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Multiproduct Competition

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ABSTRACT. – Brand proliferation is examined as an instrument of competition among established firms and as a means to limit entry in a model with both firm and product-specific differentiation. We find that the incentives to proliferate, the credibility of proliferation as an entry barrier, and the welfare properties of the equilibrium depend on the interplay between the extent of firm-specific differentiation and the ability to commit to a restricted product slate.

Compétition par les produits

RÉSUMÉ. – On examine la multiplication des marques en tant qu'instrument de concurrence entre des entreprises existantes et moyen de limiter l'entrée de nouveaux arrivants. On trouve que les incitations à cette multiplication, la crédibilité de la multiplication comme barrière à l'entrée, et les propriétés d'optimalité de l'équilibre dépendent de l'interaction entre les capacités de différenciation propres à chaque entreprise et de la possibilité de s'engager à ne mettre sur le marché qu'une gamme réduite de produits.

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1 Introduction

Product differentiation has a long tradition of economic analysis dating to the pioneering work of HOTELLING [1929], CHAMBERLIN [1933], ROBINSON [1933], and others. While this research characterizes how firms compete when products are imperfect substitutes, the early literature was relatively quiet on the question of how firms select the number of products that they will bring to the market and their characteristics. Some firms compete as full-line marketers (such as an automobile manufacturer that offers a wide range of products for sale from economy compacts to luxury sedans), while others choose to compete in niche markets. The fact that different firms in the same industry sometimes choose to compete with different product lines suggests that product selection has strategic as well as technological determinants.

BAUMOL, PANZAR and WILLIG [1982] develop a theory of product choice based on production cost efficiency. "Economies of scope" exist if costs are subadditive in all partitions of a product vector. Thus, if Q^N is a vector $(q_1, q_2, \ldots, q_N)$, production exhibits economies of scope if $C(Q^{N-S}) + C(Q^S) > C(Q^N)$, where $C(Q^N)$ is the cost of producing the vector Q^N and S refers to the partition of Q^N with positive production for s of the products and zero for the remainder. Under circumstances where firms assume that prices are independent of their actions (perfect competition or perfect contestability) they argue that firms will offer multiple products for sale when there are scope economies.

This results is contingent on the assumption of price-taking behavior. Product choice may be influenced by the desire to discriminate among consumers or to affect competition from other suppliers. Thus, for example, a firm with market power may sell products as a bundle in order to improve surplus extraction (see ADAMS and YELLEN [1976] and WINSTON [1987]). MUSSA and ROSEN [1978], KATZ [1984], and SHAKED and SUTTON [1981, 1983] describe incentives for product choice under monopolistic conditions.

This paper focuses on product choice as a strategic action to affect competition from suppliers of substitute products. SCHMALENSEE [1978] and other authors including HAY [1976], EATON and LIPSEY [1979], and LANE [1980] have argued that incumbent firms will brand proliferate to preempt entry. The basic idea is that incumbent firms can crowd the product space to deter entry, provided that they can commit to production of a set of products. Indeed, such commitment is crucial since, as JUDD [1985] argues, proliferation may not be credible because of low exit costs; in such case, a multiproduct firm is especially vulnerable to entry. A potential entrant will choose to locate at a point in the product space already occupied by one of the incumbent's products. Although this will induce maximum price competition, the rivalry will adversely impact the established firm's neighboring products, inducing the firm to abandon the

challenged brand. Thus, with low exit cost brand proliferation is not a credible commitment. A neglected but equally important question is the ability to credibly withhold a product; this becomes relevant when there are economies of scope so that incurring a sunk cost F allows firms to manufacture various products with no additional fixed cost.

In this paper we examine some issues of multiproduct competition. In particular, we first explore rival firms' incentives to manufacture several products. Next, we examine whether brand proliferation can be a credible entry deterring strategy.

Our framework has two distinctive features. First, we incorporate both brand and product-specific differentiation. For example, Renault and Peugeot each sell a line of automobiles which differ in their degree of luxury. Within each category, both companies have similar but not identical offerings: even if Renault were to mimic, say, the Peugeot 205, still it would be a Renault and consumers are typically not indifferent between various manufacturers' products. We model this phenomenon by assuming that firms are characterized by a single parameter (e. g. distance to the consumer) and products are arrayed vertically according to quality. [1] Second, we assume that there are economies of scope in the production of goods of various qualities; as pointed out above, in such a context the ability, or lack thereof, to withhold a product becomes the key to determine entry into the market. We will argue that while Judd's argument is correct, its application to multiproduct competition and entry deterrence depends on the ability of firms to precommit to a restricted product set and on the way firms' products are differentiated. We will also show that the feasibility of signalling a reduction in the product set has important welfare implications with respect to the equilibrium configuration of products. Specifically, we will argue that with low levels of firm specific differentiation the lack of ability to signal that a product will be withhold yields results that are similar to what would occur if an entrant could implement a "hit and run" strategy.

In section 2 we present the model. Section 3 analyzes the Nash equilibrium of a game where firms simultaneously choose prices and products. Section 4 characterizes the outcome of a game where product and price choices are taken sequentially and where one firm has a first mover advantage in the product stage. In section 5 we imbed this game into an entry game. In section 6 we derive the welfare implications of the model. Finally, some concluding remarks close the paper.

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1. This framework is almost identical to NEVEN and THISSE [1989]. The focus, however, is quite different. They examine the location and quality that single product firms would choose if they were to compete in prices in a second stage. By contrast, firms' location is exogenous in our model, but firms can choose to produce several products of various (exogenously given) quality levels.

2 The Model

Consider a market with two firms, a and b, which are located at the end points of a segment of length L. N consumers are uniformly distributed along this segment and have linear transportation costs. For simplicity, we normalize the unit transportation cost to one.

Each firm can produce either a "basic" good (good 0), or a "premium" good (good 1), or both. We assume that there are economies of scope as defined by BAUMOL *et al.* [1982]. In particular, we assume that the cost function of each firm is given by:

$$C(x_0, x_1) = c_0 x_0 + c_1 x_1 + F \tag{1}$$

where x_j is the quantity produced of the j-th good and we assume that $D = c_1 - c_0 > 0$.

Each consumer demands a single unit of either the basic or the premium good. Consumers choices depend not only on their location and prevailing prices but also on a taste parameter for quality $\tilde{y}$, where $\tilde{y}$ is distributed independently of location according to a density $f(\tilde{y})$ and $\underline{y}$ and $\bar{y}$ are the lower and upper bound of this distribution.

Specifically, we assume that a consumer located at $0 \leqslant t \leqslant L$, with taste parameter y derives surplus s_{rj} from buying good j at firm r:

$$s_{aj} = v + v_j y - P_j^a - t \tag{2}$$

$$s_{bj} = v + v_j y - P_j^b - (L - t) \tag{3}$$

where P_j^r is the price charged by firm r for good j, and we normalize $v_0 = 0$ and $v_1 = 1$. We also assume that v is sufficiently large to guarantee that neither firm has a local monopoly.

Thus, a consumer located at t buys product k from firm i if and only if:

$$(i, k) = \arg \max_{r, j} [s_{rj}] \tag{4}$$

provided that he derives a non-negative surplus.

Let us define t_j as the location such that a consumer is indifferent between buying good j at either firm, and y^i as the level of income (or preference for quality) such that a consumer is indifferent between buying the basic or the premium good at firm i, *i.e.*

$$t_j = (p_j^b - p_j^a + L)/2, \qquad j = 1, 2$$

$$y^i = p_1^i - p_0^i, \qquad i = a, b.$$

A consumer located at t with taste y will choose to buy the basic good at firm a if and only if:

(i) $t < t_0$ ($0a$ is preferred to $0b$);

(ii) $y < y^a$ ($0a$ is preferred to $1a$);

(iii) $y < y^b + 2(t_0 - t)$ ($0a$ is preferred to $1b$).

Figure 1 represents the market share of various goods at given prices.

3 Simultaneous Choice of Products and Prices

When firms simultaneously choose how many products to introduce and at what prices sell them, we can derive the following results.

First, it can be shown that if a symmetric Nash equilibrium exists where each firm sells two products, the Nash equilibrium margins are the same as those obtained in a standard Hotelling model where each firm sells a unique product of identical quality. Furthermore, it can be shown that it is a dominant strategy for each firm to sell both products and that existence is guaranteed at least in the case where $\tilde{y}$ is uniformly distributed, provided that the upper bound of y is large enough relative to the difference in costs of the high and low quality products (see GILBERT and MATUTES [1989]).

Thus, firms do not gain anything by introducing the second product in equilibrium. Yet, if commitment to withhold a product is not possible both firms will proliferate. What drives our results is that, given the rival firm's choice of varieties and prices, each firm has incentives to introduce a second product to capture additional clients and to price discriminate among consumers with different taste for quality. However, if each firm proliferates, competition across goods of the same quality cancels the incentives to discriminate.

To understand the economic rationale behind proliferation consider the case where firm b sells only the basic good. Figure 2 illustrates the change in consumers choices that would take place if, starting from a situation where both firms sell the basic good only, a would introduce the premium good. In the original situation, all consumers to the left of t_0 buy at firm a and those to the right buy at firm b. Let us now consider the impact on consumers' choices and a's profits from introducing the premium good at a price P_1^a such that

$$P_0^a + c_1 - c_0 < P_1^a < \bar{y} + P_0^a.$$

Some consumers who bought $0a$ will now buy $1a$; the profits a earns from these consumers increase since the margin on the premium good ($P_1^a - c_1$) is larger than that of the basic good ($P_0^a - c_0$). That is to say, by

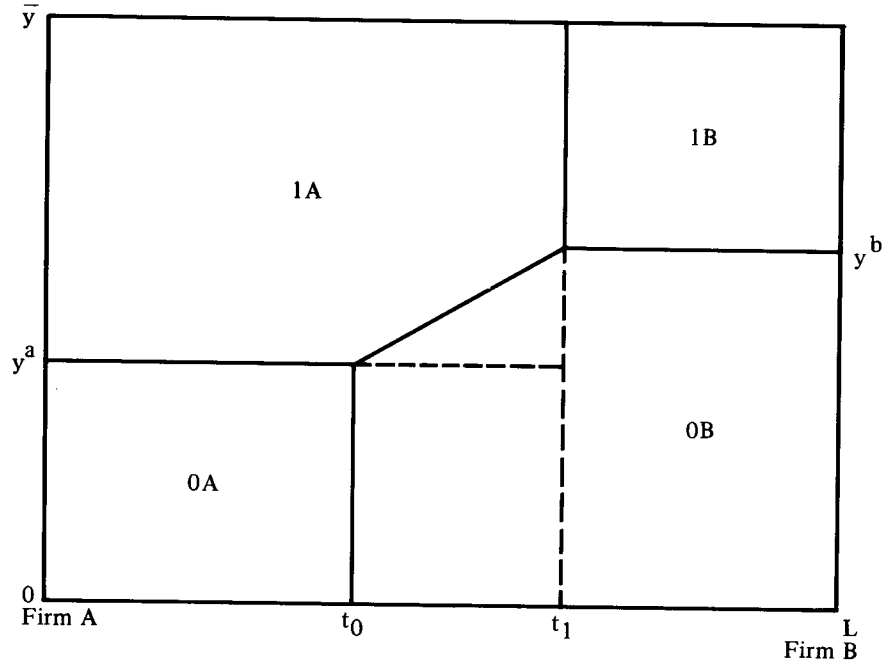

FIGURE 1

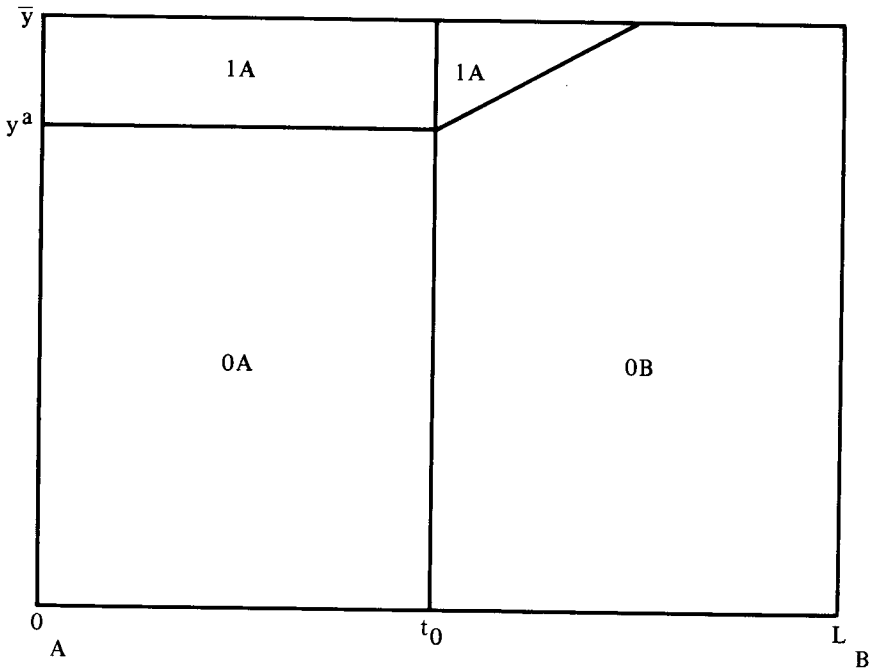

FIGURE 2

introducing the premium good firm a can price discriminate and extract additional surplus from the consumers who value quality more and hence are willing to pay for it. Furthermore, some consumers with a strong preference for quality who bought the basic good at firm b will now be willing to travel somewhat more and buy the premium good at firm a. Thus, by introducing the premium good firm a can also enlarge its customer base.

If the original situation were instead one where firm a produced only the premium good and b the basic good, by introducing the basic good at a price $P_1^a - c_1 = P_0^a - c_0$ firm a would also increase its profits: any switching between $1a$ and $0a$ would have no impact since both products would be sold at the same margin, and a's market share would be enlarged among the set of consumers with low willingness to pay for quality (since $P_1^a > P_0^a$, the consumer with lowest preference for quality who was indifferent between $1a$ and $0b$, would now choose $0a$).

A similar argument would hold if firm b produced only the premium good, or if firm b had introduced a full product slate: given the prices and the product slate of its rival, by introducing a second product firm a can always either capture additional customers or discriminate across consumers with different willingness to pay for quality or both.

Therefore, in equilibrium each firm produces a full product slate. Head-on competition with the rival firm's products, however, cancels out the incentives to discriminate: the mark-up is the same for all products. That is to say, near a symmetric equilibrium, decreasing the price of the premium good of one firm generates a negligible amount of switching of consumers buying the basic good from the rival. This substitution can hence be ignored. Furthermore, with equal mark-ups switching across a single firm products has no impact on its profit. Thus, the impact on profits from decreasing the price of the premium good is only the negative effect of the lower margin and the positive effect on the market share: there will be switching from consumers buying the premium good at the rival firm. But this trade-off is exactly as in the standard Hotelling model, so the equilibrium mark-ups are as in this model.

4 Sequential Product Choice

Assume that both firms are in the market and have sunk cost F, which allows them to produce both products. We consider the case where firms can commit to withhold some of the products by, say, not ordering supplies required to produce one of the goods. We grant firm a a first mover advantage because we want to imbed this model into an entry model in the next section. Thus, firm a decides in a first stage which products to

withhold; firm b takes an equivalent decision in the second stage. In the third stage firms compete in prices, conditional on the chosen product slate.

We restrict ourselves to the case of a uniform distribution. Even in this case, explicitly solving for an asymmetric equilibrium where one firm produces a full product slate and the other restricts itself to manufacturing either the basic of the premium good is not possible in general. Thus, we solve analytically two extreme cases, one where L approaches zero and the other where $L/\bar{y}$ approaches infinity, and develop some simulations for the intermediate case.

We can show that as L approaches zero the subgame perfect equilibrium involves firms specializing in different qualities. The reason is that as firm differentiation goes to zero rivalry forces the margins down, decreasing the level of profits. Firm a correctly forecasts that if it specializes on a given quality (the most profitable), b will in turn specialize on the second quality given that otherwise it would have to sell both of its products at a very low margin and obtain a level of profits close to zero. Basically, as L approaches zero, if both firms manufacture the same quality, they engage in Bertrand competition. Clearly, this will also damage the profits that a multiproduct firm earns from its other (substitute) product; (this argument was made by JUDD [1985]). Thus, neither firm wants to be a multiproduct firm.

As $L/\bar{y}$ goes to infinity, on the other hand, both firms will proliferate in equilibrium. Indeed, for large levels of firm differentiation, proliferation is a dominant strategy. The argument goes as follows. If, say, firm a specializes, by proliferating firm b induces a more aggressive behavior on its rival, since it becomes forced to compete with a single product against two. This hurts firm b but not enough so as to compensate for the increase in market share and the possibility to discriminate that derives from introducing a second product. Thus, if a specializes b will proliferate. Now let us assume that a produces a full product slate; if b restricts its own, in equilibrium will have a market share below one half and will set a margin below L. Thus, its profits must be less than in a symmetric equilibrium where each firm produces both products, since we know from the previous section that the equilibrium margin is L in such an equilibrium. Therefore, proliferation is a dominant strategy.

Thus, the argument that proliferation allows a firm to enlarge its market share and discriminate among its customer base generalizes to the case where the prices that will be charged by the rival firm as a result are correctly anticipated provided that $L/\bar{y}$ is large. As pointed out in the previous paragraph, however, the firm that proliferates induces a more aggressive pricing policy from its rival. Nevertheless, if the level of firm specific differentiation is large enough, such enhancement of competition is compensated by the factors (market share and ability to discriminate) that render proliferation profitable.

Finally, for intermediate values of $L/\bar{y}$, one can construct numerical examples where proliferation is still a dominant strategy and hence the market outcome. (Thus, the argument above does not hinge completely on the assumption of $L/\bar{y}$ going to infinity, though, by continuity, it requires it to be large enough.) Yet, the simulations show that both firms could

be better off if they both restricted their product slate. Next section shows that this may have some implications for entry deterrence with product proliferation.

5 On Credible Preemption

Let firm a be the incumbent firm and firm b the potential entrant. We consider the same game as before, except that there is a previous stage where the potential entrant decides whether to sunk the fixed cost F that allows production of both goods.

We shall distinguish two cases; first, that where the incumbent cannot credibly pre-commit to withholding some of its offerings; second, that where it can. In the former case, entry occurs provided that $F \leqslant NL/2$, the firm revenues net of variable cost in the equilibrium where both firms proliferate. Clearly, since it is not possible to pre-commit to withholding a product, if entry occurs, in equilibrium each firm will sell the two goods; for, each firm will take as given both the product choices and the prices of the rival firm. As we argue in section 2, in such case proliferation is a dominant strategy. Thus, unless the market is large and differentiated enough relative to the sunk costs, entry will not take place.

Let us now consider the case where a firm can credibly signal that it will reduce its product slate. In such case, the results from the previous section allow us to conclude that if L goes to zero there is entry if and only if $F \leqslant \min [N(2\bar{y}-D)^2/9\bar{y},\ N(\bar{y}+D)^2/9\bar{y}]$, the revenue net of marginal cost that would accrue to the potential entrant in the equilibrium where both firms specialize. If, on the other hand, $L/\bar{y}$ goes to infinity and there is entry, in equilibrium neither firm will commit to withhold some of its products. Thus, there is entry whenever $F \leqslant NL/2$, as in the case where abandoning a product is not credible.

The most interesting case is that where $L/\bar{y}$ is in an intermediate range. By continuity, if $L/\bar{y}$ is large enough the incumbent firm will not withdraw any of its products. Interestingly, in this intermediate range, proliferation can be a useful device to deter entry. Indeed, one can construct examples where the potential entrant would make negative profits upon entry unless the rival firm specialized; the incumbent firm, however, would not withdraw any product upon entry because for this parameter range the entrant would proliferate in such case. That is, since proliferation is a dominant strategy, upon entry the market outcome is proliferation which yields a negative pay-off, thus, the entrant will stay out and yet both firms could coexist in the market if they specialized.

Therefore, for very low levels of product differentiation relative to sunk costs of entry an incumbent firm is better off whenever it cannot signal credibly that it will reduce its product slate. For very high levels of

differentiation, the ability to commit is irrelevant since proliferation is a dominant strategy and the incumbent cannot affect entry. For intermediate levels of differentiation, still, when commitment to withdraw some products is feasible but not profitable in case of entry, the incumbent firm can deter entry by producing a full product line.

6 Welfare Implications

Since in our model there are economies of scope, the only issue is whether there should be a single firm or two firms in the market. If F is less than NL/4, both firms should be in the market producing both goods. For larger levels of F, there should be a single firm producing both goods.

If L is large enough (or commitment to withhold a product cannot be signaled), entry will occur for F less than NL/2. Thus, for F in between NL/4 and NL/2, there is an excessive number of brands in the market. That is to say, as in SALOP [1979], the market outcome results in too many firms since the entrant does not consider as a cost the loss in profits of the incumbent firm. (It does not consider as a benefit the decrease in consumers' transportation costs either; this effect calls for entry above the market outcome, but in our framework the previous one dominates.)

More interesting is that, as L goes to zero, if firms can signal a reduction in the product slate the market outcome is not necessarily efficient either. If F exceeds NL/4 the number of products is correct but they are produced by too many firms. Hence, there is no industry cost minimization and the market outcome is inefficient. Likewise, if F is less than NL/4, there are too few products since in equilibrium firms specialize and efficiency calls for proliferation of firms in the market. As in the contestability literature, there is industry cost minimization and the cost savings from stopping production of either good are lower than the revenue that accrues to the firm. Yet, the outcome is not efficient because two additional products should be manufactured given the cost structures.

These results contrast with those on contestability, where the sustainable prices and outputs coincide with Ramsey prices and outputs; (see BAUMOL *et al.* [1977]). Instead, in a sequential entry game where, if entry occurs, prices are simultaneously determined, the interplay between economies of scope and strategic pricing of substitutable products open up the range of inefficiency types.

To emphasize the role of multimarket competition consider how our results would be modified if production of good one would require an additional fixed expenditure f. For values of L close to zero, the welfare implications of the market outcome would be as before: there is entry if and only if $0 \leqslant \min[N(2\bar{y}-D)^2/9\bar{y}-F-f,\ N(\bar{y}+D)^2/9\bar{y}-F]$ and the market outcome is not efficient since the firm producing good 1 should also produce

good 0. For higher values of L, a fixed cost specific to the production of the premium good can help deter inefficient entry, i.e. entry that occurs for values of F in between NL/4 and NL/2. Obviously, entry cannot be deterred when $F+f$ is less than NL/2; but otherwise, and if F exceeds the profits that would accrue to the entrant producing the basic good when the incumbent proliferates, proliferation deters entry. This is not saying that the market outcome will be efficient; indeed, only if f is less than $N[(\bar{y}-c_1+c_0).^5]/2\bar{y}$ proliferation by the incumbent is optimal; however, even when this is not the case, the incumbent proliferates to deter entry.

Let us now consider the case where signaling credibly a reduction in the product slate is not feasible. In this case, whatever the value of L, entry will occur if F is less than NL/2. As in the case with commitment and large L, the market outcome is inefficient for F between NL/4 and NL/2. However, if F exceeds NL/2 the inability to commit makes entry deterrence feasible, resulting in both higher profits for the incumbent and the correct choice of products from a welfare point of view. As opposed to the case where firms could credibly restraint their product slate, in this case we obtain a result along the lines of the literature on contestability, where the commitment of the incumbent to a set of prices (and products) efficiently deters entry in equilibrium. The difference between the two is that the structure of the game that we have analyzed allows the incumbent to earn positive profits.

The above remarks suggest that the ability to credibly signal a reduction in the product slate is crucial from a welfare point of view at least when the level of firm specific differentiation is very low and F is relatively large. In these circumstances, the inability to signal that a product will be withheld yields results along the lines of those that would be obtained in a framework where "hit and run" entry would be feasible, even though we allow the incumbent firm to react to the choices of the potential entrant; the ability to signal, instead, yields a market inefficiency.

7 Concluding Remarks

An implication of JUDD [1985] is that, with constant marginal costs of production and in markets where there is room for production of differentiated products, firms should tend to specialize when there is a threat of entry, unless exit cost are so high that proliferation is a credible threat to deter entry. Casual observation, however, calls for a reexamination of this question. We have chosen a framework that incorporates both product specific and firm specific differentiation and where there are economies of scope. As in the one dimensional case, product commitment is a key issue to determine the market outcome; with economies of scope, however, it seems more natural to explore the ability to commit to reducing a product slate. When such commitment is feasible, we have found that specialization

occurs when the degree of firm-specific differentiation is very small, as in JUDD [1985], but as the degree of firm specific differentiation becomes large firms will proliferate.

We have imbedded this model into an entry game and our results confirm that both the ability of firms to commit to a product slate and the degree of firm specific differentiation determine whether product proliferation can be a useful entry deterring strategy. For small levels of firm-specific differentiation, the inability to commit to reduce the product slate deters entry and, interestingly, this inability to commit may result in the optimal product configuration from a welfare viewpoint. For very high levels of differentiation, the ability to commit is irrelevant since proliferation is a dominant strategy and the incumbent cannot affect entry: it only depends on the entry cost. For intermediate levels of differentiation, still, when commitment to withdraw some products is feasible but not profitable in case of entry, the incumbent firm can deter entry by producing a full product line: the market could sustain two specialized firms, yet the outcome would be multiproduct competition upon entry.

We have also explored the welfare implications and linked the inability to credibly withhold a product to the contestability results. Specifically, we have shown that, even when the incumbent is allowed to react upon entry, the contestability results hold for some parameter values if the incumbent cannot signal that it will restrict its product slate.

Thus, the model of vertical and horizontal differentiation studied in this paper casts somewhat different light on the incentives for product proliferation relative to the conclusions from a model with one dimension of product differentiation. Indeed, it permits a richer set of strategic variables for the rival firms and suggests how incentives for price discrimination may justify the choice of a full product line.

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