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BASING POINT PRICING: COMPETITION VERSUS COLLUSION*

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We consider the implications of game-theoretic models for the competitive or collusive nature of basing point pricing (BPP). In one-shot games, equilibrium price schedules do not generally conform to BPP with unrestricted price competition. Nevertheless BPP can emerge in dynamic contexts. Define modified FOB price policy as using FOB in one's natural market and matching the rival's delivered price whenever profitable. A configuration where both firms do this is a subgame perfect equilibrium of a two-stage game where firms choose first price policies and then compete in the marketplace. Further, with repeated competition BPP can be used as punishment device.

I. INTRODUCTION

THE OPINION of economists about whether the *basing point pricing* system is a device that fosters collusion or whether it constitutes an adaptation of competitive pricing policies to certain spatial environments has oscillated for quite a long period. Certainly this is not the only issue about which economists disagree. Nonetheless, the endurance of the argument may be surprising given that the issue is very much of a microeconomic nature and seems to be narrowly defined.

In this note, we shall try to clarify what we have learned from *formal* theory, particularly from simple game theoretic models. We believe that the insights gained from this type of exercise, via a disciplining effect, should prove useful to put the debate in perspective and help to guide the necessary empirical research. In this respect, the development of different equilibrium approaches can lead to specific tests allowing the rejection of some of the approaches.[1] Hence antitrust recommendations in this domain would rest on more solid theoretical and empirical underpinnings (see, for example, Phlips [1983, pp. 27 ff] and Scherer and Ross [1990, pp. 501 ff]).

Consider several producers of a homogeneous good and potential customers of this good, all distributed over a given geographical area. Basing point pricing (BPP) implies a delivered price equal to a base price plus the shipping cost to the place of delivery calculated from a *given* base point, which need not necessarily be the place where the seller's plant is set up.

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[1] For a survey of this line of research see Bresnahan [1989].

This system should not be confused with uniform delivered pricing (UDP) in which firms charge all their customers the same delivered price irrespective of their location. Clearly, both policies bear some resemblance in that they involve identical delivered prices across firms supplying any location. However, they fundamentally differ since BPP entails customers at different locations paying different delivered prices whereas UDP implies they pay the same price.

The *key question* we ask in this note is: under what conditions can basing point pricing arise as an equilibrium outcome of a well-specified pricing game? We shall consider this issue in two scenarios: static and dynamic games. In the first, as is well known, there is no scope for noncooperative sustainment of collusive outcomes since there are no possible punishments to defectors of cartel-like agreements.

II. STATIC PRICING

In Thisse and Vives [1988] (TV from now on) it was shown that under general assumptions, with firms having a single plant, unrestricted competition in prices would yield a price discrimination solution which would not in general coincide with a basing point price system or with FOB mill pricing. In this section, we argue that BPP will not emerge as a noncooperative equilibrium in price schedules, except under rather special circumstances: phantom basing points, firms playing dominated strategies, multiple plants being located suboptimally.

To fix ideas, consider a standard Hotelling model where (i) consumers are uniformly distributed over the interval [0, 1] and have inelastic demands, (ii) transport costs are linear in distance with rate t, and (iii) firms are located at the endpoints of the market (firm A at 0, firm B at 1) and produce at no cost a homogeneous good. When prices are equal, we asume that consumers

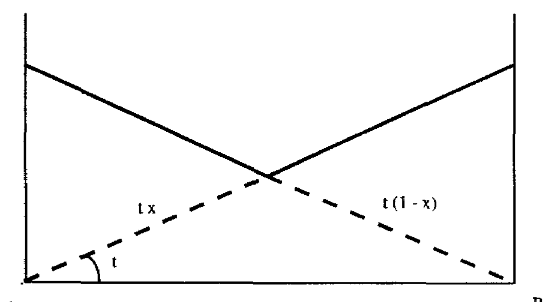

Figure 1
Equilibrium Price Schedules

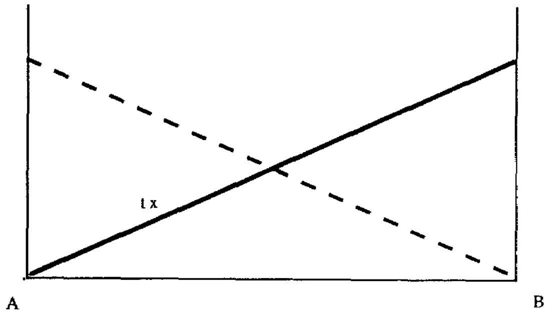

Figure 2
Equilibrium Price Schedules

patronize the nearer producer. This is reasonable since this firm can always undercut its rival at any place closer to its own location, and is in accord with the noncooperative nature of the one-shot games considered in this section. Let us explore different possibilities for BPP to emerge.

In this model, assuming that firms do not use dominated strategies (a dominated strategy involves charging a delivered price lower than the transport cost on a non-negligible set of locations), localized Bertrand competition drives prices down to the more distant firm's transport cost. In other words, the Nash equilibrium in price schedules, represented in Figure 1 by the solid line, is given by $p^i(x) = \max\{tx, t(1-x)\}$, $i = A, B$. Even this equilibrium can be seen in accord with BPP: let the base point be at $x = 1/2$ with base price $t/2$. This is a *phantom base point* since no firms are located in there! As observed by Phlips [1983, p. 27], a base point need not necessarily be the place where a seller's plant is located. For example, this is illustrated by the case of Hamburg for foreign wheat imported by sea to Germany. However, usual BPP systems do not have this feature.[2]

Another way to obtain BPP in our model is to allow firms to use *dominated strategies*. In this context, another Nash equilibrium in price schedules, represented in Figure 2 by the solid line, is given by $\tilde{p}^i(x) = tx$, $i = A, B$ (we still assume that price ties are broken in favour of the closer firm). This is equivalent to establishing a base point at 0 with a base price equal to zero. In equilibrium, firm A makes zero profits while firm B earns positive profits.

The above equilibrium is obtained by allowing firm B to price below its transport cost but above firm A's cost over non-negligible subsets of $[0, 1/2]$.

[2] The above solution could in principle also be interpreted as a multiple basing point system with firm $A(B)$ following BPP with base point at 1(0) and both quoting zero base prices. Nevertheless this arrangement would contradict the "alignment rule" according to which the customer is free to choose the base point from which delivered prices are going to be quoted. For example, a customer located in $[0, 1/2]$ would choose prices quoted from B's base point (0).

More formally, the price policy of firm B is (weakly) dominated by $p(x) = \max\{tx, t(1-x)\}$ since $p(x)$ is never below (total) unit costs $t\ (1-x)$. Such a behaviour, though strategically important, is dangerous for firm B. If there is the slightest chance that firm A would not match firm B's price, the latter would suffer a loss. If firm B considers the chance of its opponent mispricing to be small but positive, then the firm would never price as described. In other words, the above equilibrium would fail to satisfy a stability criterion similar in spirit to Selten's "trembling hand" perfection concept. Notice also that firm B earns the same profit as in the equilibrium $\{p^i(x)\}$ described in Figure 1, while firm A now earns zero profit. Hence, the BPP equilibrium $\{\tilde{p}^i(x)\}$ is Pareto-inferior to the equilibrium $\{p^i(x)\}$ from the point of view of the firms.[3]

Still another possibility, pointed out in TV (p. 131), is to consider that at one site, say 0, both firms have plants while at the other site (1) only one firm has a plant (firm B). In this case, the (unique) equilibrium price schedule is given by $\hat{p}^i(x) = tx$, $i = A, B$, since the two plants located at 0 compete under identical cost conditions at each $x \in [0, 1]$. This corresponds to having a base point at 0 with a base price of zero. However, such a locational configuration would never emerge as a subgame perfect equilibrium in which firms choose first the number of plants (at a given fixed cost per plant) and their locations, and then compete in price schedules. This is so because a firm always has incentives to separate its plants from its competitors plants in order to earn some locational rents.

More generally, the following result holds.

Proposition. Consider the following setting:

(i) a given number of firms produce a homogeneous good in plants operating under a fixed cost and a constant marginal cost;

(ii) the good is delivered according to an increasing transport cost function to a population of customers continuously distributed over a compact subset of the Euclidean space;

(iii) the local demands slope downward, customers facing (delivered) price ties patronize the lowest cost firm, and arbitrage among customers is precluded.[4]

Then, at any subgame perfect equilibrium where firms choose, first, the number of plants and their location and, second, undominated but otherwise unrestricted price schedules, we have:

(a) any two plants are never located coincidentally;

(b) at a given location, the equilibrium delivered price of a firm is

[3] Note that, when dominated strategies are allowed, another equilibrium is given by $p^i(x) = t/2$, $i = A, B$, which corresponds to UDP. Suppose $p^B(x) = t/2$, then firm A by underpricing B over $[0, 1/2]$ would reduce its profit since it would keep the same customers while charging a lower price; by underpricing B over $[1/2, 1]$ it would incur in losses since it would be pricing below the unit total cost. Pricing above $t/2$ implies no sales.

[4] Arbitrage is never profitable if transport costs are concave in distance.

—the (lowest) monopoly price if this price is not higher than the lowest unit delivery cost of the rivals (in which case the firm is said to have a monopoly position),

—the price maximizing the local profit subject to the constraint that it cannot exceed the lowest unit delivery cost of its rivals when the firm does not have a monopoly position but has the lowest unit delivery cost,

—its plant's lowest unit delivery cost, otherwise.

Proof. Using the techniques developed in TV (Proposition 1) it is readily verified that given any locational configuration equilibrium price schedules are as described in (b). At the first stage no firm wants to locate two plants together because to obtain the same revenues fixed costs would be duplicated. Further, different firms will not locate plants at the same place since profits (gross of fixed costs) earned by at least one of these plants would be zero. This is so because in the area served by these plants price competition will drive prices down to the level of the second lowest unit cost. Higher (in a weak sense) cost plants will therefore make zero gross profits and negative (net) profits. The corresponding firms could do better by locating these plants separately and obtaining positive gross profits since price competition is then relaxed. Consequently (a) follows. ■

Hence, under the plausible assumptions of the proposition, equilibrium price schedules will not conform to BPP with unrestricted price competitio^r^ as long as no phantom basing points are allowed.

III. DYNAMIC PRICING

We consider two approaches to the dynamics of price formation. First, we explore the consequences of the commitment of firms to price policies in the context of a simple two-stage game. Second, we deal with repeated price competition in the marketplace.

Suppose first that firms are constrained to choose from a finite set of price policies and that these choices represent a commitment for the firms. This commitment may come about because of costs associated to changing price policies. For instance, the price policy of a firm can be seen as an implicit contract with customers. The firm not abiding by the contract will impair its reputation. This leads us to model market competition as a two-stage game in which firms choose first their price policies and then their prices.

As an example, in our basic model, consider the choice between FOB and a version of "FOB pricing with nonsystematic freight absorption" (which we will call "modified FOB") advocated by Phlips [1983] and Scherer and Ross [1990]. In the words of Phlips [1983, p. 29] FOB pricing with nonsystematic freight absorption is "... a system of uniform mill prices coupled with freight absorption outside the natural market to counter the delivered price that the buyer might have obtained from a closer center of production".

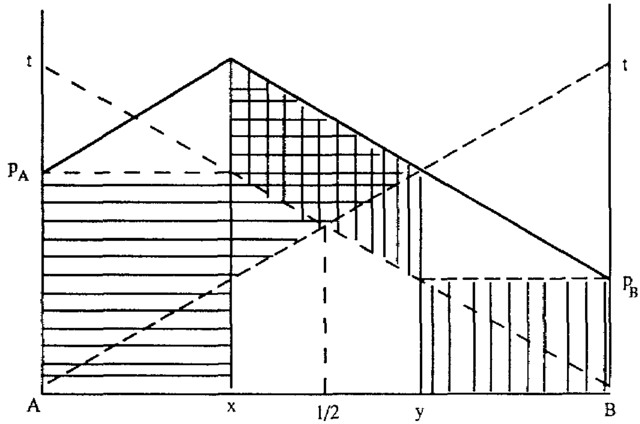

Figure 3
Firm *A*: Modified FOB Pricing. Firm *B*: FOB Pricing

Given a pair of FOB prices we define the natural market of a firm to be the set of locations where the firm has a lower delivered price. The firm follows a *modified FOB price policy* whenever it uses FOB pricing in its natural market and matches the rival's delivered price wherever profitable (this corresponds to the segment $[x, y]$ in Figure 3). Furthermore, in the area where both firms have equal delivered prices, the market is now equally shared (see, for example, Smithies [1942] for a similar assumption in his study of BPP).[5]

In our previous analysis, we assumed that customers were supplied by the least cost firm and we argued that this assumption could be justified in the context of one-shot noncooperative games. The change in the sharing rule is not innocuous: if a firm gives up undercutting over a non-negligible set of locations where it has the advantage in cost, then the corresponding market structure does not correspond to fully noncooperative behaviour in the case of a homogeneous good.[6]

When both firms use a modified FOB price policy the outcome is akin to BPP with two base points, at 0 and 1, and with market interpenetration. The

[5] It is worth mentioning what the results of the previous section become under this new sharing rule. (i) Our proposition would remain true if prices were treated as discrete variables: the lowest delivery cost firm would undercut by the smallest unit of account the second lowest delivery cost at each point where the latter is binding. (ii) Under the same assumption about prices, phantom basing points can also emerge as equilibria. (iii) The main change is with the use of dominated strategies which would no longer yield BPP. For example, in the case depicted in Figure 2, firm *B* would earn negative profits by serving half of the demand at each point of [0, 1/2]. Therefore, firm *B* would not choose the strategy described there so that BPP could not be sustained as an equilibrium outcome.

[6] By contrast, this argument does not apply to a *differentiated oligopoly* where market areas do overlap naturally.

TABLE I
SECOND STAGE PRICE COMPETITION: CASE I

A \ B	Prices: FOB	Prices: Modified FOB	A \ B	Profits: FOB	Profits: Modified FOB
FOB	(t, t)	$(4t/5, 6t/5)$	FOB	$(t/2, t/2)$	$(16t/50, 27t/50)$
Modified FOB	$(6t/5, 4t/5)$	(t, t)	Modified FOB	$(27t/50, 16t/50)$	$(3t/8, 3t/8)$

TABLE II
SECOND STAGE PRICE COMPETITION: CASE II

A \ B	Prices: FOB	Prices: Modified FOB	A \ B	Profits: FOB	Profits: Modified FOB
FOB	(t, t)	$(5t/4, 3t/2)$	FOB	$(t/2, t/2)$	$(25t/64, 107t/128)$
Modified FOB	$(3t/2, 5t/4)$	(t, t)	Modified FOB	$(107t/128, 25t/64)$	$(3t/8, 3t/8)$

existence of substantial market area overlapping is a distinctive feature of BPP (see, for example, Phlips [1983] and Scherer and Ross [1990]). It is indeed in the spirit of this pricing system that demand in the overlapping area is shared among producers. Clearly, this is possible only if price ties are no longer broken in favour of a single firm (e.g. the low cost firm).

Firms' payoffs are defined as follows in the case (modified FOB, FOB). Firm A (B)'s profit is equal to the area of the horizontally (vertically) hatched rectangle plus half the area of horizontally hatched triangle (vertically hatched parallelogram). This is because firm A (B) serves the whole market between 0 and x (y and 1), while the two firms equally share the market between x and y (see Figure 3).

Routine calculations show that the outcome of price competition at the second stage is as given in Tables I and II. There are two possible price equilibria in the mixed case. This is due to the discontinuity of the best reply of the firm using FOB pricing (say firm B) when the rival uses modified FOB (see Figure 4).[7] For high prices of firm A the optimal response of firm B is to set also a high price and share its market (given that A is using modified FOB). For low prices of A the optimal response of B is to set prices low enough so as to prevent an encroachment of its natural market by A. This explains the discontinuity in firm B's best reply and the existence of the two price equilibria. Case I corresponds to aggressive pricing and case II to soft pricing. In fact, the mixed game is a *supermodular game*: the marginal profitability of an increase in the action (price) of a firm is increasing in the action (price)

[7] Figure 4 describes the best replies of firms provided that, for Firm A, $p_B \leqslant 5t$, and, for Firm B, $p_A \leqslant 3t$. Otherwise, and respectively, $R_A(p_B) = p_A - t$, and $R_B(p_A) = p_A - t$.

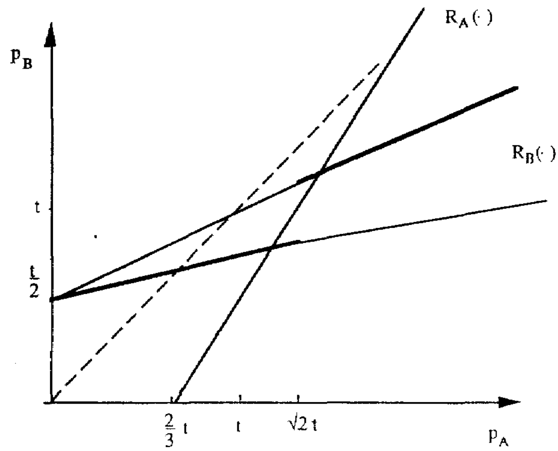

Figure 4

Best Reply of Firm A (Modified FOB): $p_A = R_A(p_B) \equiv \frac{2p_B + 2t}{3}$

Best Reply of Firm B (FOB): $p_B = R_B(p_A) \equiv \begin{cases} \frac{p_A + 2t}{4} & \text{if } p_A \leqslant \sqrt{2t} \\ \frac{p_A + t}{2} & \text{otherwise} \end{cases}$

charged by the rival. This is typical of price games under product differentiation. In a supermodular game the best replies of firms need not be continuous but they must be increasing (any jumps must be up, like in Figure 4, see Vives [1990]). It is not surprising then that there exist multiple equilibria which can be ordered. In the present case and since it is a price game (and the profit of a firm increases with the price of the rival) the ranking of equilibria translates into a Pareto ordering of them in terms of profits (Vives [Theorem 4.2 and Remark 4.5, 1990]).

It is worth noticing that prices are equal when firms choose the same price policy. This may come about since the aggressive dimension of modified FOB pricing, leading to market interpenetration, is mitigated by equal sharing of demand in the overlapping market areas. Modified FOB pricing allows a firm to penetrate the market area of its rival, but when both firms use this price policy the inducement to cut prices is reduced since a lower price will be matched by the rival. Nevertheless profits are smaller with modified FOB (which, as we have argued above, corresponds to BPP) because of cross-hauling. Furthermore, in the mixed case the firm using modified FOB enjoys a higher price and profit than its competitor. This reflects the higher flexibility of modified FOB pricing.

The two-stage game can then be solved in the usual backwards recursive manner. In case I the unique equilibrium in price policies (Table I) entails modified FOB pricing, firms getting trapped in a prisoner's dilemma type situation. Hence BPP can emerge as an equilibrium of the two-stage game (with firms using modified FOB pricing). In case II the price policy game has two asymmetric equilibria in which both firms choose different policies (Table II). However, both equilibria in case II Pareto-dominate the equilibrium arising in case I, which implies that firms settle at the price stage in a Pareto-dominated equilibrium if BPP is to obtain.

Our result qualifies statements in the literature that FOB pricing with nonsystematic freight absorption "... provides the best prospects for promoting competitive behaviour" (Phlips [1983, p. 49]), and "... appears to be the best compromise between the available extremes when market structures are oligopolistic" (Scherer and Ross [1990, p. 506]). Indeed, in our model modified FOB does not affect equilibrium prices and hurts profits of firms only inasmuch it leads to waste of resources through cross-hauling (case I) or raises equilibrium prices (increasing industry profits) and causing also wasteful cross-hauling (case II).

Concerning now the second issue, as it is well known, static models give no scope for collusion. *Repeated interaction* in the marketplace may give rise to collusive prices enforced by the threat of punishment to defectors from the agreement. The basic result is that collusion can be sustained as a (subgame perfect) noncooperative equilibrium of a repeated game whenever firms do not discount the future too much. Indeed punishments to deviants will be effective only if future payoffs matter.

In a dynamic context, what role can BPP play in the sustainment of collusive pricing? We examine in what follows the value of BPP as an incentive scheme to sustain collusion.

First of all, let us comment on the incentive properties of spatial price discrimination, of which BPP is an example, in the sustainment of collusion. A market with spatial price discrimination, like Bertrand competition in a homogeneous product market, is very competitive (see, for example, TV, Section III). The reason is that "delivered pricing makes each consumer a competitive battleground" (Carlton [1983, p. 56]). This property, nevertheless, may prove to have the paradoxical effect of helping to sustain collusion through the use of punishment strategies. Indeed, it is well known that the most collusive equilibria that can be sustained (as subgame perfect equilibria of the repeated price game) depend on the most severe punishment strategies (see Abreu [1988]). For example, in a price game with homogeneous product, constant and equal marginal costs, and no capacity limits the one-shot Bertrand equilibrium (price equal marginal cost) provides the most severe credible punishment and, therefore, its threat sustains maximal collusion.

On the other hand, spatial price discrimination policies have the potential of extracting the maximum surplus from consumers and, therefore, increase the profits to be made by collusion. However, they also increase the gains to be obtained from defecting from a cartel agreement (since a price discrimination policy allows the defector to just undercut the colluding firms at any point in space where it turns out to be profitable).

Concerning more specifically BPP, there was evidence in the cement industry of the use of discriminatory pricing policies to punish defectors: a cheating firm was punished by making its location a base point with a low base price (Machlup [1949]). Espinosa [1989a] shows how this strategy with a base price equal to zero (that is, marginal cost) yields the worst possible credible punishment to a defector in the simple model[8] we have considered in section II, provided firms are committed to supply customers at the announced delivered prices, even if this implies making losses on some market segments. Recall that in section II we have already considered this strategy and argued it would yield zero profits to the firm located at the base point. We also have pointed out there that the strategy is a dominated one. In summary, BPP is an effective punishment strategy in the sustainment of the most collusive equilibria of the game if firms can credibly commit to delivery even when it is unprofitable at the quoted prices. Notice, however, that this does not imply that BPP itself can be sustained as a cooperative outcome.

Up to now, we have supposed implicitly that all relevant variables were observable. If they are not, or if there is uncertainty then the question arises of what pricing system makes cheating easier to detect (Stigler [1949]). If prices are observable under any pricing system then delivered systems like BPP have no advantage over FOB pricing. If prices are unobservable but quantities are, then Carlton [1983] argues that FOB is superior to detect deviants. The reason is that under delivered price systems (BPP or UDP, for example), customers at any location face identical prices from different firms, and hence shifts in demand from one firm to another do not necessarily result from secret price cutting but may come about from extraneous considerations in consumer choice. In this way price cuts may be disguised as random changes in the patronizing habits of customers, thereby making price concessions difficult to detect. On the other hand FOB pricing introduces this type of indeterminacy at market boundaries only with the consequence that any significant price cut is very apparent.

IV. CONCLUDING REMARKS

What have we learned from our brief overview of the results obtained in the literature?

1. BPP can emerge as an equilibrium outcome of a noncooperative static pricing game but this tends to happen, at the present stage of research, under special and somewhat contrived circumstances.

2. When firms can commit to price policies, choosing from a restricted set,

[8] With the addition of a finite reservation price for consumers.

preliminary research indicates that equilibria resembling BPP can arise and that market interpenetration does not necessarily lead to lower prices.

3. BPP can be used as an effective punishment in a dynamic context under the proviso that firms can commit to supply customers for whom total cost exceeds price. Further, in a context with uncertainty and/or unobservable actions it is not clear that delivered price systems like BPP are good devices to foster collusion.

Several issues remain unexplained:

—BPP is usually associated with the existence of production nodes (where several firms operate) but this fact is hard to explain in the presence of price competition and homogeneous products. Product differentiation and/or the possibility of price collusion need to be investigated to account for the agglomeration of firms at such nodes.[9]

—Customers are able sometimes to carry the goods themselves by using their own transport means under FOB pricing. When producers and customers have access to different transportation technologies the relative advantages of different price policies may be affected.[10]

—The presence of uncertainty, like random shocks in demand or in transport costs, and the possibility of asymmetric information impinges upon the relative effectiveness of different policies in ways still not well understood.

—Finally, in any given situation, considerations of complexity and bounded rationality should limit the set of price policies effectively contemplated by firms. The development of formal models explaining the selection mechanisms of producers would be a welcome addition to the field.

Returning to our original question about the nature of BPP we can safely conclude by asserting that fresh research is needed, either to keep alive or to dampen and make converge the oscillations in the economists' view of this price policy.

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[9] Some work along these lines is advanced in Espinosa [1989b] and Friedman and Thisse [1991].

[10] See Gronberg and Meyer [1981] for an analysis of the spatial monopoly.

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