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The Theory of Market Pre-emption: The Persistence of Excess Capacity and Monopoly in Growing Spatial Markets

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There is a substantial literature on the use of excess capacity as a means of preventing entry into monopolistic or oligopolistic markets. Some of the interest in this issue stems from the famous anti-trust judgment against the Aluminum Company of America (Alcoa) written by Judge Learned Hand:

> It was not inevitable that it [Alcoa] should always anticipate increases in demand for ingot and be prepared to supply them. Nothing compelled it to keep doubling and redoubling its capacity before others entered the field. It insists that it never excluded competitors, but we can think of no more effective exclusion than progressively to embrace each new opportunity as it opened, and to face each new comer with new capacity already geared into a giant organization . . . .[1]

Much of the subsequent debate among economists on the issue of excess capacity as a possible barrier to entry was in a static framework, and virtually all of it has been in the standard spaceless context.[2]

In the present paper we consider a spatial market in which demand is increasing. We demonstrate that, if the growth of the market is foreseen, it will *always* pay existing firms to pre-empt the market by establishing new plants before the time when it would first pay new firms to enter. In such markets, monopolies or oligopolies will persist; plants will be built well before their outputs are required and even when current receipts and costs yield losses. Such markets will exhibit the excess capacity that many investigators have thought they discerned;[3] and this excess capacity will occur as a result of the early building of new capacity to which Judge Hand referred.

We also show that, if the existing monopoly firm will not pre-empt—or is prevented from pre-empting—the market by building capacity before it is needed, competition among potential new entrants will lead to the establishment of the unneeded capacity at virtually the same time that it would have been established by the profit-maximizing monopolist.

I. A MODEL OF MARKET PRE-EMPTION

We begin by specifying assumptions with respect to the nature of the market, the cost conditions of firms and the behaviour of firms and customers. Next we construct a set of *initial* conditions which guarantee that an *existing* firm with one plant is in a position of natural monopoly. We then allow the number of customers to increase at some future date, and demonstrate two propositions:

(a) if the existing monopolist does not establish new capacity to meet the increased demand, competition among potential new entrants will lead to the establishment of new capacity some time *before* the date at which demand increases; and

(b) the existing monopolist will always find it profitable to pre-empt the market by establishing new capacity at a time just earlier than the earliest date at which any potential new entrant would find it profitable to do so.

The first proposition, which we call *pre-emption by new entrants*, ensures that there will be temporal excess capacity in this market—capacity that is installed before it is needed. The second proposition, which we call *monopoly pre-emption*, ensures that, unless the monopoly firm either misjudges the situation or is in some way restrained, it will always maintain its monopoly even though the market grows large enough to sustain many plants. In this section we confine ourselves to cases in which there are only a few firms in the market. In Section II we investigate behaviour when the number of firms in the market is large.

(a) *Assumptions*

We consider a one-dimensional market, two units in length, with a uniform density of customers, D. Each customer has the same downward-sloping demand curve, $q = f(w)$, where w is delivered price, the firm's mill price plus transport costs. Transport costs per unit of product, $t(Z)$, are an increasing function of distance, Z, from firm to customer. Each customer buys from the plant with the lowest delivered price.

All firms have the same cost curves. Their production exhibits increasing returns to scale over a limited range of output at the plant level owing to capital indivisibilities; and, hence, average total costs of production (ATC) decline over some initial range of output. Once the firm's capital is installed it has no opportunity cost and is immobile. (All that we require is that firms have some sunk costs but it is convenient to assume that all capital costs are sunk.)

Firms maximize profits and we assume that *firms are capable of accurately calculating the flows of costs and revenues that will be associated with any plant*; that is, we adopt the assumption of perfect foresight with respect to the flow of profits. (In Section (e) below we examine in some detail the role that this assumption plays in our model.)

We assume that no firm entertains the strategy of *mill-price undercutting*. That is, no firm will charge a mill price low enough so that its delivered price at a competitor's mill door is lower than the competitor's mill price. Elsewhere we have outlined in detail our reasons for adopting this assumption.[4]

(b) *Initial conditions*

Initially let firm A serve the entire market with a plant located in the centre of the market at a_1 in Figure 1. The aggregated demand curve faced by the plant will be

$$Q = 2D \int_0^1 f\{p_A + t(Z)\}\, dZ$$

where p_A is A's mill price. Since the market is symmetrical about the plant and the density of customers is D, we integrate from 0 to 1 and multiply by $2D$. There will be some density, $D = D_0$, such that the aggregated demand curve is just tangent to the ATC curve in the declining portion of that curve.

Now consider the situation that would face a plant owned by another firm, B, and located at an arbitrary point b_1 in the market segment from -1 to a_1 in Figure 1. The *no-mill-price-undercutting* assumption implies that B's market would be

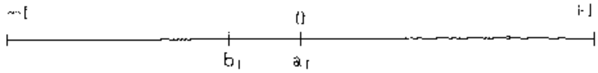

FIGURE 1

confined to some part of the interval from -1 to a_1. Thus the number of customers in B's market would be less than half the number of customers that would be in A's market in the absence of B's plant at b_1. From this it follows that the density of customers, D_2, that would allow the plant at b_1 just to cover its costs must be greater than D_0, the density that allows the single plant serving the whole market from its location at a_1 to cover its costs.

We adopt as an *initial condition* a density of customers, D_1, such that $D_0 < D_1 < D_2$, and we let firm A serve the market with a plant located at a_1. Firm A is thus earning pure profits, but given the initial density of customers, D_1, entry of other firms will not occur. We have thus specified our initial conditions so that firm A is in a position of profitable natural monopoly.

(c) *Market pre-emption*

We now consider entry when the market grows. We use comparative static analysis of a market that undergoes a single, once-for-all increase in density. It would of course be possible to consider a market that was growing continuously. While this would make it necessary to use more complicated analytical techniques than the ones we do employ, it seems to us that it would add very little to the results in which we are interested.

We assume that at some time in the future, T_2, density will increase discretely to $D_3 > D_2$. This increase in density is foreseen and, since $D_3 > D_2$, the increase is sufficient to ensure that a new firm (or firms), if given the opportunity at time T_2, would enter each of the intervals $(-1:0)$ and $(0:1)$ in Figure 1. For simplicity, we further assume that D_3 is not large enough to permit *two* new plants to be profitably operated in each of these intervals.

We ask, first: when will the two new plants be established *if firm A does nothing to pre-empt the market?* By hypothesis the new density, D_3, which occurs at T_2 is great enough so that one new plant in each interval could earn revenues in excess of costs after T_2, but neither plant could cover costs prior to T_2. Since the increase in density is foreseen, competition among potential new entrants will ensure that the opportunity to establish these plants at T_2 will not present itself. There exists some time $T_1 < T_2$ such that the present value of each of the two new plants will be zero. If at time T_1 the two new plants were established at their individual, profit-maximizing locations (say b_1 and b_2 in Figure 2), each plant would earn only a normal rate of return because the present value of profits earned after T_2 would be just offset by the losses incurred from T_1 to T_2. The existence of many would-be entrants will push the actual date of entry back in time to T_1.

This establishes the proposition concerning pre-emption by new entrants: if firm A does nothing to block entry, then some new entrant will pre-empt the

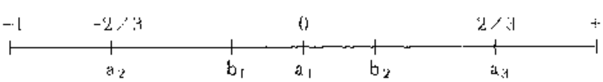

FIGURE 2

market by establishing plants at time T_1 in anticipation of the growth in density at T_2. Intertemporal excess capacity then arises in the sense that new capital is established in the market before the increase in density that justifies its existence.

The interval of time, $T_2 - T_1$, over which excess capacity exists is a function of the flow of profits that a new entrant into each half of the market could earn after T_2. This depends on customer density, which determines demand, and on costs. If ATC is declining or constant over the relevant range, then profits, and hence the size of $T_2 - T_1$, approach an upper limit as D_3 approaches D_4, where D_4 is the customer density that would allow two new plants in each of the intervals $(-1:0)$ and $(0:1)$ to cover costs.

It is useful for future arguments to define two terms:

(i) R_1 is the discounted present value at T_1 of A's plant at a_1 when new entrants establish two new plants at b_1 and b_2 at T_1.

(ii) R_2 is the discounted present value at T_1 of all three plants when A owns the plant at a_1 and new entrants establish two new plants at b_1 and b_2 at T_1.

We have of course chosen T_1 such that $R_2 = R_1$.

We ask, second: what will happen if firm A considers pre-empting the market for itself? It could, of course, effectively prevent the entry of any new firm by establishing a plant of its own in each of the intervals $(-1:0)$ and $(0:1)$ prior to time T_1. If A did this, there would be no entry of new firms at T_1. Is it in firm A's own interest to block entry in this manner, assuming that A foresees the potential for entry at T_1? Consider the consequences if A were to replicate the configuration of locations and prices that would be brought about by other firms entering the market. Just before T_1 let A establish plants at b_1 and b_2 and let A charge the prices that would emerge if new entrants owned the plants at b_1 and b_2. If there were no possibility of entry, the sales and profits that A's new plants at b_1 and b_2 take away from the old plant at a_1 could not be regarded as net additions to firm A's sales and profits. But if A does not pre-empt, new firms will enter at T_1, and firm A's stream of profits and sales from its plant at a_1 will fall abruptly at T_1. *Thus all of the sales and profits of A's new plants at* b_1 *and* b_2 *represent net additions to the stream of sales and profits that A could expect if it did not build these plants.* Since the plants add the same amount to A's profits as they would to those of a new entrant, the plants have the same value to A as to new entrants.

But A will not replicate the configuration of locations and prices that would be brought about by other firms entering the market. In the first place A will choose different locations for the new plants than would new entrants. Firm A will locate the new plants at $-2/3$ and $2/3$, points a_2 and a_3 in Figure 2, so that each plant will serve one-third of the market. This puts the three plants in their joint profit-maximizing locations. New entrants would not, however, adopt these locations; rather, they would locate plants nearer to a_1. The force that leads new entrants to locate nearer to a_1 than $-2/3$ and $2/3$ is the one analysed by Hotelling (1929) and Smithies (1941): the new entrants have no competitors to worry about on their outside flanks and they can gain customers by crowding in towards their competitor at a_1. In addition, firm A can charge the joint profit-maximizing price when it owns all three plants. Normally when there is more than one firm in the market we would expect price competition to result in prices for each plant that differed from the joint profit-maximizing prices.

We now need one further definition:

(iii) R_3 is the discounted present value at T_1 of the three plants when firm A chooses the joint profit-maximizing locations and prices.

Monopolistic pre-emption is now easily proven. The value to A of establishing two new plants in the market at T_1 is $R^A = R_3 - R_1$. The value to new entrants of the two plants (located at b_1 and b_2) is $R^B = R_2 - R_1 = 0$. Since $R_3 > R_2$ (for the two reasons stated above) it follows that $R^A > 0$. It will thus pay firm A to establish new plants just prior to T_1. This proves the monopoly pre-emption result. The value to A of monopoly pre-emption depends on the difference between the profitability of the market when three plants are owned by A and two of the plants are owned by new entrants.

(d) *Extensions of the argument*

The argument of the previous section is easily extended to interior segments of the linear market. Suppose that at T_0 firm A owns two adjacent plants and that at some time in the future, T_2, density will increase sufficiently to allow a new entrant to earn revenues in excess of costs in the market segment bounded by A's plants. There will exist a time $T_1 < T_2$ such that a new entrant would expect only a normal return on its investment and, if A does nothing, some new entrant will pre-empt the market at T_1. Monopoly pre-emption will, however, occur since the new plant will be worth more to A than to the new entrant. In this case A's advantage stems only from joint profit-maximizing prices. A enjoys no locational advantage since both A and a new entrant would locate their new plants at the midpoint of the interval between existing plants. The absence of a locational advantage for A is, however, an artefact of the one-dimensional market. In a two-dimensional spatial market an independent firm entering a hexagonal or a rectangular lattice of firms would not choose the joint profit-maximizing location (see Eaton and Lipsey, 1976b). If one firm owned all adjacent plants in the lattice it would, of course, choose the joint profit-maximizing location. Thus in two-dimensional space A again has both a locational and a price advantage over new competitors in interior market segments.

The analysis is also easily extended to a market that grows in length, holding the density of customers constant. Beginning with the initial conditions in Section (b) let the length of market increase at time T_2 sufficiently to allow a new entrant to earn revenues in excess of costs. If A does nothing, some new entrant will pre-empt the market at some time $T_1 < T_2$, but since A will choose the joint profit-maximizing prices and locations while new entrants will not do so (for reasons similar to those in Section (c)), A itself will establish the new plants just before T_1.

(e) *The role of expectations*

Expectations play a critical role in a model such as ours and there is, of course, some expectations assumption that will yield virtually any conceivable result. We wish to confine our expectations assumptions to the class that may be called *consistent expectations*: those expectations that are consistent with realizations. It seems to us that this is a desirable property to require of expectations in our model since it avoids outcomes that are caused by a mistaken view of market conditions and market processes.

In our model we have employed the strongest form of consistent expectations, *perfect* foresight. Our two basic results on competitive and monopoly pre-emption will hold, however, with weaker forms of consistent expectations. We consider below two cases of imperfect foresight.

First, firms may be uncertain of the outcome of the competitive process and hence of the equilibrium prices that will emerge should new firms enter the market. If the entrant's equilibrium price is a random variable with a distribution that is known to all firms, and if all firms are risk-neutral, then our argument goes through as before. We merely replace the perfectly foreseen values of revenues and profits with expected values. The gap between T_1 and T_2 will be unchanged whenever the expected value of the profits is identical to the perfectly foreseen value. When the existing monopoly firm A values the market at T_1 on the assumption that A pre-empts it, A has no uncertainty since A can set any prices it wishes. Hence A's valuation is unaffected by the uncertainty over the outcome of the competitive process. Thus neither the time at which pre-emption by new entrants would occur nor the incentive for monopoly pre-emption is affected by this uncertainty.

Second, assume that T_2, the time at which demand will increase, is a random variable with a known distribution. New entrants again perform the appropriate expected-value calculations, and again there will exist a $T_1 < \bar{T}_2$ such that the present value of expected profits is zero, where $\bar{T}_2$ is the mathematical expectation of the time of market growth.

The monopolist's problem is, however, slightly more complex than when T_2 was certain. As long as the realization of T_2 is later than T_1 then his pre-emptive strategy of building new capacity just before T_1 works as before. But if there is an "unlucky" realization that yields $T_2 < T_1$, then at T_2 there will be a scramble to establish capacity to meet the *existing* extra demand. The monopolist may then lose its monopoly position. To reduce the probability of this happening the monopolist may pre-empt the market by building new capacity discretely before T_1. This strategy will not, of course, eliminate the possibility that the market will actually grow before the monopolist pre-empts, and our pre-emption results must be cast in probabilistic terms when there exists uncertainty with respect to growth in the market.

The above examples show that, although perfect foresight is sufficient, it is not necessary for our results. All that we require is consistent expectations: that firms correctly apprehend the nature of any uncertainties that they face.

II. Comparisons with Spaceless Models

The pre-emption arguments developed above obviously apply, with modification, to spaceless natural monopoly, the situation in which the minimum efficient scale of production is large relative to market demand. When there is an anticipated increase in demand at some future time, (a) competition among potential entrants will ensure that if the monopolist does nothing entry will occur before the increase in demand occurs, while (b) if the monopoly firm anticipates entry, it will be led to pre-empt the market by establishing the new capacity at a time just earlier than the earliest time at which it would be profitable for a new entrant to do so. In the spaceless case the monopolist's incentive to pre-empt the market arises only from the ability to avoid price competition. One important difference between the two models then is that in a spatial model the monopolist has an added incentive to pre-empt the market since he can increase the total profit that can be extracted from the market; he does this by choosing joint profit-maximizing locations as well as prices.

The really important differences between the two models emerge when initially the number of customers is large enough so that there are many plants in the market. In spaceless models the potential for profits owing to a range of increasing returns to scale is quickly dissipated as the number of plants serving the market increases. That is, the problem of natural monopoly in spaceless models arises only where the ratio of minimum efficient scale to market demand is large. In spatial models the problem of natural monopoly is undiminished when the market is served by a large number of plants. Since the potential for profit remains in spatial models and vanishes in spaceless models as the market grows, the incentive for new entrants or existing firms to pre-empt the market via premature entry remains in spatial models and vanishes in spaceless models. It is after all the possibility of earning profits after an anticipated market growth occurs that leads firms to create capacity before the growth occurs. These arguments are elaborated below.

The propositions we wish to argue are the following. The interval $T_2 - T_1$ falls rapidly to zero as the number of plants initially serving the market is increased in the spaceless model, but does not fall at all as the number of plants initially serving the market is increased in a spatial model.

We first turn to the spaceless model and, for concreteness, consider a limit pricing strategy. Let the market demand arise from the aggregation of demands of identical individuals. As the number of individuals over which we aggregate increases, the absolute value of the slope of the market demand curve at any price decreases towards zero. As this occurs the limit price converges to the minimum cost of production, and the pure rate of return on capital goes to zero.

Now let the number of customers be large enough so that the divergence of the market price, the limit price, from the minimum cost of production is arbitrarily small. Take this as an initial condition and assume that, at some future point in time, T_2, the number of customers will grow enough so that one new entrant could earn pure profits while two would earn losses. The pure profits earned by a single new entrant will be arbitrarily small since the divergence of current price from costs of production is arbitrarily small. Since the profits anticipated subsequent to T_2 are arbitrarily small, the time T_1 comes arbitrarily close to T_2. It follows then that, as the number of customers in the spaceless model increases, T_1 goes to T_2 and excess capacity owing to pre-emption by new entrants disappears. It also follows that the monopolist's incentive to pre-empt vanishes as the market grows. The key to this asymptotic result is that the potential in static equilibrium for pure profit, which is due to barriers to entry arising solely from decreasing unit costs over an initial range of output, vanishes as the market grows through an increase in the number of customers.[5]

Now consider a spatial model. As we have shown elsewhere (Eaton and Lipsey, 1978), the potential for pure profit in free-entry equilibrium in a spatial market does not diminish as the number of customers, and hence the number of plants, is increased. We give here a very brief summary of this argument.

Consider a segment of a linear spatial market with a large number of plants spread out over the market equidistant from each other. If a firm enters a slot between any two existing plants, it will serve, at any common price, half the number of customers as are served by existing plants before its entry. If we assume for simplicity that profits are proportional to customers served, then each existing plant would need to be earning a rate of return on capital of at least $2i$ before a new firm would enter and expect a return of i (where i is the minimum rate of return on capital that will induce entry). Given a uniform increase in density over the whole market, if entry is profitable in one interval between two existing plants, it will be profitable in every interval. Thus plants per unit of space will tend to double on each successive 'round of entry' as density increases. After each round of entry, however, the disadvantage of any new entrant compared with existing firms remains the same: expected customers of the former are only half those of the latter before entry. Thus the rate of profits that can be earned by existing plants without inducing entry does not diminish as density increases.[6]

Now adopt a high initial customer density with a monopolist owning plants spread evenly throughout the market and all charging the joint profit-maximizing price, and let the monopolist have enough plants so that entry is unprofitable. Then let an increase in density at some future time, T_2, be foreseen, the increase being the maximum that would support one but not two new plants in each segment between two existing plants. Since the rate of profit that will be foreseen on a new unit of capacity at T_2 does not diminish as initial customer density is increased, it follows that $T_2 - T_1$, the interval over which competitive pre-emption would create excess capacity, will also not diminish as initial density is increased. It further follows that the incentive for an existing monopolist to pre-empt the market does not diminish as customer density is increased.

III. Summary and Conclusion

The underlying cause of the results in this paper is that large positive pure profits can persist in free-entry equilibrium in spatial models. This result, stated in Eaton and Lipsey (1978), arises because any potential new entrant can expect a demand of the order of only half that enjoyed by existing firms before entry. Thus if an anticipated future increase in demand makes it profitable to install new plants, those plants may earn (depending on the initial density of customers and plants and the amount of the increase in demand) up to twice the competitive rate of return. Competition among potential entrants for the opportunity to earn the pure profits occasioned by the increase in demand will push new entry backwards in time until the present value of the flow of all future profits is zero. In such markets the capacity will be installed well before it is needed. Because the monopolist can extract more profits from the market by locating in a joint profit-maximizing location and charging joint profit-maximizing prices, it will always pay the monopolist to pre-empt the market by installing new capacity just earlier than the earliest point in time that it would be profitable for a new entrant to do so.[7]

We have analysed only the case in which an existing monopolist pre-empts the market by building new plants and operating them at a price less than ATC until market demand increases. Other forms of spatial pre-emption are obviously possible. The firm might build the plant and leave it idle (this would make sense if marginal costs were greater than the current profit-maximizing price). The firm could announce its plans to build in the market and then find its plans subject to a series of "unexpected" delays. Provided that new entrants believed that the existing firm's plans were serious, new entry might be deterred at low cost. If only a few sites were available (a situation not allowed for in our present model) the monopolist could buy them up and put them to other uses and then use one for its new plant when the market did expand.

What public policies could prevent the excess capacity from emerging? The case is similar to a common property problem: premature entry occurs because there exists no property right to establish new capacity in the market, so that the only effective means for establishing such a right is premature entry. The State could, of course, establish property rights by auctioning off the rights to establish new capacity in various segments of a growing market. This would prevent premature entry and would allow the State to appropriate the pure profits available in the market. In order to prevent the monopolist from buying the right and then simply not exercising it, the right, if not acted upon by some specified date, would revert to the State.

Finally, we might wonder if we have proven too much. We have shown that it will always pay an existing firm to blockade entry by locating new plants in an expanding market at a time before it will pay a new firm to enter. We know, however, that new firms do sometimes enter expanding markets. How is this? Our proof employed the assumption of perfect foresight. There are many ways in which imperfect foresight can cause entry of new firms. If either the market grows unexpectedly, or the change comes to be expected only at a time at which new entry is already profitable, the market is "up for grabs" and a scramble may ensue between new entrants and existing firms. It is also possible that either existing or new firms may make mistakes. On the one hand, if the market is very large, local knowledge of one part of it may give a potential new entrant foresight that is superior to that of the distant head office(s) of the existing multi-plant firm(s). On the other hand, new firms may enter the market on false expectations. Once built, the plants will be operated by someone as long as variable costs can be covered. This leads to the general conclusion that, the more stable and easily predictable is market growth, the more will the expanding market be served by new branches of existing firms, while the more erratic and unpredictable is market growth, the greater the possibility of new firms entering to serve part of the expanding market.

Our model is not designed to explain what number of multi-plant firms inhabit a market. Should the market come to be served by more than one firm for whatever reasons, including those sketched above, these firms will, individually and jointly, have the incentive and the ability to block further entry into the market by building new branch plants at a time when it will not pay new entrants to do so.

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NOTES

[1] U.S. *vs.* Aluminum Company of America *et al.*, 44F. Supp. 97(1941) 148F, 2d 416(1945), p. 431.

[2] See, e.g., Pashigian (1968), Needham (1971), and Wenders (1971).

[3] See, e.g., Esposito and Esposito (1974).

[4] The argument is detailed in Eaton and Lipsey (1978). It focuses on the fact that existing firms have sunk costs while all costs of potential new entrants are avoidable. Thus the lowest price that

will allow an existing firm to cover avoidable costs is lower than the lowest price that will allow a potential new entrant to cover avoidable costs. It then follows that a new entrant would be forced to charge a price lower than its avoidable cost if it wished to undercut the existing firm's mill price. This is clearly not profitable since all the new entrant's costs are avoidable.

[5] Another way of seeing this result is to note that, as the demand curve gets flatter, the fall in price needed to sell the output of one more indivisible unit of capital operated at its least-cost output gets smaller and smaller. Thus the excess of price over costs that can occur when N plants sell their optimal outputs without allowing an $N + 1$th plant to cover its costs diminishes to zero. Hence the rate of pure profit that can be earned by existing units of capacity in free-entry equilibrium also diminishes to zero in a spaceless model.

[6] The intuitive argument in the text is based on the simplifying assumption that the firm's revenues are proportional to the number of customers. Actually in this model a new entrant will expect to have the same number of customers but more than half the revenues as are enjoyed by an existing firm before entry given any common price. Although the new entrant has only half the customers, it is closer to them and thus will have a lower delivered price over its market than would the original firm for any common mill price. Thus for every common price the ratio of *sales of a new plant to sales of an existing plant before entry* is more than half. Interestingly enough, however, as density of customers and hence density of plants is increased this price effect diminishes, since the distance to a firm's market boundary diminishes. Thus the difference between a firm's mill price and the delivered price at its market boundary diminishes as well. For this reason, as density increases, the ratio defined above *diminishes* towards one-half. This means that the profits that can be earned by existing plants without inducing entry *increases*. Thus in a spatial model the maximum possible duration of the interval $T_2 - T_1$ *increases* as density increases—the opposite result to the one in a spaceless economy (see Eaton and Lipsey, 1978, expecially Section VI).

[7] See Schmalensee (1977) for an interesting case to which the analysis of our paper seems to apply.

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