Multiple Equilibria in a Simple Model of Search with Entry

Sugato Dasgupta*

Diamond (1971) analyzed a goods market wherein identical buyers with unitary demand searched sequentially over identical monopolistically competitive firms. The equilibrium market price was shown to be the monopoly price. Suppose, now, that to participate in a "Diamond-market," prospective buyers are charged a small but positive entry fee. Since the market price fully extracts consumer surplus from entering buyers, no one finds it worthwhile to pay this entry fee. To study the non-trivial implications of consumer entry, I modify the Diamond-model slightly. The modified model displays two interesting features: buyers with strictly positive entry fees enter the goods market, and the goods market generates multiple equilibrium prices.

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JEL Classification: L11, L13

I. Introduction

In a seminal paper, Diamond (1971) analyzed a goods market with the following features: identical prospective buyers with unitary demand and gross valuation, v, searched sequentially, at a fixed cost per observation, over identical monopolistically competitive firms. A remarkable result was established: regardless of the

* Associate Professor, Centre for Economic Studies and Planning, Jawaharlal Nehru University, New Delhi 110067, India, (Tel) +91-11-26704499, (Fax) +91-11-26717586, (E-mail) sugatodasgupta@rediffmail.com. This paper, which is based on a chapter of my dissertation at the Massachusetts Institute of Technology, has benefited from the guidance of Daron Acemoglu and Peter Diamond. An anonymous referee suggested changes that improved the paper's expositional quality. Of course, the usual disclaimer applies.

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magnitude of the search cost, the equilibrium market price was unique and equal to the monopoly price, v. Since real-world retail markets are frequently characterized by a substantial degree of price variation, Diamond's "unique market price" conclusion posed a perplexing paradox.

Motivated in part by the above paradox, several authors have constructed market models that exhibit price dispersion in equilibrium. I mention here a few of the important contributions. Considering models of monopolistic competition, Axell (1977), Salop and Stiglitz (1982), Albrecht and Axell (1984), and Rob (1985) obtain price dispersion when buyers differ in search costs; Diamond (1987) emphasizes the case wherein buyers have different valuations of the good; while Reinganum (1979) explores a setup in which firms have different production costs. In models of non-sequential search, Butters (1977), Salop and Stiglitz (1977), and Burdett and Judd (1983) demonstrate that price dispersion emerges when buyers differ *ex post* in the number of price offers received. Finally, Shilony (1977) and Varian (1980) analyze models of oligopoly and identify price dispersion with the mixed strategy pricing behavior of firms.

In this note, I explore yet another aspect of the Diamond (1971) model; specifically, I consider the issue of market entry by buyers. Assume first that in order to participate in a Diamond-style goods market, prospective buyers are charged a small but positive entry fee. Since the equilibrium market price extracts all the consumer surplus from entering buyers, no one finds it worthwhile to pay the entry fee. In sum, with a positive entry fee, trading in the goods market ceases.

To study the non-trivial implications of buyer entry, certain modifications in the Diamond (1971) structure are clearly required. I examine a model that differs from Diamond's setup in two essential ways. First, I assume that there is heterogeneity in the buyer pool with respect to the magnitude of the entry fee. Furthermore, for some buyers (*e.g.*, teenagers in a shopping mall or hagglers in a bazaar), the entry fee is posited to be negative. Second, I impose heterogeneity in the buyer pool with respect to the gross valuation of the good.

My model generates two interesting propositions. First, I establish the existence of an equilibrium with the following property: some buyers, though subjected to a strictly positive entry fee, nonetheless enter the goods market to purchase the commodity. What is the intuition for this result? Notice that buyers with negative entry fees enter the goods market regardless of the ensuing market price. It turns out that the guaranteed entry of such buyers forces the market price to settle at a level that permits some buyers with positive entry fees to trade as well. Second, the model inevitably generates multiple equilibrium prices. The multiple equilibria can be ranked in terms of aggregate welfare: the trade volume and aggregate welfare decrease as the equilibrium price is raised.

The rest of this note is structured as follows. In section II, I describe the search model and analyze its equilibrium. In section III, I conclude by discussing the implications of the model's solution.

II. The Search Model

I consider a market for a homogeneous commodity with agents of two sorts: buyers, the potential demanders of the good, and firms, the suppliers of the good. Time is measured in discrete intervals and the horizon is infinite.

A. Buyer Attributes

In generic period t, buyers of unit measure are born. A buyer survives for two periods; thus, birth in period t leads to death at the conclusion of period $(t+1)$.

After birth, each generation-t buyer decides whether to enter the period-t goods market. Should a buyer opt to enter, she is subjected to an entry fee, denoted by c. In each generation, a fixed proportion $\mu \in (0, 1)$ of buyers have c-values that are negative. Such buyers receive positive benefits from market participation *per se*. For the remaining buyers, of proportion $(1-\mu)$, a more conventional assumption is invoked. Their c-values are represented by a cumulative probability distribution function $F(c)$ with density $f(c)>0$ defined on the interval $[0, C]$ ($F(0)=0$ and $F(C)=1$).

Upon entering the goods market, a generation-t buyer has the option to purchase one unit of the commodity in either period t or period $(t+1)$. Consumption of the commodity yields an instantaneous benefit, denoted by v. Different buyers have different v-values. In each generation of buyers, the v-values are represented by a cumulative probability distribution function $G(v)$ with density $g(v)>0$ defined on the interval $[0, C]$ ($G(0)=0$ and $G(C)=1$). For analytical tractability, c and v are assumed to be independent random variables.

Consider a buyer born in period t. Associated with this buyer is her pair of attributes (c, v). Four cases need to be reviewed. First, should the buyer opt for non-entry in the period-t goods market, her net payoff is 0. Second, if the buyer enters the period-t goods market and purchases the commodity in period t at price p_t, her net payoff is $(v-p_t-c)$. Third, if the buyer enters the period-t goods market and purchases the commodity in period $(t+1)$ at price p_{t+1}, her net payoff is $[\delta\times(v-p_{t+1})-c]$, where $\delta\in(0, 1)$ is the discount factor common to all buyers. Fourth, should the buyer enter the period-t goods market and exit without purchase, her net payoff is $-c$.[1]

B. Firm Attributes

I abstract from firms' entry decisions and simply assume that there are m infinitely-lived firms in the goods market. As it turns out, this is an innocuous assumption because the set of equilibrium prices in the goods market is independent of m.[2] Given the independence property, the process by which m is determined can obviously be left unspecified.[3]

[1] My treatment of buyer payoffs merits scrutiny. I have in effect assumed that the only explicit search cost is the discounting of utility from purchases made one period later. This approach to modeling search cost is of course pervasive in the literature (see, *e.g.*, Diamond (1987), Rubinstein and Wolinsky (1985), and the exhaustive survey on labor market search-theoretic models by Rogerson *et al.* (2005)). Furthermore, the results in this note are *unchanged* if search cost is modeled instead by allowing buyers to sample up to two prices sequentially at a fixed cost per observation.

[2] To see the independence property clearly, refer to Equation (7). Equation (7) gives the necessary and sufficient conditions for a price, $\bar{p}$, to be an equilibrium. Notice that m does not feature in Equation (7).

[3] It is also not difficult to suggest ways of making m endogenous. Given Equation (7), one can select an equilibrium price, $\bar{p}$. This done, let $\Pi(\bar{p})$ denote the per period profit that firms earn in aggregate when the market price is $\bar{p}$ in each period t. If a firm incurs a fixed cost c_f to enter the goods market, then free entry ensures that m is given by the following equation: $m\times c_f=(1/(1-\delta))\Pi(\bar{p})$, where $\delta\in(0, 1)$ is the discount factor common to all firms.

Consider the actions of firm i in period t. At the start of period t, on a take-it-or-leave-it basis, firm i sets a period-t price, denoted by p_{it}. Thereafter, by a process to be described shortly, buyers are assigned to firm i. Given p_{it}, each assigned buyer decides whether to procure the good from firm i: firm i's period-t demand equals the number of purchasing buyers. I assume, as is standard in the search literature, that firm i can instantaneously produce the quantity required to meet its period-t demand (capacity constraints are therefore ruled out) and strictly for notational ease, set firm i's (constant) marginal cost of production to 0.[4]

In setting price p_{it}, firm i's objective is to maximize its discounted profit stream. I shall impose assumptions to ensure that firm i's dynamic problem reduces to a static one.

C. Matching of Consumers to Firms

At the start of period t, buyers in the goods market are of two kinds. In the first category are buyers born in period $(t-1)$ who entered the goods market in period $(t-1)$, rejected the price offered in period $(t-1)$, but decided nonetheless to sample the period-t price. In the second category are buyers born in period t who enter the period-t goods market. In period t, each buyer (from both the above categories) is randomly assigned to one of the m firms in the goods market. Since a firm's allotment of buyers is independent of its price history, the optimally chosen p_{it} maximizes firm i's profit in period t.

D. Entry of Consumers

I shall restrict attention to equilibria wherein:

$$p_{it}=\bar{p}, \ \forall i, \ t. \tag{1}$$

Thus, in equilibrium, a time- and firm-independent price prevails in the goods market. All buyers correctly anticipate $\bar{p}$. Hence, a generation-t buyer enters the goods market if her (c, v)-pair satisfies 1) $c<0$, or 2) $c\geq 0$ and $(v-\bar{p}-c)\geq 0$.[5, 6]

[4] Notice, therefore, that if q_{it} is firm i's period-t demand corresponding to the period-t price p_{it}, firm i's cost of production in period t is 0 and its profit in period t is $p_{it}\times q_{it}$.

E. Another Equilibrium Restriction

Consider a generation-t buyer with the following two characteristics: $c<0$ and $v<\bar{p}$. Since $c<0$, the buyer enters the period-t goods market. Since $v<\bar{p}$, the buyer does not procure the commodity in period t or period $(t+1)$. I shall restrict attention to equilibria wherein such a buyer exits the goods market after one round of search (that is, at the conclusion of period t) with a time-invariant probability of $(1-\pi)\in[0, 1]$.[7]

F. Aggregate Demand at an Exogenously Fixed Price

Finally, to understand how the model functions, consider the following hypothetical situation. Suppose all firms are forced to charge an exogenously given price p in every period t; that is, $p_{it}=p$, $\forall i, t$. Suppose, also, that buyers realize that sellers set $p_{it}=p$, $\forall i, t$.[8] What, then, is the period-t aggregate demand at price p?

[5] Notice that since in equilibrium, $p_{it}=\bar{p}, \forall i, t$, discounting ensures that generation-t buyers who enter the goods market to purchase the commodity actually make the purchase in period t itself. For such buyers, there is no equilibrium search. But, this admittedly awkward "no equilibrium search" result crops up in several well known models in the search-theoretic literature. Indeed, costly search is obviously ruled out in any model where the price of the traded good has a degenerate distribution (see, *e.g.*, Diamond (1971) and Rubinstein and Wolinsky (1985)).

[6] It should be clear by now that this note studies search issues in an overlapping generations framework. Why is such a framework used? Fix a set of buyers that enter the goods market, howsoever modeled. At least some buyers in this set will eventually trade and exit the goods market. To obtain a steady-state equilibrium price, $p_{it}=\bar{p}$, $\forall i, t$, the exiting set of buyers must be replaced by new entrants. Exit and fresh entry fit naturally in an overlapping generations framework.

[7] Two observations are relevant here. First, a generation-t buyer with $c<0$ and $v<\bar{p}$ is indifferent between exiting the goods market at the conclusion of period t (one round of search) and exiting the goods market at the conclusion of period $(t+1)$ (two rounds of search). Given indifference, exiting with probability $(1-\pi)$ after one round of search is optimal for the buyer. Second, note that π is an endogenous variable and not a fixed parameter. Furthermore, given the buyer's indifference between "further search" and "exit," π can be pegged at any value in the interval [0, 1]. Indeed, in the proofs of Propositions 1 and 2, I will choose π to lie in a specific subinterval of [0, 1].

[8] Note that the exogenously given p is not necessarily the equilibrium price in the market, $\bar{p}$.

Consider how many generation-t buyers purchase the commodity at price p. First, a proportion μ of generation-t buyers have c-values that are negative. These buyers enter the period-t goods market and purchase the commodity immediately (that is, in period t) if gross valuation, v, weakly exceeds p. Hence, aggregate demand from such buyers equals $[\mu \times (1-G(p))]$.

Second, a proportion $(1-\mu)$ of generation-t buyers have non-negative c-values. For this group, a buyer with (c, v)-pair such that $(v-p-c) \geq 0$ enters the period-t goods market and purchases the commodity immediately (that is, in period t). Hence, aggregate demand from such buyers equals $[(1-\mu) \times \int_p^C F(v-p)dG(v)]$.

Third, observe that in period t, the generation-$(t-1)$ buyers still in the market are those with $c<0$ and $v<p$. Such buyers do not contribute to the period-t aggregate demand at price p. In sum, the period-t aggregate demand at price p, denoted $D(p)$, is:

$$D(p) = [\mu \times (1-G(p))] + [(1-\mu) \times \int_p^C F(v-p)dG(v)]. \tag{2}$$

Given the search model that I have described, Proposition 1 establishes the existence of an equilibrium market price, $\bar{p}$, in the open interval $(0, C)$. Since $\bar{p}<C$, notice that a buyer with a (c, v)-pair such that $c>0$ and $(v-\bar{p}-c) \geq 0$ enters the goods market and purchases the commodity. The upshot of all this is as follows: some buyers with strictly positive entry fees choose nonetheless to trade in the goods market.

Proposition 1

For the goods market, the existence of a time- and firm-independent equilibrium price in the open interval $(0, C)$ is guaranteed.

Proof: The solution consists of two parts. Given a putative equilibrium price $\bar{p}$, I first ensure that it is unprofitable for firm i in period t to raise its price from $\bar{p}$ to $(\bar{p}+\varepsilon)$. Thereafter, I verify that it is also unprofitable for firm i in period t to lower its price from $\bar{p}$ to $(\bar{p}-\varepsilon)$.

Raising price to $(\bar{p}+\varepsilon)$. Suppose firm i charges a price of $(\bar{p}+\varepsilon)$. I evaluate the firm's period-t demand, denoted $D_i(\bar{p}+\varepsilon)$, in two steps. First, all generation-$(t-1)$ buyers assigned to firm i in period t have gross valuations, v, less than $\bar{p}$. Hence, they do not contribute to demand $D_i(\bar{p}+\varepsilon)$. Second, a generation-t buyer assigned to firm i in period t behaves as follows: 1) if gross valuation, v, is such that $(v-\bar{p}-\varepsilon)\geq\delta\times(v-\bar{p})$, the buyer purchases the good from firm i; otherwise 2) the buyer exits firm i and purchases the good in period $(t+1)$ at the putative equilibrium price of $\bar{p}$.

I now compute the number of generation-t buyers assigned to firm i in period t with v-values satisfying $(v-\bar{p}-\varepsilon)\geq\delta\times(v-\bar{p})$ - that is, $v\geq k\equiv[\bar{p}+(\varepsilon/(1-\delta))]$. Two distinct situations arise. First, a mass (μ/m) of generation-t buyers with firm i have negative c-values. Of these buyers, a proportion equal to $(1-G(k))$ have gross valuations weakly exceeding k. Second, generation-t buyers of mass $(1-\mu)$ have c-values that are non-negative. Since $\bar{p}$ is the conjectured market price, the proportion of such buyers that 1) enter the period-t goods market and 2) have gross valuations weakly exceeding k equals $[\int_k^C F(v-\bar{p})dG(v)]$. Given the random matching process, firm i obtains a $(1/m)$ share of all entering buyers. Thus, $D_i(\bar{p}+\varepsilon)$ is:

$$D_i(\bar{p}+\varepsilon)=(1/m)\times[\mu\times(1-G(k))]+(1/m)\times[(1-\mu)\times\int_k^C F(v-\bar{p})dG(v)]. \quad (3)$$

When firm i sets a price of $(\bar{p}+\varepsilon)$, its period-t profit, denoted $R_i(\bar{p}+\varepsilon)$, is $(\bar{p}+\varepsilon)\times D_i(\bar{p}+\varepsilon)$. If "market price of $\bar{p}$" is an equilibrium, $R_i(.)$ must decline for local increases of price relative to $\bar{p}$. This is equivalent to the following condition:[9]

$$D_i(\bar{p})\leq\frac{\bar{p}\times g(\bar{p})\times\mu}{m\times(1-\delta)} \quad (4)$$

Lowering price to $(\bar{p}-\varepsilon)$. Suppose firm i charges a price of $(\bar{p}-\varepsilon)$. I evaluate firm i's period-t demand, denoted $D_i(\bar{p}-\varepsilon)$, in two steps. First, firm i is assigned generation-$(t-1)$ buyers of mass $((\mu\times\pi\times G(\bar{p}))/m)$. All such buyers have gross valuations v less than $\bar{p}$ (otherwise, purchase and exit would have occurred in period

[9] I will assume that the second-order condition for profit maximization is satisfied. The second-order condition is satisfied if 1) $g'(v)\geq 0$, or 2) $g(v)\geq(|g'(v)|/(1-\delta))$. Note that if the v-values are uniformly distributed among buyers, then $g'(v)=0$. Hence, in this case both conditions 1 and 2 hold.

$(t-1)$ itself). The proportion of such buyers with $v \in [\bar{p}-\varepsilon, \bar{p})$ is given by $([G(\bar{p})-G(\bar{p}-\varepsilon)]/(G(\bar{p}))$. Since these buyers procure the good from firm i at the reduced price $(\bar{p}-\varepsilon)$, their contribution to $D_i(\bar{p}-\varepsilon)$ equals $((\mu \times \pi \times [G(\bar{p})-G(\bar{p}-\varepsilon)])/m)$.

Consider the behavior of a generation-t buyer assigned to firm i in period t. The buyer purchases the good from firm i if and only if her gross valuation v weakly exceeds $(\bar{p}-\varepsilon)$. How many such buyers arrive? First, a mass (μ/m) of generation-t buyers with firm i have c-values that are negative. Of these buyers, a proportion equal to $[1-G(\bar{p}-\varepsilon)]$ have gross valuations weakly exceeding $(\bar{p}-\varepsilon)$. Second, a mass $(1-\mu)$ of generation-t buyers have non-negative c-values. Since $\bar{p}$ is the conjectured market price, the proportion of such buyers that 1) enter the period-t goods market and 2) have gross valuations weakly exceeding $(\bar{p}-\varepsilon)$ equals $[\int_{\bar{p}}^{C} F(v-\bar{p})dG(v)]$. Given the random matching process, firm i receives its $(1/m)$ share of all entering buyers. Thus, $D_i(\bar{p}-\varepsilon)$ is as follows:

$$D_i(\bar{p}-\varepsilon)=\frac{\mu \times \pi \times [G(\bar{p})-G(\bar{p}-\varepsilon)]}{m}+\frac{\mu \times [1-G(\bar{p}-\varepsilon)]}{m}+\frac{(1-\mu)\times \int_{\bar{p}}^{C} F(v-\bar{p})dG(v)}{m} \tag{5}$$

When firm i sets a price of $(\bar{p}-\varepsilon)$, its period-t profit, denoted $R_i(\bar{p}-\varepsilon)$, is $(\bar{p}-\varepsilon)\times D_i(\bar{p}-\varepsilon)$. If "market price of $\bar{p}$" is an equilibrium, $R_i(.)$ must decline for local decreases of price relative to $\bar{p}$. This is equivalent to the following condition:[10]

$$D_i(\bar{p}) \geq \frac{\bar{p}\times g(\bar{p})\times \mu \times (1+\pi)}{m} \tag{6}$$

Using Equations (4) and (6), a price of $\bar{p}$ can be sustained in equilibrium if and only if the corresponding aggregate demand (refer to Equation (2) for the expression) satisfies the following condition:

[10] I will assume that the second-order condition for profit maximization is satisfied. The second-order condition is satisfied if 1) $g'(v) \leq 0$, or 2) $g(v) \geq ((|g'(v)| \times v)/2)$. Note that if the v-values are uniformly distributed among buyers, then $g'(v)=0$. Hence, in this case both conditions 1 and 2 hold.

$$\frac{\bar{p}\times g(\bar{p})\times\mu}{1-\delta} \geq D(\bar{p}) \geq \bar{p}\times g(\bar{p})\times\mu\times(1+\pi) \qquad (7)$$

I have assumed that $g(.)$ is a continuous function and strictly positive on the interval [0, C]. Furthermore, it is easy to show that $D(0)$ strictly exceeds 0 and $0=D(C)<[C\times g(C)\times\mu\times(1+\pi)]$. Since $D(.)$ is a continuous function, the Intermediate Value Theorem guarantees that the set $S_L \equiv \{p \mid D(p)=[p\times g(p)\times\mu\times(1+\pi)],\ p\in(0,\ C)\}$ is non-empty. Given that $\pi\in[0,\ 1]$ is arbitrary, I shall choose π such that $(1+\pi)$ is strictly less than $(1/(1-\delta))$. As a result, any element of S_L satisfies Equation (7). In sum, I have proved the existence of a steady-state equilibrium price in the open interval (0, C). ■

In this note, the assumptions are few in number and not unreasonable. Yet, somewhat unexpectedly, Proposition 2 points out that the goods market must have multiple equilibrium prices. Notice also that this multiple equilibrium result obtains without placing restrictions on parameter values (*e.g.*, δ is any number in the open interval (0, 1)) or choosing specific functional forms (*e.g.*, $g(.)$ is any positive density function on the interval [0, C]).

Proposition 2

For the goods market, there exist multiple time- and firm-independent equilibrium prices.[11]

Proof: Note that $D(0)$ strictly exceeds 0 whereas $0=D(C)<((C\times g(C)\times\mu)/(1-\delta))$. Therefore, the Intermediate Value Theorem guarantees that the set $S_R \equiv \{p \mid D(p)=((p\times g(p)\times\mu)/(1-\delta)),\ p\in(0,\ C)\}$ is non-empty. Furthermore, for $\pi\in[0,\ 1]$ chosen such that $(1+\pi)$ is strictly less than $(1/(1-\delta))$, it is clear that any element of S_R constitutes a steady-state equilibrium price. Observe, finally, that S_L and S_R are disjoint sets. Hence, I have proved the existence of multiple steady-state equilibrium prices. ■

[11] I have only endeavored to establish the existence of multiple steady-state equilibria. In many cases (*e.g.*, when $f(.)$ and $g(.)$ are densities corresponding to the uniform distribution), there is a continuum of steady-state equilibrium prices. I have not emphasized this aspect since it is tangential to the main thrust of this note.

III. Conclusion

In this note, I have modified slightly the well-known goods market model of Diamond (1971). The modified model yields two new results. First, I establish the existence of an equilibrium in which some buyers, though subjected to a strictly positive entry fee, nonetheless choose to enter the goods market and purchase the commodity. Second, the goods market inevitably generates multiple equilibrium prices.

The model that I have constructed hinges on two critical assumptions that merit further scrutiny. First, I have introduced heterogeneity among prospective buyers with respect to gross valuations, v. Suppose, instead, that all prospective buyers share a common gross valuation, v_c. Standard arguments establish that the unique equilibrium market price in this case is also v_c. Thus, only buyers with negative c-values enter the goods market and purchase the commodity. In other words, without heterogeneity in gross valuations, my model collapses to that of Diamond (1971).

Second, I have maintained that a strictly positive fraction, μ, of prospective buyers have negative entry fees. Suppose, instead, that $\mu=0$. In this case, the goods market simply shuts down. Why? Assume, to the contrary, that the goods market allows some trading in equilibrium and that the equilibrium market price is therefore $\bar{p}<C$. Since all buyers correctly anticipate $\bar{p}$, those entering the goods market have gross valuations, v, weakly exceeding $\bar{p}$. But, when the lowest v-type in the market is fixed at $\bar{p}$, firm i's profit increases should it deviate unilaterally and set a price slightly higher than $\bar{p}$.[12] This, in turn, contradicts the premise that $\bar{p}$ is an equilibrium market price to begin with.

I now focus on a particular equilibrium market price, $\bar{p}$. Exclusively because of the search environment (note the absence of strategic interactions in my model), each firm's demand curve has a kink at $\bar{p}$. Why? Suppose firm i in period t raises its price from $\bar{p}$ to $(\bar{p}+\varepsilon)$. Then it loses generation-t buyers assigned to it with gross

[12] To see that such a deviation is profitable for firm i, refer to Equation (4). Recall that if the inequality in Equation (4) is violated, a small increase in price from the putative equilibrium price of $\bar{p}$ is profitable for firm i. But, given $\mu=0$, the right-hand side of Equation (4) is 0. On the other hand, the left-hand side of Equation (4) is $[(1/m)\int_{\bar{p}}^{C} F(v-\bar{p})dG(v)]>0$. So, the inequality in Equation (4) is violated when μ is set to 0.

valuations v satisfying $\delta\times(v-\bar{p})>(v-\bar{p}-\varepsilon)$. Such buyers respond to the price hike by searching for one more period; the good is purchased in period $(t+1)$ at price $\bar{p}$. Note that firm i's demand loss is increasing in δ. Now, suppose firm i in period t lowers its price from $\bar{p}$ to $(\bar{p}-\varepsilon)$. Given the structure of my model, the lower price does not induce additional search from prospective buyers assigned to other firms. Firm i's increase in demand comes from generation-$(t-1)$ buyers assigned to it in period t with gross valuations v satisfying $v\geq(\bar{p}-\varepsilon)$. Clearly, firm i's demand increase is increasing in π, the time-invariant probability with which generation-$(t-1)$ buyers remain in the period-t goods market. When $(1+\pi)<(1/(1-\delta))$ (refer to Equation (7)), the elasticity of demand with respect to a price increase relative to $\bar{p}$ exceeds the elasticity of demand with respect to a price decrease relative to $\bar{p}$.[13]

The central result of this note is the multiplicity of equilibrium market prices. In other words, the location of the kink in a firm's demand curve is indeterminate. What accounts for this indeterminacy? When prospective buyers conjecture a low market price, even those with low gross valuations enter the goods market. Given the resulting distribution of gross valuations in the goods market, individual firms find it optimal to charge a low price, thereby validating buyers' initial beliefs. By contrast, when prospective buyers predict a high market price, only those possessing high gross valuations enter the goods market. With high-type buyers populating the goods market, individual firms discover that charging a high price maximizes private profits. Hence, firms' pricing behavior matches buyers' forecasts.

The multiplicity of equilibrium market prices has an interesting implication. Following convention, I measure aggregate welfare as the sum of consumer and producer surplus. Given the structure of the model, it is immediate that aggregate welfare increases as the volume of sales rises. Thus, the model's multiple equilibria are ranked in terms of aggregate welfare: aggregate welfare decreases as the equilibrium price is raised.

[13] Stiglitz (1987) also uses a search environment to show that a firm's demand curve may have a kink at the market price. My model, which is undoubtedly less involved, differs from Stiglitz (1987) in several ways-Stiglitz's buyers demand $x(p)$ units of the good at price p; when a firm changes its price from the putative equilibrium, the altered price distribution is *immediately* known to all prospective buyers; and so on.

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