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Credible Entry Threats into Contestable Markets: A Symmetric Multi-Market Model of Contestability

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The theory of contestable markets emphasizes potential competition; yet it is reticent on the identity of potential entrants. Recent literature discusses the (im)possibility of hit-and-run entry for several types of entrants. Cairns and Mahabir (1988) argue that existing firms in related markets are most likely to be capable of hit-and-run entry, but unlikely to be motivated. This paper expands their arguments by sketching a multi-market framework and by discussing a model that captures most of the current debate. The model marks a first step into revising contestability theory along the lines of this debate.

INTRODUCTION

Potential competition is an elusive concept in contestable markets theory. It drives decision-making by incumbent firms. Yet if a 'feasible' and 'sustainable' market outcome exists, incumbent firms will successfully deter entry, and the entry threat will not materialize. This may explain the almost complete absence of potential entrants in Baumol *et al.* (1982). Shepherd (1984) and Cairns and Mahabir (1988) question the existence of the hit-and-run entry threat: do potential entrants exist who are alert to enter almost instantaneously, and if so do they have sufficient capacity to fully replace the incumbent firm? Moreover, if such firms exist, are they motivated to hit-and-run? By raising such questions, these authors shift emphasis from the incumbent firm (he) to the potential entrant (she). They argue that existing firms in related markets approach the hit-and-run ideal more closely than either new firm entrants or unrelated existing firms such as conglomerates. Since a related firm has already invested in capacity, she needs less time and (sunk) entry costs than a completely new firm or unrelated conglomerate. The salience of the entry threat may depend upon the source of entry (Hines 1957, pp. 132–3; Brunner 1961, p. 250; Scherer 1980, pp. 248–50). These ideas gain cogency in the context of the emerging multi-market framework, which explores (potential) entry by existing firms located in related markets (Brander and Krugman 1983; Bulow *et al.* 1985; Calem 1988). We will argue that multi-market competition is an attractive framework for discussing potential entry into a contestable market. The multi-market framework is of interest in its own right, as case studies indicate the need for theory on potential competition when both incumbent firm and potential entrant have a home market to defend (Watson 1982; Karnani and Wernerfelt 1985; van Witteloostuijn and van Wegberg 1991).

This paper represents a first step in developing a multi-market restatement of contestability theory along the lines of Cairns and Mahabir (1988) and Calem (1988). It introduces a conceptual and formal middle ground that recognizes the comments by Shepherd (1984) and Cairns and Mahabir (1988), while keeping as close as possible to the contestable markets theory. The model establishes the Bertrand analogue to Calem's (1988) two-market Cournot model

for the symmetric duopoly case. It will appear that the capacity constraints are crucial for determining the outcomes of the game. Particularly, perfect contestability results occur only if *both* firms face sufficient excess capacity: both firms should be able simultaneously to serve total demand in both markets. Moreover, neither firm will choose an entry-deterring strategy if entry cost is sufficiently small and capacity restrictions are binding (over both markets). A model offers a rationale for an unsustainable pricing strategy. On the one hand, entry diminishes home market profits of the incumbent firm. On the other hand, entry imposes excess capacity upon the incumbent firm and diminishes the entrant's capacity to meet demand in her home market. The latter two effects may create a profitable reciprocal entry opportunity into the entrant's home market. The net effect may be that allowing entry raises profits.

The argument is organized as follows. Section I reviews the discussion on potential entrants and contestability. Section II discusses the conceptual framework of multi-market competition. Section III introduces a model that captures essential elements of the current debate on contestability. Section IV offers an appraisal. Section V summarizes the argument and evaluates conclusions.

I. Credible Entry Threats and Contestability

Contestable markets theory is based upon a condition of free entry and costless exit (Baumol *et al.* 1982, p. 349). That is, entry requires no product-specific costs. Moreover, entry lags are short. Any positive profit of incumbent firms attracts full-scale hit-and-run entry before the incumbent can reply. As a consequence, price-cutting entrants snatch away even temporary profit opportunities. Shepherd (1984) and Cairns and Mahabir (1988) enquire into the source of a credible hit-and-run entry threat. If potential entrants are new firms, they need time and sunk entry costs to build up capacity. Presumably, then, potential hit-and-run entrants are existing firms transferring goods to, rather than investing in, the entry market (Shepherd 1984, p. 584). For example, import competition constitutes a major threat against market shares of dominant firms (Scherer 1980, pp. 241 and 249–50).

Cairns and Mahabir (1988) question the entry motive of an existing firm. Suppose she really devotes resources to hit-and-run entry. By shipping goods to an entry market, she withdraws these goods from her home market if she faces binding capacity constraints. This induces excess demand in her home market, which in turn invites further entry by entrants from other markets, provided any entry barriers are surmountable. These entrants capture consumers deserted by the initial entrant. When she returns from her hit-and-run activity, the entrant may discover she no longer has a home market (Cairns and Mahabir 1988, p. 271). Thus, entry has an opportunity cost, consisting of home-market profits forgone, the size of which depends on the entrant's capacity constraint. An anticipative firm with a binding capacity constraint will not give in to temporary entry opportunities.

This argument points to excess capacity as a source of credible entry threats. If firms have excess capacity, they can hit-and-run while continuing to serve their home market. Costly excess capacities are not sustainable in a contestable market, however (Cairns and Mahabir 1988, p. 271). If excess capacity involves

a cost, a lower-cost firm with capacity just right will prey upon a high-cost firm with excess capacity. In similar vein as Penrose (1959), Cairns and Mahabir (1988, p. 273) point to sustainable sources of overcapacity. For example, excess capacity may be due to indivisible equipment, in which case it does not impose avoidable costs on the firm. This suggests that the existence of incumbent firms with sustainable excess capacity in nearby markets is a necessary condition for hit-and-run entry. We will substantiate this in a multi-market framework.

II. The Multi-Market Approach

A multi-market framework consists of (in our case) two markets which are somehow related. That is, an incumbent firm in one of these markets is able to enter the other market by using existing home-market resources. Using existing resources for an entry activity does involve some costs, in particular adjustment costs in the case of technology-substitute competition and transport costs in the case of export competition. Entry is easy for established firms if these costs are low (Calem 1988, p. 171). Thus, the defining characteristic of a set of *related markets* is ease of entry by established firms.

Ease of entry does not hold for new firm entrants, or for diversifying firms from unrelated markets. Entry by these firms is associated with sunk costs of, for instance, product development and capacity investment. Such costs are usually related to entry barriers. This harks back to pioneering studies which argued that related firms are not deterred by conditions that provide unsurmountable entry barriers to others (Andrews 1949; Hines 1957; Brunner 1961; Caves 1971; Yip 1982). For instance, Caves (1971) notes a paradox. A multinational firm enters other countries in order to exploit her economies of scale, product differentiation advantages and absolute cost advantages (including low capital costs derived from retained earnings and good credit ratings). These entry *inducements* coincide with Bain's (1956) entry *barriers* to new firms. Empirical tests by Gorecki (1975, 1976) and Shapiro (1983) confirm that variables (such as R&D intensity) which have a significantly negative effect upon new firm entry may have a positive or insignificant effect upon existing firm entry.

The use of shared resources in home and entry markets may give rise to entry inducements. Unlike intangible assets, such as know-how, tangible assets are rivalrous in use; that is, when used for one (entry) market, they are not (simultaneously) available to another (home) market. This imposes an opportunity cost upon entry, which may undermine the credibility of the entry threat. Excess capacity may be a credible entry inducement. The firm may also shed the excess capacity, however. If excess capacity is costly (because of wages of the employees, for example), she may want to shed the excess by laying off workers. This may be costly too, however, in so far as exit barriers exist. Excess capacity may be prolonged to serve random demand fluctuations, in which case it is profitable from a home-market perspective (e.g. Hviid 1990, p. 135). Moreover, if capacity is indivisible, shedding capacity may require selling the used capital goods, divestiture of the business unit, or closing down some of the firm's current production. The markets for used capital goods and for business units may be very imperfect. (Some assets are 'lemons'.) Closing down may be costly or may hurt the firm's other activities. In cases with exit

barriers, random demand and indivisible units, therefore, it may be more profitable to search for new outlets for the firm's products. Excess capacity will then drive the entry decision. An example of price-cutting excess capacity-driven entrants is in Lambkin (1988). She finds them to be associated with 'early followers', that is with businesses that enter markets later than pioneers but earlier than late entrants.

In the competition with an existing firm entrant, the incumbent firm has a different menu of instruments compared with competition against a new firm entrant. In particular, the incumbent may choose to retaliate in the established entrant's home market. This move is called *reciprocal entry* (Calem 1988, p. 180). Case studies support the observation that entry may invite reciprocal entry by the incumbent firm (Watson 1982; Karnani and Wernerfelt 1985). An alternative case, however, is a *one-sided entry* threat, if the potential entrant's home market is safe against entry (Calem 1988, p. 175). In the case of reciprocal entry, multi-market competition can have a number of outcomes. For example, all firms may decide to enter into each other's home market (Brander and Krugman 1983; Calem 1988; Anderson and Fischer 1989; Venables 1990). Thus, they develop into multi-market firms. Conversely, neither firm may enter for fear of provoking reciprocal entry into his/her home market (Bulow *et al.* 1985, pp. 505–6[n]). In an intermediate case, the 'mutual foothold equilibrium', firms maintain a foothold in each others' markets (Karnani and Wernerfelt 1985); that is, they have a commitment to a fast reciprocal entry reply without the foothold itself inviting retaliation.

The unique features of multi-market competition show that each type of potential entrant induces its own entry (deterrence) game. Bain's (1956) limit price model and Baumol *et al.*'s (1982) contestable markets theory seem to ignore this. They present one basic type of game in order to capture 'the' entry threat. Heterogeneity of potential entrants, however, has both quantitative implications (subsumed by Bain in the size of the limit price) and qualitative implications (features of the entry game). Initially, economists who advocated the salience of established-firm entry, such as Andrews (1949), focused on its quantitative aspects—that is, on established firms' entry lags, costs and scale. The game-theoretical studies, beginning with Brander and Krugman (1983), focused on the qualitative aspects, in particular on the multi-market context of established firm entry.

III. Hit-and-Run Entry Between Two Markets

In the contestability model it is assumed that firms control prices only. This is a critical and controversial assumption.[1] The problem is that a profit-maximizing rationing rule instead chooses *quantities* (scales of entry) such that marginal revenue minus marginal cost is equated across markets (Clemens 1951). Models where firms control quantities do exist (Calem 1988; Anderson and Fischer 1989; Venables 1990). In these two-stage games firms first choose total capacity and subsequently decide on output levels for each market. Prices are determined in the product market, rather than being quoted by the firms. A fully specified model would have firms choose output (or capacity) levels as well as prices.[2] This paper goes halfway by analysing a model where (*a*) firms select both quantities and prices in home and entry markets for (*b*)

different conditions of productive capacity. The model focuses on two dimensions: excess capacity, and ease of entry (indicated by low entry costs) of the existing firm entrant. Special attention is paid to the capacity levels necessary to sustain a credible hit-and-run entry threat. The amount of excess capacity required is a telling indicator of the realism of the (multi-market interpretation of the) contestable markets theory.

Symmetric duopoly

A and B are two identical (country) markets of the same tradable consumer good. There are two firms. Firm 1 is the incumbent firm in market A and likewise firm 2 in market B. Both have constant and identical unit production costs $C(\geq 0)$ and unit transport or entry costs $E(\geq 0)$. Our focus is on perfectly contestable markets, where entry cost is zero and price equals average production cost ($E=0$ and $p=C$), and imperfectly contestable markets, where the entry cost is positive (but can be arbitrarily small) and price is set to deter entry ($E>0$ and $p=C+E$). In each market the demand function $D(p)$ is downward-sloping in the price p, and bounded between 0, for $p \geq R$, and $D(0)<\infty$, for $p=0$. The functions $(p-C)D(p)$ and $(p-C-E)D(p)$ are single-peaked; that is, there is a unique p^m which maximizes net revenue, and for $p<p^m$ net revenue increases in p. This entails that $(p-C)D'(p)+D(p)$ is downward-sloping: that is, $(p-C)D''(p)+2D'(p)<0$ (similar for unit costs $C+E$). Primes ($'$) refer to derivatives. Linear ($D''=0$) and concave demand ($D''<0$) are sufficient conditions. To give each firm an incentive to consider prices in excess of $C+E$, we assume that $C+E$ falls short of the monopoly price, p^m, which maximizes the profit $(p-C)D(p)$: $E \leq p^m - C$. Capacities of both firms are equal to K. For the sake of convenience, we assume that $K > D^i(C+E)$, $i=A, B$; that is, capacity restrictions are non-binding if only one market is served against the entrant's unit cost. To keep notation tractable, we use lower- and upper-case letters to refer to markets A and B, respectively. Call x and X firm 1's supply in markets A and B, and, likewise, y and Y for firm 2. Prices are p_i in market A and P_i in market B, ($i=1,2$. Figure 1 summarizes the crucial symbols.

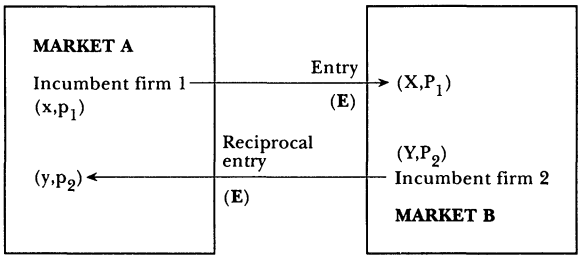

FIGURE 1. Two-market model.

Simultaneous markets

The game evolves in three subgames. The firms decide on home-market prices p_1 and P_2 (subgame 1), entry market prices P_1 and p_2 (subgame 2), and quantities x, X, y and Y (subgame 3). In subgame 3 the firms allocate their

capacity to the two markets and consumers decide which firm to buy from.[3] Payoffs (profits) accrue as a result. The *simultaneous-markets* assumption implies that in each subgame the firms decide simultaneously (Bulow *et al.* 1985, pp. 489–90). The markets are segmented; that is, prices may differ between markets as there is no arbitrage trade (Brander and Krugman 1983, p. 314). Following the theory of contestable markets, in each market the incumbent decides first. Hit-and-run entry occurs if an entrant undercuts the incumbent's price (subgame 2) and captures his sales (subgame 3). In an (im)perfectly contestable market hit-and-run does not actually occur; it is rather a response to unsustainable pricing, and so out-of-equilibrium behaviour, by the incumbent firm. A perfect equilibrium is the natural device for enquiring whether the threat is effectuated when called for.

Demand rationing

Given the prices in a market, consumers buy from the lowest-priced supplier up to his/her capacity. If any residual demand arises, they turn to the other supplier. The literature has developed several *demand rationing schemes.* We adopt the one in Levitan and Shubik (1972), which is, admittedly, the easiest to use.[4] In this scheme, if the lowest-priced supplier i sells q_i units, residual demand for the highest-priced supplier j with price p_j is $D(p_j)-q_i$. We use the tie-breaking rule that, if two firms quote the same price, all consumers turn to the incumbent firm. Predation therefore requires that the entrant strictly underprices the incumbent firm. This resembles the Bertrand assumption in contestability theory. The firm, for instance firm 1, anticipates individual demand levels $d^i(\cdot)$, $i=A, B$, by the rule that

$$(1) \qquad d^A(p_1)=\begin{cases} D^A(p_1) \text{ if } p_1 \leq p_2 \\ \max\{D^A(p_1)-y, 0\} \text{ if } p_1 > p_2, \end{cases}$$

where y is firm 2's sales level in market A.

Supply rationing

The firms may meet more demand in both markets than they can satisfy, given their capacity constraints (K). We use the following *supply rationing rule.* The firm will fully serve demand in his/her most profitable market; (s)he will then operate his/her residual capacity to supply the other market. The most profitable market to firm 1 is his home market A if $p_1-C \geq P_1-E-C$. In the case of a tie (if $p_1-C=P_1-C-E$), the firm prefers to sell in his home market. Thus, the profit-maximizing supply schedule for, say, firm 1 is

$$(2) \qquad x=\begin{cases} \min\{K_1, d^A(p_1)\} & \text{if } p_1 \geq P_1-E \\ \min\{K_1-X, d^A(p_1)\} & \text{if } p_1 < P_1-E, \end{cases}$$

and similar for X in market B. Moreover, $x=0$ if $p_1<C$, and $X=0$ if $P_1 \leq C+E$. Thus, the firm serves his most profitable market first, respects his capacity constraint ($x+X \leq K_1$), and avoids producing unsold goods ($x \leq d^A(p_1)$).

An equilibrium outcome of the game is $(p_1, P_2, P_1, p_2, x, X, y, Y)$. The question to be answered is whether the entry-deterring prices in settings with perfect contestability (C) and imperfect contestability ($C+E$) constitute equilibria in our two-market game. An (im)perfectly contestable markets

equilibrium is associated with $p_1 = P_2 = C + E$ (where E may be zero), while the entrant's prices are not below the incumbent's ($P_1 \geq P_2$; that is, $P_1 = P_2 + \Delta_2$ with $\Delta_2 > 0$). So, we can produce the following definition.

Definition. A contestable markets equilibrium is defined as $(C+E,\ C+E,\ C+E+\Delta_1,\ C+E+\Delta_2,\ D(C+E), 0, 0, D(C+E)), \quad \Delta_i > 0,\ i = 1, 2.$

We will identify values of E and K where neither firm will unilaterally defect from this contestability equilibrium. If both firms quote a price equal to $C+E$ in the first stage, they will not underbid each other in the entry market game, since doing so would entail a loss. In the third subgame each firm therefore faces home-market demand $D(C+E)$. Thus, any defection from the proposed equilibrium must occur in the first subgame.[5]

Firm 1's profits are as follows. In the proposed equilibrium, each firm's profit margin equals E, with profits of $ED(C+E)$. If firm 1 unilaterally defects in the first stage by quoting a $p_1 > C+E$, firm 2 may prey upon firm 1 in the second stage. Firm 2's supply in market A depends on relative profitability, that is, on whether $p_2 > P_2 + E(=C+2E)$ or $p_2 \leq P_2 + E$. If, on the one hand, $(p_2 <) p_1 \leq P_2 + E = C + 2E$, firm 2 will serve her home market first and use her excess capacity $(K - D(C+E))$, which is positive by assumption, for entry into market A. This may be called *partial entry*: firm 1 loses part of his home market sales. Firm 2's profits are $ED(C+E) + (p_2 - C - E)[K - D(C+E)]$, where firm 2 just underbids firm 1 ($p_2 = p_1 - \varepsilon$ with ε arbitrarily close to zero). This payoff exceeds his profit for the strategy where firm 2 does not prey upon firm 1 $(=ED(C+E))$. Firm 1 satisfies residual demand in his home-market demand, $D(p_1) - [K - D(C+E)]$, with a profit equal to $(p_1 - C) \times [D(p_1) + D(C+E) - K]$. Anticipating this in the first stage, firm 1 sets a price p_1 that maximizes his profit, subject to the constraints that $C + E < p_1 \leq P_2 + E(=C+2E)$. If, on the other hand, $p_1 (> p_2) > P_2 + E$, firm 2 will first enter market A, serve all demand $D(p_2)$, and satisfy her home market B by deploying her excess capacity $(K - D(p_2))$, where $p_2 = p_1 - \varepsilon$. This may be called *total entry*: firm 1 loses all home-market sales. Firm 1 will satisfy residual demand in his entry market B. His profit equals $(P_1 - C - E)[D(P_1) + D(p_1 - \varepsilon) - K]$, which is maximized by an appropriate choice of p_1 in the first and P_1 in the second stage. Obviously, firm 1 is interested in keeping p_1 as low as possible in order to induce firm 2 to deploy as much of her capacity as possible in market A. Thus, $p_1 = P_2 + E + \varepsilon = C + 2 + \varepsilon$. This implies a profit of $(P_1 - C - E)[D(P_1) + D(C+2E) - K]$, which firm 1 maximizes by an appropriate choice of P_1. Firm 1's profits π^1 then equal

$$(3) \qquad \pi^1 = \begin{cases} \text{(a)}\ \ ED(C+E) \text{ if } p_1 = C+E \text{ [entry deterrence]}, \\ \text{(b)}\ \ \max_{p1}\,(p_1 - C)[D(p_1) + D(C+E) - K] \text{ if } C+E < p_1 \leq C+2E \text{ [partial entry]}, \\ \text{(c)}\ \ \max_{P1}\,(P_1 - C - E)[D(P_1) + D(C+2E) - K] \text{ if } p_1 = C+2E+\varepsilon \text{ [total entry]}. \end{cases}$$

This induces a proposition.

Proposition. (i) If entry costs are zero ($E = 0$), the proposed perfectly contestable market equilibrium ($p_1 = P_2 = C$) holds if, and only if, each firm's capacity exceeds demand in both markets, that is if $K \geq 2D(C)$. (ii) If entry costs are positive ($E > 0$), the proposed imperfectly contestable equilibrium ($p_1 = P_2 = C + E$) holds if, and only if, 'sufficient' excess capacity exists.

Proof. (i) The first option (3a) entails zero profits with sales of $D(C)$. The second option (3b) refers to an empty set ($C < p_1 \leq C$). The third option (3c) entails positive profit and sales if, and only if, $K < 2D(C)$. Thus, if $K \geq 2D(C)$, the first option has zero profits and is the only one with positive sales. If $K < 2D(C)$, the third option is the only one with strictly positive profits. □

Proof. (ii) The profit levels in equation (3) are functions of E and K. Call these functions $G_i(E, K)$, with $i = 1, 2, 3$; for example, $G_1(E, K) = ED(C+E)$. Firms defect from the contestable markets outcome if at least one i $(=2, 3)$ exists such that $G_i(E, K) > G_1(E, K)$. The *sustainability frontier*, $S\{(E, K)\}$, contains the (E, K)-values where each firm is just indifferent between obeying and defecting from the contestable markets outcome: $S\{(E, K)\} = \{(E, K) \mid \exists i G_i(E, K) = G_1(E, K)$ and $\forall j\ (\neq i)\ G_j(E, K) < G_1(E, K), i, j = 2, 3\}$. The frontier falls between the curves $K = D(C+E)$ and $K = 2D(C+E)$. If $K = D(C+E)$, then $G_1(E, K) < G_2(E, K)$, provided that the profit function $(p-C)D(p)$ is single-peaked at p^m. That is, since $C+E < p_1 \leq C+2E$, it follows that $G_1(E, K) = ED(C+E) < (p_1 - C)D(p_1) \leq 2ED(C+2E) = G_2(E, K)$. Thus, firm 1 defects from the proposed equilibrium: the curve determined by $K = D(C+E)$ is inward of the sustainability frontier. If $K = 2D(C+E)$, then $0 = G_i(E, K) < G_1(E, K)$ for $E > 0$ and $0 = G_i(E, K) = G_1(E, K)$ with $E = 0$ for $i = 2, 3$. Thus, this curve is outward of the sustainability frontier. □

So, 'sufficient' excess capacity is required to sustain an imperfectly contestable markets equilibrium. The intuition can be clarified by choosing a specific functional form of demand. Figure 2 illustrates the result for an example with linear demand: $D(p) = R - bp$, where $R, b > 0$ (see Appendix 1).

For the sake of convenience, call $a := R - bC$ and $e := bE$. By assumption, we restrict ourselves to an *admissable region* (contained by points *BEDFG*) enclosed by the lines $E = p^m - C$ (where $e = \frac{1}{2}a$) and $K = D(C+E)$ (where $K = a - e$). The curve *BCAD* is the sustainability frontier. On the line *BF* holds: $K = 2D(C+E)$ $(= 2(a-e))$. In areas 1 and 2 the contestable markets equilibrium is reached. In area 3 firms defect from this proposed equilibrium notwithstanding excess capacity $(D(C+E) < K)$. Along the curve *BC* in area 3, firm 1 defects by inducing total entry by firm 2, and along *CA* and *AD* firm 1 induces partial entry by firm 2. The non-emptiness of area 2 in this example illustrates an interesting point. In contestable markets theory the entry threat is driven by the potential entrant's ability to completely duplicate the incumbent firm (total entry). This suggests an excess capacity for each entrant equal to demand in the incumbent's market evaluated at the unit cost $C+E$: that is, $K > 2D(C+E)$. Area 2 shows that, if excess capacity is below this level, the entrant may still induce the incumbent to deter entry by a unit entry cost price $(= C+E)$. Furthermore, the figure shows that for given capacity an increase in unit entry cost may bring the firms from area 3 to area 1 or 2; that is, an increase in unit entry cost may facilitate entry deterrence with unit cost prices $(= C+E)$.

The proposition does not establish which prices firms will quote in area 3. While being short of conclusive proof, we suggest that firms resort to a mixed equilibrium. We demonstrate the following lemma.

Lemma. In area 3, a symmetric pure equilibrium does not exist.

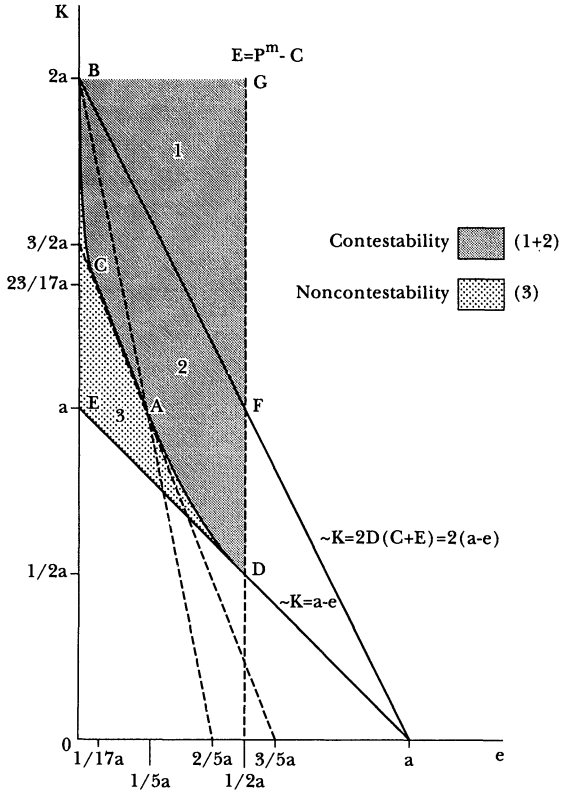

FIGURE 2. Perfect and imperfect contestability.

Proof (see Appendix 2). If a pure equilibrium exists, it must therefore be asymmetric. But in a symmetric game each asymmetric equilibrium has its mirror image: that is, there are pairs of these equilibria. If an equilibrium offers payoffs (V, W) to firms 1 and 2, its mirror-image equilibrium offers payoffs (W, V); that is, the roles of both firms are simply changed. This shows that it is impossible for both firms to prefer the same equilibrium: if $V > W$, firm 1 prefers the former and firm 2 the latter equilibrium. This rules out the possibility that the firms have a compelling reason to coordinate on a Pareto-optimal equilibrium. The outcome of the non-cooperative game is thus random. This is in striking contrast to the (im)perfectly contestable markets outcome. Whether the randomized outcome is a (mixed) equilibrium is another matter. A folk theorem among game theorists suggests that the number of equilibria is uneven: that is, if there are two pure equilibria, there must be a third mixed equilibrium. We cannot, regrettably, prove this conjecture.[6]

IV APPRAISAL

What drives these results is that the firms' entry decisions in a multi-market context are interdependent by an *endogenous opportunity cost* (Calem 1988, p. 172). Entry causes a loss of home-market sales owing to the reduction of home-market capacity (a direct effect) and the triggering of reciprocal entry (an indirect effect). The indirect effect implies an endogenous opportunity cost

of entry as it makes firm 1's opportunity cost of entry dependent upon firm 2's reciprocal entry decision. For instance, firm 1's scale of entry into market B, X, has two effects upon his home-market profits. First, there is the *direct opportunity cost* that the entry sales, X, reduce the residual capacity left to serve home-market demand, $K_1 - X$. The direct opportunity cost is the loss of profits, $(p_1 - C)[d^A(p_1) - x]$ if sales x fall short of demand $d^A(p_1)$, provided that without entry firm 1 would have been able to serve all forthcoming demand. Second, there is the *indirect opportunity cost.* The entry level, X, reduces firm 2's residual home-market demand, $d^B(P_2)$, and sales, Y, which raises firm 2's residual capacity, $K_2 - Y$, to serve her entry market A. This in turn raises firm 2's scale of reciprocal entry, y, which reduces firm 1's home-market demand $d^A(p_1)$.[7]

This paper assumes symmetric ease of entry—that is, reciprocal entry. Real-world cases often show one-sided entry, however. For instance, entrants may have protected home markets, as illustrated by Japanese firms. Indeed, models on the multinational enterprise often assume that the multinational has a secure home market (see e.g. Horstmann and Markusen 1989). In the United States incursions by protected entrants have induced pressures towards a strategic trade policy which issues a demand for reciprocal access to the entrant's home market, while threatening with protectionism otherwise (Yoffie and Milner 1989, p. 113). In terms of our model, contestable markets outcomes pertain if the entrant (say, firm 2) has sufficient capacity to serve both her own protected home market B at the profit-maximizing price P^m *and* the entry market A for a price equal to or above the unit cost $(C+E)$. Anticipating this, the incumbent in market A quotes the entry-deterring price $(=C+E)$. This result holds if $D(C+E)+D(P^m) \leq K$. The contestable markets outcome pertains, but only for the entry market A. Thus, contestability does not arise as a general (benchmark) case for both markets.

V. Conclusion

The framework developed in this paper supports in a formal context Cairns and Mahabir's (1988) critique on contestability. (Im)perfect contestability requires sufficient excess capacity. Otherwise, the possibility of hit-and-run entry does not force the incumbent to quote a sustainable (zero entry profit) price. The model also serves a positive purpose. We suggest that the multi-market framework is the proper setting for the kind of restatement of contestability that Cairns and Mahabir have in mind. The multi-market competition framework is still in its infancy, however. It is far removed from addressing the full complexity of Cairns and Mahabir's (re)vision. To be precise, their proposal is to study potential entry by *multi-product* firms in a *multi-market* setting. So far, multi-product firm contestability has only been analysed with an unidentified entry threat (Baumol *et al.* 1982; Kim 1987). With multi-market competition, multi-product firms may face potential entry by existing rivals from different markets for each of their products. Hence, rather than total entry, where one entrant replaces the incumbent firm entirely, there is partial entry, where one entrant replaces only one product in the product line offered by an incumbent firm. This is certainly a more realistic approach: Cairns and Mahabir's (1988) revisionist view would imply that the theories of multi-market

competition (e.g. Bulow *et al.* 1985; Calem 1988) and multi-product firms (e.g. Brander and Eaton 1984; Shaked and Sutton 1990) are combined. The complexity of this undertaking, however, justifies paying attention first and foremost to the single-product case.

Future research in this area can deal with several technical issues such as different consumer rationing schemes, endogenous capacity choice, and fixed rather than variable entry costs. Furthermore, it may be of interest to tie in other aspects of multi-market competition. For instance, a positive multi-market spillover can induce a firm to enter another market (Bulow *et al.* 1985). If firms meet in several markets, they may try to extend collusion from one market to all markets where they meet (Pinto 1986; Bernheim and Whinston 1990). Multi-market contact may increase the incidence of tacit collusion by facilitating the implicit transfer of signals through price-cutting, output reduction and the like. Future research may, for example, identify the capacity level necessary to prevent multi-market collusion.

The multi-market framework in this paper, as well as in Bulow *et al.* (1985) and Calem (1988), can contribute to our understanding of entry strategies by existing firms. The multi-market theory shows that new-firm entry needs to be sharply distinguished from potential competition by existing firms. New firms have neither the cost advantages nor the strategic weaknesses of a vulnerable home market. Contestable markets theory is only one example where this aspect of potential competition is ignored. If this assessment is correct, the relevance of the multi-market framework goes beyond the theory of contestable markets.

APPENDIX 1

Equation (3) implies that each firm compares the contestable markets equilibrium payoff $ED(C+E)$ with prices (p_1) equal to $C+E$ to the defection payoffs

$$\max_{p_1}(p_1-C)(D(p_1)+D(C+E)-K)$$

if $C+E<p_1\leq C+2E$ and

$$\max_{p_1}(P_1-C-E)(D(P_1)+D(C+2E)-K)$$

if $p_1=C+2E+\varepsilon$ $(\varepsilon>0)$. We will solve these constrained maximization programs, called program I and program II respectively, and then specialize by assuming a linear demand function, $D(p)=R-bP$. For the sake of brevity, only interesting cases are presented. The full proof is available on request from the authors.

Program I: $\max_{p1}(p_1-C)[D(p_1)+D(C+E)-K]$ if $C+E<p_1\leq C+2E$ [equation (3b)].

Rewrite this problem into $\max_p(p-C)[D(p)+D(C+E)-K]$ subject to (i) $p-(C+E)\geq 0$, (ii) $C+2E-p\geq 0$ and (iii) $[D(p)+D(C+E)-K]\geq 0$. For the sake of convenience, the strict inequality restriction $p>C+E$ is transformed into the quasi-inequality constraint $p\geq C+E$, which does not affect the results. The Lagrange function is

$$L(p,\lambda_1,\lambda_2,\lambda_3)=(p-C)[D(p)+D(C+E)-K]+\lambda_1(p-C-E)$$
$$+\lambda_2(C+2E-p)+\lambda_3[D(p)+D(C+E)-K].$$

The Kuhn-Tucker conditions are, given that the objective and the constraints are

concave functions (Beavis and Dobbs 1990, p. 54), as follows:

$$\partial L/\partial p = (p-C)D'(p) + D(p) + D(C+E) - K + \lambda_1 - \lambda_2 + \lambda_3 D'(p) = 0,$$
$$p - C - E \geq 0,$$
$$C + 2E - p \geq 0,$$
$$[D(p) + D(C+E) - K] \geq 0,$$
$$\lambda_1(p - C - E) = 0,$$
$$\lambda_2(C + 2E - p) = 0,$$
$$\lambda_3[D(p) + D(C+E) - K] = 0,$$
$$\lambda_i \geq 0 \ (i = 1, 2, 3).$$

Case 1: $\lambda_1 > 0, \lambda_2 = 0$ and $\lambda_3 = 0$
$\lambda_1 > 0 \Rightarrow p = C + E \Rightarrow \pi = E[2D(C+E) - K] = 0$. Moreover, $\partial L/\partial p = ED'(C+E) + 2D(C+E) - K + \lambda_1 = 0 \Rightarrow \lambda_1 = K - 2D(C+E) - ED'(C+E) > 0 \Rightarrow K > 2D(C+E) + ED'(C + E)$. Call this area A in (E, K)-space. With linear demand $D(p) = R - bp$, the frontier equals $K = 2D(C+E) + ED'(C+E) = 2(R - bC - bE) - bE = 2(R - bC) - 3bE = 2a - 3e$, where $a := R - bC$ and $e := bE$. Hence, A equals $\{e, K; K > 2a - 3e\}$.

Case 2: $\lambda_1 = 0, \lambda_2 > 0$ and $\lambda_3 = 0$

$$\lambda_2 > 0 \Rightarrow p = C + 2E \Rightarrow \pi = 2E[D(C+2E) + D(C+E) - K].$$

Moreover, $\partial L/\partial p = \lambda 2Eb'(C + 2E) + D(C + 2E) + D(C + E) - K - \lambda_2 = 0 \Rightarrow \lambda_2 = 2ED'(C + 2E) + D(C + 2E) + D(C + E) - K > 0 \Rightarrow K < 2ED'(C + 2E) + D(C + 2E) + D(C + E)$. Call this area C in (E, K)-space. With linear demand, $D(p) = R - bP$, this amounts to the frontier $K = 2(R - bC) - 5bE = 2a - 5e$, which defines C as the set $\{e, K; K \leq 2a - 5e\}$.

Case 3: $\lambda_1 = 0, \lambda_2 = 0$ and $\lambda_3 = 0$
$\lambda_1 = 0 \Rightarrow p \geq C + E, \lambda_2 = 0 \Rightarrow C + 2E \geq p$, and $\partial L/\partial p = (p - C)D'(p) + D(p) + D(C + E) - K = 0$, from which price and payoff follow. Note that an internal solution must exist within the constraints; that is, $\partial L/\partial p(=C+E) > 0 = \partial L/p(=p) > \partial L/\partial p(=C+2E)$, knowing that $\partial L/\partial p(=p)$ is a downward-sloping curve: $\partial^2 L/\partial p^2 = (p - C)D''(p) + 2D'(p) < 0$, by the assumption of single-peakedness. The constraints then imply that $ED'(C+E) + 2D(C+E) - K > 0 > 2ED'(C+2E) + D(C+2E) + D(C+E) - K$; that is, $2ED'(C+2E) + D(C+2E) + D(C+E) < K < ED'(C+E) + 2D(C+E)$. Call this area B in (E, K)-space. With linear demand, $D(p) = R - bP$, B is defined as $\{e, K; 2a - 5e < K < 2a - 3e\}$.

Program II: $\max_{P1} (P_1 - C - E)(D(P_1) + D(C+2E) - K)$ if $p_1 > C + 2E$ [equation 3c)].

Rewrite the program into $\max_p (p - C - E)[D(p) + D(C+2E) - K]$ subject to (i) $p - C - E \geq 0$ and (ii) $D(p) + D(C+2E) - K \geq 0$. The Lagrange function is

$$L(p, \lambda_1, \lambda_2) = (p - C - E)[D(p) + D(C+2E) - K] + \lambda_1(p - C - E) + \lambda_2[D(p) + D(C+2E) - K],$$

with the Kuhn-Tucker conditions that

$$\partial L/\partial p = (p - C - E)D'(p) + D(p) + D(C+2E) - K + \lambda_1 + \lambda_2 D'(p) = 0,$$
$$p - C - E \geq 0,$$
$$D(p) + D(C+2E) - K \geq 0,$$
$$\lambda_1(p - C - E) = 0,$$
$$\lambda_2[D(p) + D(C+2E) - K] = 0,$$
$$\lambda_i \geq 0 \ (i = 1, 2).$$

Case 4: $\lambda_1 = 0$ and $\lambda_2 = 0$

$\lambda_1=0 \Rightarrow p \geq C+E$ and $\lambda_2=0 \Rightarrow D(p)+D(C+2E)-K \geq 0$. Moreover, $\partial L/\partial p=(p-C-E)D'(p)+D(p)+D(C+2E)-K=0$. The associated payoff is the interior maximum. By assumption, $(p-C-E)D'(p)+D(p)$, and therefore $\partial L/\partial p$, is downward-sloping. At $p=C+E$ it must hold that $0<\partial L/\partial p$. Therefore, $0<D(C+E)+D(C+2E)-K$; that is, $K<D(C+E)+D(C+2E)$. With linear demand $D(p)=R-bP$, the frontier is $K=2(R-bC)-3bE=2a-3e$, which gives area D equal to $\{e, K; K<2a-3e\}$. This includes both areas B and C.

To sum up, the payoff of program II equals zero unless $K<D(C+E)+D(C+2E)$, which is the area D that includes both areas B and C. That is, solution of programs I and II shows that in the linear case three areas of interest exist: areas A, B and C. In area A profit is zero (an inconsistent case). Defection is profitable if, and only if, the payoff of program I and/or II exceeds the payoff $ED(C+E)$ $(=E(R-bC-bE))$ with $p_1=C+E$. We now proceed with the linear demand case: $D(p)=R-bP$. The assumption $D(C+E)<K$ can be rewritten as $a-e<K$, and the assumption $E<p^m-C$ can be reformulated as $e<\frac{1}{2}a$. This defines the *admissible* region $\{(e, K); e<\frac{1}{2}a$ and $a-e<K\}$. Noting that $E=e/b$ and $C=(R-a)/b$, the following equilibrium strategies per area can be determined.

Area A: $\{e, K; 2a-3e<K\}$. Firm 1 (and, along similar lines, firm 2) faces three options. Option 1: $p_1=C+E$ with profits $\pi^1=ED(C+E)=e(a-e)/b$. Option 2: $p_1=C+E+\varepsilon<C+2E$ (program I above) with profits $\pi^2=E[2D(C+E)-K]=e[2(a-e)-K]/b$. Option 3: $p_1>C+2E$ (program II above) with profits $\pi^3=0$. Firm 1 then faces the question, Does π^2 exceed π^1? $\pi^2-\pi^1=e(a-e-K)/b$. By assumption, $a-e=D(C+E)<K$: therefore, $\pi^2-\pi^1<0$. Firm 1 will not defect from the contestable markets equilibrium.

Area B: $\{e, K;\ 2a-5e<K<2a-3e\}$. Firm 1 (and, for that matter, firm 2) faces three options (as above). Option 1: identical to option 1 in area A. Option 2: $\pi^2=[2(R-bC)-bE-K]^2/4b=(2a-e-K)^2/4b$. Option 3: $\pi^3=[2(R-bC)-3bE-K]^2/4b=(2a-3e-K)^2/4b$. $\pi^2>\pi^3$ as $0<2a-3e-K<2a-e-K$ (if $e>0$). Firm 1's problem is to choose option 1 or 2. Define $\Delta:=4b(\pi^2-\pi^1)=(2a-e-K)^2-4e(a-e)=K^2+K(2e-4a)+5e^2-8ae+4a^2$. $\Delta=0$ if, and only if, $K_{1,2}=2a-e\pm 2\sqrt{[e(a-e)]}$. Since $K<2a-3e<2a-e\leq 2a-e+2\sqrt{[e(a-e)]}=K_2$, K_2 falls out of range. Thus, firm 1 is indifferent between obeying or defecting from the equilibrium if, and only if, $K=K_1=2a-e-2\sqrt{[e(a-e)]}$; he defects if, and only if, $K<K_1$ (within the set B). K_1 intersects B's lower bound $K=2a-5e$ at $(0, 2a)$ and point $A=(a/5, a)$. K_1 intersects B's upper bound $K=2a-3e$ at $(0, 2a)$ and point $D=(\frac{1}{2}a, \frac{1}{2}a)$. In the admissible region (where $e<\frac{1}{2}a$) K_1 is downward-sloping as $\partial K_1/\partial e=-1-(a-2e)/\sqrt{[e(a-e)]}<0$. At point A the slope is $-5/2$ and at point D the slope is -1.

Area C: $\{e, K; K\leq 2a-5e\}$. Firm 1 (and, similarly, firm 2) faces the three options as above. As for profits, π^1 in area C is identical to π^1 in area A, $\pi^2=2e(2a-3e-K)/b$, and area C's π^3 is identical to area B's π^3. Firm 1 faces two problems. (i) Call $\Delta=\pi^2-\pi^1=e(3a-5e-2K)/b$. Firm 1 is indifferent ($\Delta=0$) if $K=(3a-5e)/2$. Firm 1 defects if (but not only if: see (ii)) $K<(3a-5e)/2$. (ii) Call $\Delta=4b(\pi^3-\pi^1)=(2a-3e-K)^2-4e(a-e)=K^2+K(6e-4a)+13e^2-16ae+4a^2$. $\Delta=0$ if, and only if, $K_{1,2}=2a-3e\pm 2\sqrt{[e(a-e)]}$. $K\leq 2a-5e<2a-3e\leq 2a-3e+2\sqrt{[e(a-e)]}=K_2$: therefore K_2 is out of range. Firm 1 is indifferent in problem (ii) if, and only if, $K=K_2=2a-3e-2\sqrt{[e(a-e)]}$; he defects if, and only if, $K<2a-3e-2\sqrt{[e(a-e)]}$. Problems (i) and (ii) imply that firm 1 defects if, and only if, $K<\max\{3a-5e)/2, 2a-3e-2\sqrt{[e(a-e)]}\}$. To find the maximum of the two upper-bound frontiers, it is instructive to know that $K_1(0)=2a$, $K_1(a/5)=3a/5$, and $K_1(a)=-a$. So $\partial K_1/\partial e=-3-(a-2e)/\sqrt{[e(a-e)]}$, and thus $\partial K_1/\partial e(0)=-\infty$. If $e<a/2$, then $\partial K_1/\partial e<0$: that is, the frontier is decreasing in e. The frontier is convex as $\partial^2 K_1/\partial e^2=\{2e(a-e)+\frac{1}{2}(a-2e)^2\}/e(a-e)^{3/2}>0$. K_1 intersects C's upper boundary $K=2a-5e$ at the points $B=(0, 2a)$ and $H=(\frac{1}{2}a, -\frac{1}{2}a)$. K_1 intersects the line $K=(3a-5e)/2$ at point $C=(a/17, a23/17)$ and $(a, -a)$. The line $K=(3a-5e)/2$ intersects the line $K=(3a5e)/2$ at point $C=(a/17, a23/17)$ and $(a, -a)$. The line $K=(3a-5e)/2$ intersects C's upper boundary line $K=2a-5e$ at point $A=(a/5, a)$.

So the areas A, B and C in (e, K)-space give the critical points $A=(a/5, a)$, $B=(0, 2a)$, $C=(a/17, a23/17)$, $D=(\frac{1}{2}a, \frac{1}{2}a)$, $E=(0, a)$, $F=(\frac{1}{2}a, a)$ and $G=(\frac{1}{2}a, 2a)$. Points B and C are on the curve $K=2a-3e-2\sqrt{[e(a-e)]}$ (where program II is the alternative to sustainable pricing; that is, $\pi^1=\pi^3>\pi^2$). Points C and A are on the line $K=(3a-5e)/2$ (where program I is the alternative to sustainable pricing: that is, $\pi^1=\pi^2>\pi^3$). Points A and D are on the curve $K=2a-e-2\sqrt{[e(a-e)]}$ (where program I is the alternative to sustainable pricing: that is, $\pi^1=\pi^2>\pi^3$). Points D, F and G are on the line $e=\frac{1}{2}a$ and points E and D are on the line $K=a-e$. (Both lines delimit the admissible region.) The results are summarized in Figure 2 in the text. We conclude that, within the admissible region, firm 1 defects for (e, K) values in area 3, enclosed by points $BCADE$. He does not defect from the contestable market equilibrium in area 2, enclosed by points $BCADF$, or area 1, enclosed by points BFG.

APPENDIX 2

Proof of the lemma.
Call the symmetric pure equilibrium (p, p, r, r, q, z, z, q). Home-market prices p will exceed the 'contestable' level of $C+E$. (Firms deviate from pricing equal to $C+E$ only if they can do better.) Distinguish two cases.

Case (1a), $r \leq C+E<p$, and (1b), $C+E<p \leq r$. In both cases, neither firm sells in his/her entry market: either it is not profitable (case 1a) or the price is too high (case 1b). As a result, home-market sales $q=D(p)$, entry market sales $z=0$, and profits are $(p-C)D(p)$. This cannot be an equilibrium, for each firm will defect in the second stage by underbidding the other firm. For instance, firm 1 will quote a P_1 such that $C+E<P_1<p$. He is also the only (case 1a) or the lowest-priced (case 1b) supplier in his home market (assuming that firm 2 does not defect). In the third subgame the firm can choose to serve the home market first, with sales $D(p)$ and entry sales $X=\min\{D(P_1), K-D(p)\}$, or to serve the entry market first, with entry sales $X=D(P_1)$ and home-market sales $x=\min\{D(p), K-D(P_1)\}$. This means that profits then follow from

$$\max\{(p-C)D(p)+(P_1-C-E)\min\{D(P_1), K-D(p)\},$$
$$(p-C)\min\{D(p), K-D(P_1)\}+(P_1-C-E)D(P)\}.$$

This exceeds the equilibrium profit $(p-C)D(p)$ as $K-D(p)$ is strictly positive. (This follows from $D(p)<D(C+E)<K$.) Firm 1 thus defects.

Case (2): $C+E<r<p$. Each firm is lowest-priced supplier in his/her entry market. From the rationing rules (1) and (2) it follows that entry market sales are $z=D(r)$, home-market sales are $q=0$, and equilibrium profits are $\pi^e=(r-C-E)D(r)$. In the case of unilateral defection by firm 1, however, firm 1 may quote a price $p_1=C+E$, while firm 2 continues to quote $P_2=p$. In the second stage, firm 2 cannot profitably underbid firm 1, $p_1=C+E<p_2$, and firm 1 will underbid firm 2 in his home market, $C+E<P_1<p$. Being lowest-priced supplier in both markets, in the third stage firm 1 may serve either his home market or his entry market first. He realizes a (defection) profit

$$\pi^d=\max\{ED(C+E)+(P_1-C-E)\min[K-D(C+E), D(P_1)],$$
$$E\min[D(C+E), K-D(P_1)]+(P_1-C-E)D(P_1)\},$$

subject to $P_1<p$. Since $D(P_1)<D(C+E)<K$, π^d strictly exceeds the (constrained optimal) profit level $\pi^c:=\max_p(P-C-E)D(P)$ subject to $P<p$. This in turn weakly exceeds the equilibrium profit $\pi^e=(r-C-E)D(r)$ for $r<p$: as a default, firm 1 may choose $P_1=r$, such that $\pi^c=\pi^e$. Thus, $\pi^d>\pi^c\geq\pi^e$. Firm 1 will again defect. Both cases together imply that if $C+E<p$, no price r exists which induces a unique pure equilibrium. □

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NOTES

1. But this is also a time-honoured assumption. Consider Andrews (1949, p. 174): 'At that normal costing price, the business man will be prepared to supply whatever his market will take, ignoring any extra-ordinary rise in his costs, so far as his equipment and labour-force will let him.' Perry (1984) shows that, if a monopolist controls price and quantity simultaneously, in a setting otherwise identical to a perfectly contestable market, he may choose a price-quantity schedule such that he deters entry while earning positive profits.
2. Venables (1990) explores several multi-market models. One comes close to ours by using Bertrand competition. However, it explores differentiated products, since this allows demand to be continuous in the firm's own price. The case of homogeneous products seems, as yet, not to have been explored.
3. One can think of two chain stores, which publish their new week's prices on Saturday, and which stock their shops on Monday morning. Consumers buy from the incumbent store unless the entrant's store is lower-priced. The model assumes centralized pricing; that is, the chain store, rather than local managers, sets prices in both markets. This is one area where chain stores have different strategies.
4. This rule is also used by Kreps and Scheinkman (1983) and Gelman and Salop (1983). Dixon (1987, p. 289) offers a number of rationales for this rationing rule, including the unique connection between the Levitan and Shubik rationing rule and the Cournot model. Davidson and Deneckere (1986) present a comparison with another often employed scheme.
5. Subgame perfection implies that, if firm 1 unilaterally defects in the first subgame, firm 2 defects from the proposed equilibrium in the second and third subgames.
6. We do not apply Dasgupta and Maskin's (1986) existence proofs of mixed equilibria for we read their theorems as applying to open-loop Nash equilibria rather than closed-loop perfect equilibria.
7. This confirms Kaldor's (1935, p. 48) visionary statement on excess-capacity-induced entry by existing firms: 'Let us suppose that one of them finds it profitable to produce another commodity, highly competitive with the products of some other producers. These latter producers will now find the demand for their products reduced; and *this* may make it profitable for them to engage in the production of a second, or even a third, commodity—even if it was not profitable before.' Kaldor (1935, pp. 48-9) observes that (in our terms) an endogenous opportunity cost drives this process.

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