability to discriminate is, as we emphasized earlier, necessary if a (competitive, Nash) market equilibrium is to exist. We assume, in particular, that there are two types of widgets, blue widgets and green widgets. Each store can only sell one kind of widget.[69] Then, if the store charges too high a price, it will induce a badly matched shopper (a blue widget lover arriving at a green widget store, or conversely) to continue shopping: it faces, at a critical reservation price level (to be calculated below) a significant price elasticity. Thus, one possible form of equilibrium is a single price equilibrium, where the price is set at the reservation price of the badly matched individual; but this means that the well matched individual enjoys some surplus, and it is the chance of getting this surplus which induces individuals to enter the market, and which accordingly enables equilibrium to exist.

On the other hand, it is possible that there may exist a price distribution, with some stores charging a high price, and only selling to those who are well-matched, and some stores charging a low price, selling to those who are ill-matched as well.

To ascertain the conditions under which each of these equilibria can arise, we assume that there is an equal number of blue and green widget lovers, and that the reservation price for a blue widget lover for a blue widget is u_1 and for a green widget is u_2 (and conversely for the green widget lover). The costs of search of all individuals are assumed identical, and equal to s. In equilibrium, half the stores sell green widgets, half blue widgets; the individual knows this, but does not know which sells which. As in our earlier search models, the individual knows (or has beliefs about) the probability distribution of prices; in particular, we consider first the possibility of a single price equilibrium.

Single-price equilibrium. The ill-matched individuals' reservation price is the lesser of u_2 and that price, $\tilde{p}$, such that the individual is indifferent between

[69] This assumption is more plausible where the differences in commodities are service characteristics – the store either has many salesmen, so that it takes but a few minutes to be waited on, or it has few salesmen, so that it may take an extended period to be served – with individuals differing in the extent to which they value these service characteristics (e.g. correlated with the value of their time). Clearly, it would be possible for any store to stock both blue and green widgets. On the other hand, inventory costs may be lower if the firm specializes in one of the two types of widgets.

paying $\tilde{p}$, thereby enjoying the surplus $u_2 - \tilde{p}$, and continuing to search, paying the price p^*. We assume the individual is risk neutral. Since, on average it will take him two searches, his expected utility will be $u_1 - p^* - 2s$.

Thus, if the firm's price is set so as to deter further search, p is set such that

$$u_2 - p = u_1 - p^* - 2s.$$

But this immediately implies that unless

$$u_1 - u_2 = 2s,$$

there cannot exist a single price equilibrium. If, conversely, the price is set so as to capture all of the surplus from the mismatched individual, it must be that

$$u_1 - p^* - 2s = u_1 - u_2 - 2s < 0$$

as the firm does not fear losing these individuals. But then the expected surplus of a shopper is:

$$\frac{u_1 - u_2}{2} - s < 0.$$

Hence, in this case, there cannot exist a single price equilibrium. But a slight modification of the model allows for a single price equilibrium: all we require is that the second search costs more than the first. Then the no search inequality becomes:

$$u_1 - u_2 < \text{expected search costs, } s^*$$

while the positive expected surplus inequality becomes:

$$\frac{u_1 - u_2}{2} - s_1 > 0,$$

where s_1 is the cost of the first search. Since

$$s_1 < s^*/2,$$

the first search is less than the average cost of finding a good match, the two inequalities may be simultaneously satisfied.

Two-price equilibrium. In the two-price equilibrium, some stores charge the price u_1, and some charge either u_2, or the price which just induces search among the ill-matched. Assume that the fraction charging a low price is λ. Then, by the same argument as earlier, if each search costs the same amount, the only possible equilibria must have the low price below u_2.

For simplicity, let us continue with the assumption that each search costs s. Now, the reservation price equation needs to be modified. If one continues to search for the widget of the preferred color, there is a probability $(1 - \lambda)/2$ that on a search one will find a high price well-matched store, and a probability $\lambda/2$ that one will find a low price well-matched store. Thus, the expected price one has to pay is:

$$\bar{p} = \lambda p^{\mathrm{L}} + (1 - \lambda) p^{\mathrm{H}}.$$

Since the low price will equal the reservation price, and the high price will equal u_1, the reservation price equation thus becomes:

$$\begin{aligned} u_2 - p^{\mathrm{L}} &= u_1 - \bar{p} - 2s, \\ &= \lambda\left(u_1 - p^{\mathrm{L}}\right) - 2s \end{aligned}$$

or

$$p^{\mathrm{L}} = u_1 - \frac{u_1 - u_2 - 2s}{1 - \lambda}.$$

The analysis proceeds just as in our analysis of the Theory of Sales; in equilibrium, the two kinds of stores must make equal profits. For simplicity, we assume a zero cost of production and a fixed cost of creating a firm. Thus, equal profits is equivalent to equal revenues. The low price stores sell to everyone who arrives at their doorstep; the high price stores only to the well matched. Since sales at the low price store must be twice those at the high price, prices must be half, i.e.

$$p^{\mathrm{L}} = u_1/2,$$

or, substituting into the reservation price equation, we obtain:

$$\lambda = \frac{2u_2 - u_1 + 4s}{u_1}$$

It is easy to verify that, provided

$$2u_2 - u_1 + 4s > 0$$

and

$$u_1 - u_2 - 2s > 0,$$

there exists a value of λ, $0 < \lambda < 1$, for which profits at all stores are equal, and all stores are maximizing profits. Equilibrium is characterized by a price distribution.[70]

11. Other mechanisms for conveying information about quality

Reputation is only one of several mechanisms by which the potential problems arising from consumers' inability to observe perfectly product quality prior to purchase become ameliorated. In this section we make note of several other mechanisms.

Disclosures. Firms could disclose their product quality. High quality firms have an incentive to disclose that they are in fact high quality. If they do not, they will be grouped with lower quality firms, and the price which consumers will be willing to pay will be accordingly lower. One might ask: Is it not in the interests of all firms that are lower than average not to disclose their quality? If disclosure were costless and there were severe penalties for fraud, then it pays every firm to disclose its quality. For assume that only the best firms disclosed their quality. The remaining firms would be grouped together, classified as low quality. It would then pay the best of these to disclose its quality. The process would continue until only the worst firm had not disclosed that it was, in fact, the worst firm. But, by what has been called the Walras' law of screening, if all but one firm has disclosed its quality, then, in effect, the worst firm has had itself disclosed as such [see Stiglitz (1975) and Grossman (1981)]. The assumptions underlying the analysis, that disclosure – and the verification and enforcement of truth-telling – are costless are sufficiently far from the mark that, at least in many markets, consumers continue to face considerable uncertainty about product quality.

Certification. In many markets, consumers may rely on information specialists, experts, to screen various products, to certify their qualities. Retail stores and middlemen can be thought of as performing this function. *Consumer Reports* provide some information concern product quality. The economics of certification, including who bears the cost, and the circumstances under which it does and does not pay to become certified, are discussed at greater length in Stiglitz (1989).

Guarantees. Guarantees provide one important way, not only to transfer risk [Heal (1977)], but also to convey information, in those situations where the critical quality variable concerns the likelihood that the product fails to perform. The fact that a firm is willing to insure its product against breakage may mean

[70] We still need to check the positive surplus condition, ensuring that individuals actually enter the market, and we have to confirm that an individual arriving at the high price store does not search for a low price store.

that it is confident that its product breaks down with only a low probability. If firms were risk neutral, then the guarantee serves effectively as a disclosure statement concerning quality. If firms are risk averse, then the magnitude of the guarantee (the amount of risk which the firm is willing to absorb) may serve as a self-selection device,[71] with higher quality firms being willing to provide better guarantees. Problems of moral hazard – the possibility of the product's breakage being due to misuse by the purchaser – put limits on the use of guarantees. In many cases, too, there may be ambiguities concerning whether the product is performing in the manner promised or expected, and enforcement of guarantees is often costly.

Prices. Prices often convey information. Elsewhere [Stiglitz (1987a)] I have provided a more extended discussion of the circumstances and mechanisms by which prices convey information. Here, I want only to mention a few aspects of this which are particularly relevant to the problem of product quality. (We have already noted one instance in which prices convey information: buyers know that if the firm charges too low a price, it will have no incentive to maintain its reputation, and hence maintain quality.)

Akerlof (1970), in his classic discussion of lemons in the automobile market, showed how prices affected the quality of cars being sold: when the price was low, only those with lemons were willing to sell their cars, and this was reflected in the prices buyers were willing to pay. He argued that imperfect (asymmetric) information concerning product quality lead to thin markets for used cars.

In most product markets, however, sellers do not passively take the market price as given (as Akerlof assumed). They can announce, for instance, a high price, higher than the price being charged by other firms. The question is: Why should consumers believe that the firm in question is offering a higher quality commodity, rather than just trying to fool them into paying more for the same quality as other stores are offering?

In monopolistic markets there are circumstances in which prices can convey information. Assume there are two types of consumers. Some value quality more than others. For simplicity we assume that a fraction α derive u_1 from the high quality commodity and u_2 from the low quality commodity. The other group gets the same utility, u_2 from the two qualities. Both groups have utility functions which are linear in the consumption of other goods, and purchase at most one unit of the commodity in question. Thus, an individual in the first group (which we will refer to as the quality lover) has a utility of $u_i - p$ if he buys a commodity of quality i. Assume the monopolist cannot discriminate among the two groups. Assume further that each firm has no choice concerning its quality, that is, a firm is endowed either with a low quality technology where it costs c_b to produce a unit, or a high quality technology, where it costs c_g to produce a unit.

[71] See Rothschild and Stiglitz (1976) for an analysis of competitive self-selection equilibria.

It is possible to show that there may be a revealing equilibrium, where the high quality firms charge a high price, sell to only a fraction of the consumers, and the low quality firms charge a low price. The highest price which the high quality lovers would be willing to pay is u_1 and the highest price which the low quality lovers would be willing to pay is u_2. These will be equilibrium prices provided

$$u_2 - c_b \geq (u_1 - c_b)\alpha$$

and

$$(u_1 - c_g)\alpha \geq u_2 - c_g.$$

In this particular example, the equilibrium is exactly the same as it would be in a standard monopoly-with-perfect-information equilibrium. But assume that the quantity demanded by the high quality lovers depended on the price. It is possible that at the price the monopolist would have charged, with perfect information, it pays the low quality producer to imitate, that is, the increased profits from higher prices more than offsets the lower sales. Then, there may exist a self-selection (signalling) equilibrium, in which the monopolist increases his price above the perfect-information monopoly price; at this higher price and correspondingly lower sales, profits are lower for the lower quality firm than if he simply announced that he was lower quality and sold his product at the low price.

In more competitive situations, however, price is not likely to be an effective signal of quality (apart from its role in reputation mechanisms discussed in the previous section). Assume there were a large group of high quality stores and a large group of low quality stores. Each consumer enters the market only once, and knows nothing about any particular firm other than the price being charged (but he has some understanding of how markets work). The high price firms claim to be high quality. Assume that there is a U-shaped cost curve. Free entry ensures that each in equilibrium is making zero profits and operating at the bottom of the U-shaped cost curve. There are two possibilities. Figure 13.14(a) illustrates the case where if a low priced, low quality firm switched, by increasing its price, and the market misinterpreted this to mean that he had also switched the quality of his product, his profits would be increased; there cannot exist a competitive signalling equilibrium. Figure 13.14(b) illustrates the other possibility where, even in competitive markets, prices may convey information concerning product quality.[72]

[72] The essential property is that the minimum point on the high quality average cost curve lie above the low quality average cost curve.

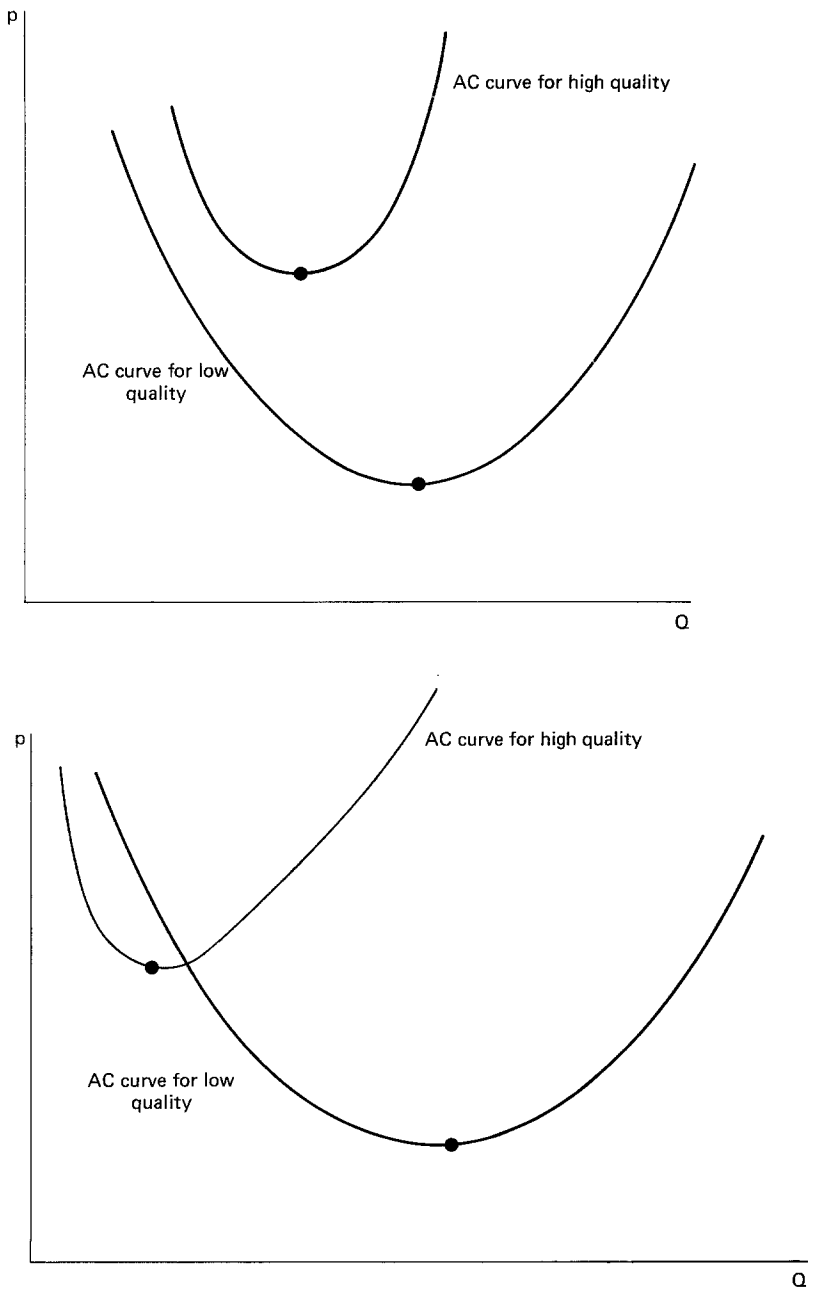

Figure 13.14. There may or may not exist competitive equilibria in which price conveys information about quality.

The reason that price may be an effective signal of quality is that there is a cost to raising price-reduced sales. If the marginal cost of producing low quality goods is lower, then the reduced sales is more costly to the low quality producer than to the high quality producer. Still, both high and low quality producers gain from higher prices, and it is therefore not surprising that in many circumstances, prices are ineffective in conveying information concerning product quality.

On the other hand, in the situations described in the preceding section where there are repeat customers, prices do convey information. But note that it is the low introductory offer which conveys information – it only pays a firm to sell at a price below marginal costs if it believes that the individual will return. Though the reputation models we constructed in the previous section work most effectively when the individual is a repeat customer, similar models can be constructed for items, such as consumer durables, which are purchased only periodically, so long as individuals communicate with each other, that is, the sense of consumer satisfaction is communicated from one individual to another.

12. Advertising

This chapter has focused on markets in which consumers are imperfectly informed, and gather information by search. Consumers also obtain information as a result of *advertising* by stores.

Most advertising is not informative. The typical Marlboro ad, with a cowboy smoking a cigarette, or a Virginia Slims ad, or a Budweiser Beer ad conveys no credible information concerning the nature of the product being sold, the price at which the product is sold, or where the product may be obtained. Firms spend money on ads such as these because they believe it increases their profits, because such ads have an effect on demand curves. But the effects on the demand curves are not those resulting from conveying information. The prevalence of these ads serves to remind us of the limitations of the theory of consumer behavior, which assumes rational individuals having well formed preferences. Such ads often seek to convince individuals of the existence of important differences, when there are none. To the extent that they are successful, they shift (at least part of) the demand curve upwards, leading to higher prices; with costly entry, the extra profits may be dissipated in excess entry. To the extent that there is no "real" product differentiation, welfare would seem to be unambiguously lowered: but how are we to judge welfare in a world in which individuals gain greater pleasure out of smoking a Marlboro cigarette, because they have pleasant sensations when they do that, stimulated by the images left in their mind by the ad?[73]

[73] For an argument that it is still possible to make welfare judgments, see Dixit and Norman (1978).

There are some forms of advertising which actually do convey information, and which affect demand curves because of the information which they convey.[74] Advertising a new product provides valuable information to the consumer that may stimulate him to try it out. Some newspaper ads do convey information about price and product availability. Price advertising can be modeled as reducing consumers' search costs, and in the models with homogeneous commodities ("Bargains and Ripoffs"), this not surprisingly leads to a decrease in average price. But the effect of advertising product variety may be ambiguous. As consumers become more aware of product differences, prices rise, leading to more entry. Though consumers may be better matched, if there is excess product differentiation in the initial equilibrium, it is possible that these losses exceed the gains from better matching [Salop (1978b), Salop and Stiglitz (1987)].

Advertising it not well modeled simply as another input into a production process. While economists have little to say about that large fraction of advertising which has little if any information value (either why it has the effects it has, or how to make welfare statements concerning its value), to the extent that advertising conveys information,[75] it presents the full range of difficulties that we encountered earlier in our analysis of market equilibrium where information is acquired via a process of search (including market equilibrium being characterized by price distributions).

13. Concluding remarks

Consumers are imperfectly informed. They do not know the characteristics of all the products in the market, or the prices at which they are available at all sellers. There is no Walrasian auction ensuring that a particular commodity is sold at the same price by all stores. There is no Government Inspector ensuring that what appear to be two identical commodities are in fact identical. And given the myriad of variations in product characteristics, the consumer is constantly having to make decisions concerning whether the differences in qualities are worth the differences in prices. We have argued that these informational imperfections have fundamental implications for how product markets function, at least for many (most) of the commodities which consumers purchase. These considerations may be relatively unimportant in the market for wheat, so favored by Principles textbooks, or perhaps even in the market for steel. But elsewhere, they are

[74] The models of Butters (1977a, 1977b) and Grossman and Shapiro (1984) provide examples of an attempt to analyze market equilibrium with informative advertising.

[75] I have deliberately had little to say about those models in which advertising is used to signal firm quality; as I argued earlier, there are better ways of signalling than providing uninformative advertising (what is sometimes called burning money) and thus it seems unlikely that that can be the only, or even primary, reason for advertising.

potentially of considerable importance. They help explain why such markets are inherently imperfectly competitive, why prices may be considerably in excess of marginal costs, why entry may be difficult. They help explain not only why equilibrium may be characterized by price dispersions, but also why, in some circumstances, equilibrium *must* be characterized by price dispersions. Finally, they help explain price rigidities, thus contributing to our understanding of why the economy fails to respond well to certain types of disturbances.

Appendix: Notation

M = number of stores
L = number of individuals
S_t^j = cost of the tth search for jth individual
$S^j(t)$ = total cost of finding out about t stores (for jth individual)
u = reservation price
p = price
I_0 = individual's income
Q_1^j = quantity of good consumed by jth individual
$F(s)$ = fraction of individuals with search costs less than or equal to s
Q^H = quantity sold by high price store
Q^L = quantity sold by low price store
λ = fraction of stores sharing the low price
a = minimum average cost (U-shaped cost curve)
m = marginal cost of production
C = fixed costs
$G(p)$ = proportion of stores charging price greater than p

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