Slotting Allowances and Product Variety in Oligopoly Retail Markets

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Abstract: Slotting fees are fixed charges paid by manufacturers to retailers for access to the retail market. While the effects of this practice on retail prices have been widely studied, slotting contracts can also alter product variety decisions. We study a generalized Chen-Riordan (2007) spokes model that distinguishes between consumer preferences for retail outlets and product variety, and show that the strategic use of slotting allowances by oligopoly firms increases the equilibrium level of product variety. Absent slotting allowances, variety is undersupplied relative to the social optimum. For a class of models in which heterogeneous consumers have unit demand for their most desired product variant, equilibrium slotting fees restore optimality.

Keywords: vertical contracts, retail oligopoly, product variety.

JEL Classifications: L13, L14, D43.

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1. Introduction

Slotting allowances are up-front tariffs paid by manufacturers to retailers for access to supermarket shelves. They are pervasive in grocery retailing, are exchanged in a large number of product categories, and are especially common in frozen and refrigerated foods, dry grocery, beverages, snacks, candy, and microwaveable shelf-stable foods. The fees range between over $2,000 and up to almost $22,000 (per item, per retailer, per metropolitan area) in the U.S. (FTC, 2003; Rey, Thal, and Verge, 2011). They are applied to new products – as "product introduction allowances" – and to existing products through "pay-to-stay fees." The latter are annual recurring payments often linked to premium product placement, for instance in end caps, eye-level shelves, and special displays. Slotting charges are also common in other retail settings, including book stores, pharmacies, and big box retailers of home improvement and office supplies.

The economic effects of slotting allowances are highly controversial. They can enhance efficiency by pricing scarce shelf space (Sullivan, 1997), by better allocating the risk of new product failure between retailer and manufacturer (Bloom, Gundlach, and Cannon, 2000), by compensating a retailer for implicit product promotion that benefits manufacturers (Klein and Wright, 2007), or by providing a signal of manufacturers' private information about the likelihood of product success to retailers (Chu, 1992; Lariviere and Padmanabham, 1997; Richards and Patterson, 2004).

Slotting allowances also can have anti-competitive effects in the presence of market power either upstream (by manufacturers) or downstream (by retailers). With upstream market concentration, slotting contracts can foreclose markets to *de novo* entrants (Shaffer, 2005), enable one retailer and a monopoly manufacturer either to foreclose a rival retailer (Marx and Shaffer, 2007) or coordinate without retail exclusion (Rey, Thal and Verge, 2011), and/or enable national brand manufacturers to control the retail prices of other (competitively supplied) goods (Innes and Hamilton, 2006, 2009).[1] With downstream market power, slotting allowances enable retailers to commit to higher wholesale prices that result in higher retail price equilibria (Shaffer, 1991).[2]

In this paper, we consider the case of downstream market power, with imperfectly competitive retailers who face competitive suppliers. This focus is motivated by evidence of retail concentration, particularly for the multi-product environments in which slotting contracts are most pervasive (see, for example, Inderst and Wey, 2007; Rey, Thal, and Verge, 2011; and for U.S. food markets in particular, Sexton and Zhang, 2006). With oligopoly retailers, slotting contracts have well known effects on equilibrium product prices (e.g., Shaffer, 1991), but can also affect retailers' choice of product variety.

We focus in this paper on the latter effects, on product variety. Indeed, the number of products sold at supermarkets increased dramatically following the inception of slotting allowances as a grocery practice in 1984. For instance the median number of stock-keeping units (SKUs) at U.S. supermarkets more than doubled (from 16,500 to almost 39,000) over the period 1990-2010 (Progressive Grocer, FMI). Consistent with

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[1] See also Hart and Tirole (1990), McAfee and Schwartz (1994), O'Brien and Shaffer (1992), and Rey and Verge (2004), where a monopoly manufacturer faced with multiple retailers can use bilateral two-part slotting contracts to support higher prices. If the contracts are private, however, the manufacturer is opportunistic in bilateral negotiations (exploiting effects on other retailer margins) and will not be able to support the monopoly outcome.

[2] With rival manufacturers supplying one retailer, O'Brien and Shaffer (1997) show how manufacturers with bargaining power can support monopoly pricing by signing contracts that enable marginal cost wholesale pricing with fixed rebates to manufacturers. Like slotting arrangements, these contracts are two-part, but unlike typical slotting arrangements, the fixed ("slotting") fees are negative.

this stylized fact, we demonstrate that slotting allowances lead to greater product variety in our retail market equilibrium.

We study a symmetric multi-product retail oligopoly in which retailers select prices and product variety under non-localized spatial competition. While there is a vast industrial organization literature on product variety (for example, see Chen and Riordan, 2007), most of this literature does not distinguish between variety and retail penetration, instead modeling atomistic producers who each supply a single product variant at a point on a Hotelling line or a Salop circle.[3] We consider a simple generalization of the spokes model of Chen and Riordan (2007, CR) that distinguishes these choices and builds naturally on Shaffer's (1991) insights on vertical contracts. In our analysis, each retail outlet is represented as a point on either a Salop circle (as in Innes, 2006, for example) or a spoke (as in CR) and chooses the number of product variants to offer at that location, consistent with our implied focus on multi-product retail markets. In distinguishing variety choices (at each retail location) from retail penetration (number of outlets), our approach is similar in spirit to Anderson and DePalma (1992) and Hamilton and Richards (2009). However, in contrast to these papers, we study the strategic effects of vertical contracts by modeling a plausible sequential choice structure for variety, contracts, and prices under non-local retail competition. For conceptual clarity, we focus on heterogeneous consumers who have inelastic demand for their most desired variant ('brand') in the neighborhood of equilibrium prices, so that product variety decisions

[3] A nice recent example of this stream of models is Rey and Salant (2012). A number of papers relate loosely to ours in that they examine product variety outcomes in retail markets, or study multi-product retail environments. For example, Inderst and Shaffer (2007) consider how merged retail buyers can sometimes use a single-sourcing strategy to enhance profit when faced with powerful suppliers; this strategy reduces the cross-market range of products. Other literatures study multi-product retail models designed to explain loss leading (e.g., Chen and Rey, 2013) or product bundling (e.g., Armstrong and Vickers, 2010). Our paper is distinguished from this work by its focus on the impact of vertical contracts on intra-retail-outlet variety provision when there is one-stop shopping.

have market efficiency effects while retail prices do not. This permits us to pinpoint the welfare implications of slotting allowances on product variety.

Absent slotting allowances, we find that oligopoly retailers undersupply product variety relative to the socially optimal resource allocation. Our main result is that slotting fees enhance social welfare by increasing product variety and thereby countering the problem of undersupply. These outcomes are due to three incentive effects that drive variety choices in our model. First, expanding product lines generates a *consumer surplus effect*. Longer product lines create better matches between consumers and brands, and this increases consumer utility. Absent strategic considerations and absent slotting contracts – the two forces that fuel our second and third incentive effects – oligopoly retailers face exactly these consumer surplus benefits of increased product variety. The reason is that, because retailers use price discounts to attract (and control) store traffic, they are free to set variety to capture their own customers' marginal willingness-to-pay for increased in-store product assortment.

Second is the *strategic effect* of product line decisions on retail prices. If one retailer increases its product assortment, rivals respond by discounting their retail prices in order to counter the resulting loss in store traffic. This rival price response in turn deters the retailer from increasing product variety. Absent slotting allowances, the consumer surplus effect and strategic effect together lead retailers to provide too little product variety from the social perspective.

Third is a *slotting contract incentive effect* on product variety decisions. Slotting allowances serve to raise equilibrium retail prices (Shaffer, 1991), and introducing new products is more valuable to retailers when retail margins are high than when retail margins are low. Consequently, retailers' use of slotting allowances jointly facilitates higher prices and longer product lines in the oligopoly equilibrium. When consumer demand within a product category is inelastic, we show that the *slotting contract incentive effect* exactly counteracts the *strategic effect* of product variety decisions at the equilibrium level of slotting allowances; hence slotting allowances precisely align the market equilibrium with the social optimum.

2. The Model

R retailers service consumers with *n* stores each. With $R \geq 2$, the total number of stores becomes $N=Rn$, which is fixed for this analysis. The total consumer market is normalized to size one without loss. Each consumer demands one unit of product. After choosing a retail store j from which to purchase, a consumer selects the specific product to purchase from the v_j varieties available at the store. Products (different varieties) are supplied to retailers by competitive producers who face constant per-unit cost of production $c \geq 0$. Retailers can sign two-part (slotting fee) contracts with producers that stipulate a fixed payment to the retailer, *s* (which can be negative), and a per-unit wholesale price paid by the retailer to suppliers, *w*. Retailers bear a fixed cost *f* of stocking each additional product variety, leading to stocking costs equal to $f\,v_j$ at store j. Consumers have preference over both retailers and products as described next.

Consumer product preferences. Consumer preferences for variety are captured by a parameter θ that can vary across consumers. Varieties are symmetric in the sense that consumer utility depends only upon the number of (symmetric) varieties available at a retail store. A consumer type θ thus obtains the net benefit, once arriving at a store j that stocks the number v_j of different varieties,

$$B(v_j,\theta) - p_j \tag{1}$$

where p_j is the price charged by retailer j for one unit of any variety. We assume that $B_v>0$, $B_{vv}<0$, and $B_{v\theta}\geq 0$. In the population of consumers, θ is distributed according to the density (distribution) function $g(\theta)$ ($G(\theta)$) with support $[\underline{\theta},\bar{\theta}]$.

Variety benefits of this form arise, for example, from a unit-circumference Salop circle on which consumers are uniformily distributed; v varieties are symmetrically spaced; and a consumer's preference/transport costs of purchasing a variety located distance d from his or her location on the circle are $\theta\, d$. Before arriving at a retailer, consumers know the strength of their preferences θ, as well as the retailer's variety v and price p, but do not know their own specific location on the Salop "variety circle." Once they arrive at the retailer – and shop – they uncover their product preference location and purchase the variety that is closest, obtaining the net benefit (gross of price), $U^*- \theta d$, where U^* is gross product value (assumed sufficiently large that all consumers purchase) and d is the distance to the closest variety. Ex-ante, before arriving at the retailer, the consumer ascribes equal probability to each location on the Salop circle and thus obtains the expected net benefit of shopping at retailer j (before deducting price):

$$B(v,\theta) = U^* - \theta\, E(d) = U^* - \theta\, 2v \int_0^{1/(2v)} x\, dx = U^* - [\theta/(4v)],$$

where $B_v = \theta/(4v^2)>0$ and $B_{vv} = -\theta/(2v^3)<0$.

Consumer retail preferences. We consider a model of non-localized retail competition in which each retail outlet competes with all other retail outlets, rather than only with proximate neighbors (as in models of localized competition). Chen and Riordan (2007) develop a canonical model of this form. We implicitly extend their model to distinguish between product variety choices (made at each retail location) and retail penetration (numbers and preferences over retail stores, modeled with non-local competition). To avoid dwelling on the intricacies of the non-local competition models (which are interesting and subtle, but not our central focus), we assume a linear demand structure that represents alternative primitive models – such as Chen and Riordan (2007) – as special cases.

Suppose each store has "captive customers" β and competes with each of the (N-1) other stores for non-captive customers α. In each of the latter competitions, the two stores vie for customers who are uniformily distributed on a unit (Hotelling) line between them, yielding the share of customers to store j (vs. store k) equal to:

(2) $$y^*(p_j,v_j;p_k,v_k) = \tfrac{1}{2} + (\Delta u_{jk}/2t)$$

where $$\Delta u_{jk} = \int_{\underline{\theta}}^{\bar{\theta}} [B(v_j,\theta)-B(v_k,\theta)]g(\theta)d\theta + (p_k-p_j)$$

t = inter-retailer unit-distance consumer preference cost

Store j's total customer demand thus becomes:

(3) $$D_j = \alpha \left[\sum_{k\neq j, k\in\{1,\ldots N\}} y^*(p_j,v_j;p_k,v_k) \right] + \beta$$

Implicit in this specification is a premise that all consumers who can be served in our N-store market, are served in a neighborhood of the equilibrium. This assumption, like our unit demand specification, restricts us to inelastic market-level demands for which the pricing effects of slotting contracts have no welfare implications. We can thereby isolate the welfare implications of slotting contracts on retailers' product variety decisions (our focus). The inelastic demand feature of the model also implies a fixed number of "served" and "unserved" customers in the market.[4] Adding up the demands in (3) across the N stores gives the fixed number of served customers:

(4) $$Q_S = N(N\text{-}1)(\alpha/2) + N\beta \leq 1.$$

where the inequality is implied by the assumed consumer market size of one.

Also implicit in this specification is the premise that consumer variety preferences are independent of consumer retail preferences in the following sense. For any given consumer retail preference (for example, a consumer's location on the j-k Hotelling lines or on the set of Chen-Riordan (2007) spokes), the density (distribution) of θ is the same. Implications of relaxing this assumption – when the strength of retail preferences may be (positively or negatively) correlated with the strength of variety preferences – are discussed in Section 5.

The demand structure in (3) arises from a Chen and Riordan (2007, CR) spokes model in which consumers only purchase if their first or second preferred retail stores are available (see our working paper for details). In this case, given our complete coverage assumption (CR's Case I), the demand in (3) emerges with $\alpha=2/[M(M\text{-}1)]$ and $\beta = 2(M\text{-}N)/[M(M\text{-}1)]$, where M (>N) is the exogenous number of consumer preference spokes and the proportion of customers served is $Q_S = N(M\text{-}N\text{-}1)/[M(M\text{-}1)] < 1$. Alternately, the CR model can be modified to allow consumers to have higher order retail preferences (third-preferred and so on) that are sufficiently strong that a consumer will purchase from higher order (less preferred) outlets when better (more preferred) outlets are not

[4] In the Chen-Riordan (2007) spokes model, for example, there are a fixed number of customers who have neither first nor second-preferred retail stores available in the market and are therefore unserved. We assume that all other consumers have sufficiently strong product preferences ($B(v,\theta)$) that they demand product even if only their second-preferred store/spoke is available (CR's Case I).

available, but sufficiently weak that they prefer lower order (more-preferred) outlets in a relevant neighborhood of equilibrium prices and varieties. In this case, the demand structure in (3) again arises with $\alpha=2/[M(M-1)]$, $\beta = (M-N)(M+N-1)/[M(M-1)N]$, and $Q_S = 1$. Finally, Innes (2006) describes another model of non-localized competition, a "random preference Hotelling model" in which the N retail stores are equally spaced on a unit-circumference Salop circle; consumers are uniformily distributed on the circle with unit-distance "transport" costs t; and any possible ordering of the N stores among the N locations occurs with equal relative frequency. This structure also produces store-level demands as in equation (3) with $\alpha=2/[N-1]$, $\beta = -(N-1)/N$, and $Q_S =1$.

The Game. Strategic interaction between retailers is modeled as a three-stage game. In the first stage (Stage 1), each retailer chooses the number of varieties to stock in each of her stores, v_j. Stage 1 is also the contract stage, when retailers simultaneously propose two-part contracts with competitive brand manufacturers that stipulate a fixed slotting allowance (s_j) and wholesale price (w_j) for each brand ($b_i \in \{1,\ldots v_j\}$) the retailer decides to stock. The slotting fee s is paid by the manufacturer to the retailer, and the wholesale price w is the unit price paid by the retailer to the manufacture for the manufacturer's product variant. In the second stage (Stage 2), brand manufacturers either accept or reject the retailers' contracts, and in the third and final stage (Stage 3), retailers compete in prices subject to market-clearing conditions on consumer demand, equation (3). We characterize a symmetric subgame perfect Nash equilibrium, solving by backward induction.

3. Optimal Product Variety

The socially optimal provision of product variety solves

$$(5) \qquad \max_{v} \int_{\underline{\theta}}^{\bar{\theta}} B(v,\theta)\, g(\theta)\, d\theta\, Q_S - fvN \qquad ,$$

where Q_S is the total number of consumers served in the market, as defined in (4). Equation (5) maximizes the average consumer benefit of variety (equal to *B()* for a served customer and zero for an unserved customer), less costs of supplying a variety of v in each of the N retail outlets. Differentiating (5), the social optimum v^* is characterized by the first-order necessary condition,[5]

$$(6) \qquad \max_{v} \int_{\underline{\theta}}^{\bar{\theta}} B(v,\theta)\, g(\theta)\, d\theta\, Q_S = fN.$$

Condition (6) states that the marginal return to product variety among served customers is equal to the marginal cost of stocking the brands at each of the N symmetric retail stores.

4. Market Equilibrium

A. Stage 3 Retail Pricing

We begin with the pricing game in Stage 3. Because we are focusing on a symmetric equilibrium, it suffices to characterize prices of two retailers, call them Retailer 1 (R1) and Retailer 2 (R2). R1 has a retail price (p_1), variety (v_1), and wholesale price (w_1) distinct from all other retailers. R2 has a retail price (p_2) that is distinct from all other retailers, but variety (v_0) and wholesale price (w_0) that are the same as all retailers other than R1. All other retailers have the retail price p_0, variety v_0 and

[5] We implicitly make the usual endpoint assumptions to ensure a positive and bounded solution to (6): $B_v(0,\underline{\theta}) \geq fN$ and $B_v(\bar{v}, \bar{\theta}) \leq fN$ for $\bar{v} > 0$. By our concavity assumption on *B()*, the solution to (6) is unique.

wholesale price w_0. Solving the pricing choices of the two retailers, R1 and R2, combined with the symmetry condition, $p_2=p_0$, will give us equilibrium Stage 3 R1 profits that are a function of its own (v_1,w_1) pair and the corresponding pair for all other firms (v_0,w_0). With these profits, we can characterize the symmetric equilibrium choices (from Stage 1) of (v_1, w_1) by R1, imposing the symmetry condition, $(v_1,w_1)=(v_0,w_0)$.

To describe Stage 3 profits, let $B^*(v) = \int_{\underline{\theta}}^{\bar{\theta}} B(v,\theta)\, g(\theta)\, d\theta$ denote average consumer benefits of variety and let $\Delta B = B^*(v_1)-B^*(v_0)$ denote the relative consumer valuation of product variety available at retailer 1 compared to all other retailers. Given product variety choices and wholesale prices from prior stages of the game (as described above), R1 sets the retail price p_1 to maximize its gross profit

$$\pi_1 = n_1 \{ (p_1-w_1) D_1 + (s_1 - f)\, v_1 \}$$

where

D_1 = per-store demand of R1

$$= \left\{ \alpha \left[\left(\frac{n_1 - 1}{2} \right) + n_2 \left(\frac{1}{2} + \frac{\Delta B}{2t} + \frac{p_2 - p_1}{2t} \right) + n_0 (R-2) \left(\frac{1}{2} + \frac{\Delta B}{2t} + \frac{p_0 - p_1}{2t} \right) \right] + \beta \right\}$$

For expositional purposes, we distinguish here between store numbers of R1 (n_1), R2 (n_2), and the other (R-2) retailers (n_0). R1's profits are derived from the retail margin (p_1-w_1) on each unit of demand D_1, at each of its n_1 stores. For each product variant stocked, R1 also obtains the slotting fee s_1 (if R1 signs slotting contracts) less the unit stocking cost f. R1's per-store demand D_1 is comprised of three sets of demand terms. The first term reflects store demand for retailer 1 when competing with its own $(n_1$-1) other stores, each of which selects identical prices and product variety as the representative store. The second term gives R1's store demand when competing with the n_2 stores of retailer 2, and the third term is R1's store demand when competing with the n_0 stores of each of the remaining (R-2) retailers.

Making the substitution $n_0 = n_1 = n_2 = n$ and $N = Rn$ into D_1 and simplifying the resulting expression gives the profit of retailer 1 at the representative store, which is

$$\text{(7)} \qquad \frac{\pi_1}{n} = (p_1 - w_1)\left[k_1 + \frac{\alpha n}{2t}\left((p_2 - p_1) + (R-2)(p_0 - p_1)\right)\right] + (s_1 - f)v_1$$

where

$$k_1 = \left(\frac{\alpha}{2}\right)\left[N - 1 + (N-n)\frac{\Delta B}{t}\right] + \beta .$$

Differentiating equation (7) with respect to p_1 and substituting for $p_2 = p_0$ (by symmetry) gives R1's first-order necessary condition for a profit maximum:

$$\text{(8)} \qquad k_1 + \left(\frac{\alpha}{2t}\right)(N-n)(p_0 - 2p_1 + w_1) = 0 .$$

Proceeding similarly for retailer 2 (R2), profit at its representative store is

$$\text{(9)} \qquad \frac{\pi_2}{n} = (p_2 - w_0)\left[k_0 + \frac{\alpha n}{2t}\left((p_1 - p_2) + (R-2)(p_0 - p_2)\right)\right] + (s_2 - f)v_2 ,$$

where

$$k_0 = \left(\frac{\alpha}{2}\right)\left[N - 1 - n\frac{\Delta B}{t}\right] + \beta .$$

Differentiating equation (9) with respect to p_2 and substituting for $p_2 = p_0$ gives R2's first-order necessary condition for a profit maximum,

$$\text{(10)} \qquad k_0 + \left(\frac{\alpha}{2t}\right)\left(np_1 - Np_0 + w_0(N-n)\right) = 0 .$$

The equilibrium in the pricing stage is characterized by the solution to equations (8) and

(10). Solving these equations gives

$$\text{(11a)}\quad p_1^e = \left(\frac{N}{2N-n}\right)w_1 + \left(\frac{N-n}{2N-n}\right)w_0 + \left(\frac{2t}{\alpha}\right)\left[\left(\frac{N}{(N-n)(2N-n)}\right)k_1 + \left(\frac{1}{2N-n}\right)k_0\right],$$

$$\text{(11b)}\quad p_0^e = \left(\frac{2(N-n)}{2N-n}\right)w_0 + \left(\frac{n}{2N-n}\right)w_1 + \left(\frac{2t}{\alpha}\right)\left[\left(\frac{n}{(N-n)(2N-n)}\right)k_1 + \left(\frac{2}{2N-n}\right)k_0\right].$$

Note that, in the symmetric equilibrium ($w_0 = w_1 = w,\ v_0 = v_1 = v$),

$$k_0 = k_1 = k = \frac{\alpha(N-1)}{2} + \beta = Q_S/N$$

and the equilibrium prices are

$$p_0^e = p_1^e = p^e = w + \frac{2kt}{\alpha(N-n)}.$$

B. Stage 2 Contracting

In the second stage of the game, each manufacturer is willing to accept the slotting contract proposed by a retailer provided he receives a net return no less than his opportunity costs. With a competitive manufacturing industry, these opportunity costs can be normalized to zero without loss of generality. Accordingly, each manufacturer accepts the contract proposed by retailer 1 whenever

$$\text{(12)}\qquad n\,(w_1-c)D_1/v_1 - s_1 \geq 0$$

where c is unit manufacturing cost. In equation (12), the manufacturer compensates the retailer for any departure of the contracted price from unit cost with the payment of a slotting allowance, as in Shaffer (1991). Because manufacturers are competitive, the retailer can and will drive the manufacturer rents in equation (12) to exactly zero, so (12) holds with equality. Substituting this condition into the equilibrium Stage 3 profits of R1 from (7) gives:

$$\text{(13)}\qquad \pi_1 = n\,[\{\,k_1 + (\alpha/2t)(N-n)(p_0^e-p_1^e)\,\}\,(p_1^e-c) - fv]$$

where p_1^e and p_0^e are given in equations (11a) and (11b),

(14) $$p_0^e - p_1^e = \frac{(N-n)}{(2N-n)}(w_0 - w_1) + \frac{2t}{\alpha(2N-n)}(k_0 - k_1),$$

k_1 is given in (7), k_0 is given in (9), and k_0-k_1 = $-\alpha N \Delta B / 2t$. Because the slotting fees exactly exhaust producer wholesale margins (equation (12)), retailers face true unit product costs c as of Stage 1, as indicated in equation (13).

C. Stage 1 Selection of Variety and Contracts

In Stage 1, retailer 1 selects variety v_1 and wholesale price w_1 to maximize the profit π_1 in equation (13). The symmetric equilibrium settings for variety and wholesale price solve the corresponding optimality conditions, together with the symmetry restrictions, v_1=v_0=v and w_1=w_0=w. The resulting first order conditions, at the symmetric equilibrium, are:

(15) v: $$k\frac{\partial p_1^e}{\partial v_1} + \left(w - c + \frac{2kt}{\alpha(N-n)}\right)\left[\frac{\partial k_1}{\partial v_1} + \frac{\alpha(N-n)}{2t}\left(\frac{\partial(p_0^e - p_1^e)}{\partial v_1}\right)\right] = f\ ,$$

(16) w: $$k\frac{\partial p_1^e}{\partial w_1} + \left(w - c + \frac{2kt}{\alpha(N-n)}\right)\frac{\alpha(N-n)}{2t}\left(\frac{\partial(p_0^e - p_1^e)}{\partial w_1}\right) = 0\ ,$$

respectively, where we have made the substitution for $p_1^e - c = p^e - c = w - c + \frac{2kt}{\alpha(N-n)}$.

To better understand the product line decisions of oligopoly retailers, it is helpful to decompose the marginal return to product variety on the left-hand side of (15) into three terms:

(1) The first term is the *non-strategic incentive effect*, the incentive that would prevail if there were no slotting fees (w=c) and no strategic effects (of variety on prices):

$$\left(\frac{2kt}{\alpha(N-n)}\right)\frac{\partial k_1}{\partial v_1}$$

(2) The second term is the *strategic effect*, the added incentive due to the impact that variety has on retail prices (again absent slotting fees):

$$k\frac{\partial p_1^e}{\partial v_1}+\frac{2kt}{\alpha(N-n)}\frac{\alpha(N-n)}{2t}\left(\frac{\partial(p_0^e-p_1^e)}{\partial v_1}\right)=k\{\frac{\partial(p_0^e-p_1^e)}{\partial v_1}+\frac{\partial p_1^e}{\partial v_1}\}=k\,\frac{\partial p_0^e}{\partial v_1}$$

(3) The third term is the *slotting contract incentive effect*, the incentive created by any departure of wholesale price from cost, *w-c*:

$$(w-c)\left[\frac{\partial k_1}{\partial v_1}+\frac{\alpha(N-n)}{2t}\left(\frac{\partial(p_0^e-p_1^e)}{\partial v_1}\right)\right].$$

Per condition (15), the retailer invests in product variety until the marginal return to variety – the sum of these three effects – equals the marginal cost of introducing a new brand, *f*.

Evaluated in the symmetric equilibrium ($v_1=v_0=v$), the *non-strategic incentive effect* is

(17) $$\left(\frac{2kt}{\alpha(N-n)}\right)\frac{\partial k_1}{\partial v_1}=kB_v^*=\left[\left(\frac{\alpha(N-1)}{2}\right)+\beta\right]B_v^*=\left[\frac{Q_S}{N}\right]B_v^*$$

where $B_v^*=\int_{\underline{\theta}}^{\overline{\theta}}B_v(v_1,\theta)f(\theta)d\theta=\partial\Delta B/\partial v_1$, $k=\dfrac{\alpha(N-1)}{2}+\beta$ (from the definitions of $k_0=k_1=k$ in (7) and (9), with $v_1=v_0=v$) and the last equality substitutes for Q_S (the number of served customers) from equation (4). B_v^* is the marginal return to product variety in added consumer utility and k is the size of the market served by the representative retail store, for instance k = ½ in a Hotelling duopoly model (N = 2, α = 1, β = 0). The *non-strategic incentive effect* thus represents the marginal benefit of an additional brand among consumers served by the retail store. Setting the non-strategic incentive term in (17) equal to the unit stocking cost f replicates the social optimality condition for variety in equation (6). We thus have:

Proposition 1. If retailers do not account for the strategic effects of their variety choices on product prices and do not set slotting fees, then variety will be set optimally in the symmetric equilibrium.

The intuitive logic for this proposition is somewhat subtle. There are two components to this logic. First, like a monopolist, a retailer sets price to trade off benefits in higher revenue from "existing customers" against costs of higher price in reducing demand. Here, the demand reduction takes the form of reduced store traffic, with higher price triggering a loss of customers to rival retailers. Price is therefore the retailer's instrument for control of store traffic. Second and as a result, variety is chosen to trade off benefits of enabling higher prices for customers – while *preserving incentives for customers to choose the retailer* – against the unit stocking cost f. The marginal benefit of variety to a retailer is therefore the *marginal* customer's marginal willingness to pay for variety (MWTP) – the additional price premium that the retailer can charge and preserve consumers' retail choice incentives – times the retailer's equilibrium market share. In equilibrium, retailers equate this marginal benefit – k times the MWTP – with the stocking cost f. This equation produces the same choice condition as in the welfare maximization, provided *marginal* customers – those who are indifferent between two different retailers in the equilibrium – have the same variety preferences, on average, as do *all* customers. Because we assume that consumer retail and variety preferences are independent, the latter qualification is satisfied here.

Turning to the *strategic incentive effect* in the variety condition (15), we can rewrite this term as follows:

(18) $$k \, \frac{\partial p_0^e}{\partial v_1} = - \, k \left(\frac{n}{2N-n} \right) B_v^* < 0.$$

where we substitute for:

$$\frac{\partial p_0^e}{\partial v_1} = \left(\frac{2t}{\alpha} \right) \left[\left(\frac{n}{(N-n)(2N-n)} \right) \left(\frac{\partial k_1}{\partial v_1} \right) + \left(\frac{2}{2N-n} \right) \left(\frac{\partial k_0}{\partial v_1} \right) \right]$$

$$\frac{\partial k_1}{\partial v_1} = \frac{2t}{\alpha} \, (N\text{-}n) \; B_v^* \qquad , \qquad \frac{\partial k_0}{\partial v_1} = - \, \frac{2t}{\alpha} \, n \; B_v^*$$

The strategic incentive effect represents a *cost* of higher variety to the retailer, giving rise to the negative sign in equation (18). Providing a longer product line attracts customers to the retailer's store, at the expense of rival retailers. The rival retailers, who seek to counter the resulting loss of market share, respond by reducing retail prices. An increase in product variety thus results in more aggressive price competition as rival retailers respond to a relatively unfavorable brand position by discounting prices in their product lines. This rival price response favors a lower level of product variety.

Proposition 2. Absent slotting allowances, retailers under-provide product variety in the symmetric market equilibrium relative to the socially optimal level, $v_{NS}<v^*$.

Proof. Setting $w = c$ in equation (15), the market provision of product variety is given by equating terms in (17) and (18) to the unit stocking cost f. By Proposition 1 and the inequality in (18) the two terms in (17) and (18) are less than f at $v=v^*$. The Proposition therefore follows from concavity of $B^*(v)$. □

Now consider the role of slotting allowances. Slotting allowances provide the retailer with the ability to contract for a higher wholesale price in exchange for a tariff received from the manufacturer. The insight of Shaffer (1991) is that retailers will want to exploit this ability. Each retailer uses a slotting contract to pre-commit to a higher (above-cost) wholesale price, which implicitly pre-commits her to a higher retail price in the pricing stage of the game (Stage 3). The benefit of this pre-commitment is that it spurs rivals to raise their retail prices, which enables the contracting retailer to achieve a higher price without sacrificing market share. In other words, above-cost wholesale price contracts enable retailers to temper price competition to their advantage.

In the present setting, the slotting contract also gives retailers an independent instrument – separate from product variety – to control rival retail prices. As a result, the *strategic incentive effect* of product variety is eliminated. Setting an elevated wholesale price in the contract stage signals rival retailers the intent to set correspondingly higher retail prices in the pricing stage, thereby allowing the retailer to extend the length of her product line without triggering an aggressive price response by rivals. The higher retail prices produced by slotting fees give rise to higher retail margins (*p-c*), which in turn raise incentives to attract customers with increased product variety. The resulting increase in variety provision incentives exactly offset the strategic under-provision incentives present without any slotting fees.

Formally, the *slotting contract incentive effect* above can be rewritten as follows:

$$(19) \qquad (w-c)\left[\frac{\partial k_1}{\partial v_1}+\frac{\alpha(N-n)}{2t}\left(\frac{\partial(p_0^e-p_1^e)}{\partial v_1}\right)\right]=(w-c)\left(\frac{\alpha}{2t}\right)\frac{(N-n)^2}{(2N-n)}B_v^* .$$

where (using equations (11a)-(11b) and the definitions of k_1 and k_0 in eq.s (7) and (9)),

$$\frac{\partial(p_0^e-p_1^e)}{\partial v_1}=\left(\frac{2t}{\alpha(2N-n)}\right)\left(\frac{\partial(k_0-k_1)}{\partial v_1}\right)=-\left(\frac{N}{2N-n}\right)B_v^*$$

$$\left(\frac{\partial(k_0 - k_1)}{\partial v_1}\right) = -\left(\frac{\alpha N}{2N - n}\right) B_v^*$$

Using equations (17)-(19), the variety condition (15) can be written as

(15')
$$k\left(1 - \left(\frac{n}{2N-n}\right) + (w-c)\left(\frac{\alpha}{2t}\right)\frac{(N-n)^2}{2N-n}\right) B_v^* = f$$

By Proposition 1, condition (15') will be satisfied at the optimal variety level, v=v*, when the bracketed sum equals one, that is, when the wholesale price is set equal to the w* that solves:

(20)
$$(w^* - c) = \frac{2nt}{\alpha(N-n)^2} k > 0.$$

Note that the optimal slotting fee is positive in order to elevate prices and thereby raise incentives to attract customers with an increased number of product variants on offer at a retailer's stores. The raised variety provision incentive is designed to exactly offset the strategic deterrent to variety provision.

Turning to the retailers' choice of w in the symmetric market equilibrium, as described by equation (16), we can factor terms in (16) to obtain:

$$k\frac{\partial p_0^e}{\partial w_1} + (w^e - c)\frac{\alpha(N-n)}{2t}\left(\frac{\partial(p_0^e - p_1^e)}{\partial w_1}\right) = 0$$

Substituting for $\frac{\partial p_0^e}{\partial w_1} = \frac{n}{2N-n}$ and $\frac{\partial(p_0^e - p_1^e)}{\partial w_1} = \frac{-(N-n)}{2N-n}$ (using equations (11a) and (11b)) gives the equilibrium contract choice,

(21)
$$(w^e - c) = \frac{2nt}{\alpha(N-n)^2} k = (w^* - c).$$

The equilibrium wholesale price w^e thus equals the optimal wholesale price w*, implying our main result:

Proposition 3. In the symmetric market equilibrium, retailers set positive slotting fees that support optimal product variety choices.

5. Extensions

Relationship between consumer variety preferences and retail preferences. We have assumed that the distribution of variety preferences, $g(\theta)/G(\theta)$, is invariant to retail preferences. As a result, consumers with weak retail preferences – those who are indifferent between two retailers in the equilibrium, who we have called "marginal consumers" – have variety preferences drawn from the same distribution as all other consumers.

Suppose instead that consumers with weak retail preferences tend to have stronger variety preferences: they care more about getting the variety right than about the retailer they frequent. Then marginal customers will, on average, have stronger variety preferences than does the average consumer. Because retailers base their variety calculus on *marginal* customers who they compete to attract to their stores, whereas the social optimization is based on the *average* customer, Proposition 1 will no longer hold. Absent strategic considerations and slotting contracts, the market will provide greater variety than is efficient in order to attract the strong-variety-preference marginal customers to stores. If the non-strategic over-provision of variety is small, then strategic incentives for variety under-provision will be more harmful than the *marginal consumer preference incentive* for excess variety, and slotting contracts will continue to increase welfare by raising variety. However, if the non-strategic over-provision of variety is large, the opposite will be true: strategic incentives for under-provision will enhance welfare by offsetting *marginal consumer preference incentives* for over-provision. In this case, slotting contracts will reduce welfare by eliminating the strategic incentives.

Conversely, suppose that consumer retail and variety preferences are positively correlated: consumers who have stronger retail preferences will tend to have stronger variety preferences as well. In this case, marginal consumers will have weaker variety preferences on average than does the average consumer. As a result, Proposition 1 will again fail to hold, but now the market will under-provide variety absent strategic incentives and slotting contracts. Hence, by eliminating strategic incentives for even greater under-provision of variety, slotting contracts will increase welfare.

Competition in outlets. We have fixed the number of retailers R, stores per retailer n, and total stores $N=Rn$. While characterizing entry equilibria is beyond our scope here, some potential implications bear comment. In competitive free-entry markets with atomistic retailers (n=1) and no product variety choices at the retailer level, Chen and Riordan (2007, CR) show that, relative to the socially optimal number of stores, both excess entry and deficient entry are possible in the market equilibrium. For a given number of spokes, excess entry occurs when entry costs are sufficiently small and deficient entry occurs when entry costs are sufficiently large.

In our model, incentives for excess or deficient entry are reinforced in the following sense. Entry costs equal the unit stocking cost f times the equilibrium variety level v plus any fixed set-up cost. Moreover, under plausible conditions, post-entry equilibrium variety choices decline with the number of retail outlets N.[6] Hence, entry

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[6] Without slotting fees, equilibrium variety solves equation (15') with $w=c$, implying (where "$\overset{s}{=}$" means "equals in sign"): $dv/dN \overset{s}{=} (\partial k/\partial N)(N-n)(2N-n)+nk < 0$, where the inequality follows if $k=(1/N)$ (as in the CR model with complete coverage or the Innes (2006) random preference Hotelling model) or if Q_S is as

costs also fall with N, which accentuates both excess and deficient entry incentives relative to a corresponding fixed entry cost.

Slotting fees, by making stores more profitable in equilibrium, promote entry. If there is excess entry absent any slotting fees, then allowing slotting contracts will increase the extent of excess entry and have competing effects on product variety. For given N, the fees raise equilibrium variety as described in the analysis above; however, by prompting entry and raising N, the conditionally optimal level of variety sustained by the slotting contracts, $v^*(N)$, falls. Welfare effects of the slotting contracts in this setting will depend upon the trade-offs caused by the competing effects on entry and variety.

On the other hand, if there is deficient entry absent slotting contracts, then the contracts can improve efficiency both by increasing the number of stores in equilibrium and elevating variety to its conditionally optimal level. For example, if equilibrium store numbers remain no greater than first-best with slotting contracts, the contracts will be unambiguously welfare enhancing.

The order of play. We have assumed in this paper that retailer variety is selected prior to price competition and at the same time as slotting fees. Suppose instead that variety choices are made at the time that outlets are constructed; for example, supermarket size and layout may dictate the scope for product variety. If so, then variety would be chosen before slotting contracts, which are in turn determined before price competition.[7] In this case, equilibrium variety (with slotting contracts) can be determined

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described above for the two-preference CR model ($k=(M-N-1)/(M(M-1))$, n=1 (the atomistic entry case), and $M<2N^2$. With slotting fees, equilibrium variety is as given in equation (6), implying: $dv^*/dN \overset{s}{=} (\partial k/\partial N) < 0$, where the inequality follows from any of the models underpinning equation (3).

[7] Alternately, one might imagine retailers announcing slotting fee practices prior to the selection of variety. However, this would require an implausible retailer ability to pre-commit to contracts. Once variety is

by (i) solving equation (16) and its retailer 2 (R2) analog for wholesale prices w_1 and $w_2=w_0$; (ii) substituting these solutions into the pricing equations (11a) and (11b) and solving for pricing outcomes as a function of R1's variety v_1 and other retailers' variety v_0; and (iii) plugging these solutions into R1's profit function, maximizing by choice of variety v_1, and invoking symmetry, $v_1=v_0=v$. Following this logic gives post-variety equilibrium profit for R1:

(22) $$\pi_1 = n\left\{\left(\frac{\alpha}{2}\right)\left(\frac{N}{(N-n)^2}\right)\left[\left(\frac{(N-n)^3}{2N(N-n)+n^2}\right)\Delta B + \left(\frac{2t}{\alpha}\right)k\right]^2 - fv\right\}$$

Differentiating (22) gives the symmetric equilibrium first order condition for $v_1=v$ (=v_0):

(23) $$B_v^* \ k\,\eta - f = 0$$

where $\eta = \eta_S = \left(\dfrac{2N(N-n)}{2N(N-n)+n^2}\right)$. Without slotting fees, recall that equilibrium variety solves (23) with $\eta = \eta_{NS} = 1 - \left(\dfrac{n}{2N-n}\right)$ (from condition (15') with $w=c$). Similarly, optimal variety v^* solves (23) with $\eta = \eta^* = 1$. It is easily seen that $\eta_{NS} < \eta_S < \eta^*$, implying (by concavity of B^*):

> **Proposition 4**. If product variety choices are made before slotting contracts are determined, then in the symmetric market equilibrium, retailers set positive slotting fees that support a level of product variety v_S that is (a) higher than in the symmetric equilibrium without any slotting contracts v_{NS}, and (b) lower than is optimal: $v_{NS}<v_S<v^*$.

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chosen and suppliers contacted, surely retailers can revise any pre-announced slotting policy; if so, slotting choices cannot precede variety choices.

When product variety is chosen before slotting contracts, retailers' ability to sign the vertical contracts (vs. no contracts) leads to a smaller increase in variety than in the analysis above, where variety and contract terms are determined at the same time. The reason is that greater variety, by attenuating inter-retailer price competition, reduces the strategic incentives to elevate slotting fees, which compromises their benefit in raising retail prices. However, slotting fees nonetheless continue to enhance welfare by increasing variety provision.

Elastic demands. As is common in product differentiation models like ours, we have assumed unit demands at the consumer level. Inelastic demands are conceptually useful because they enable us to pinpoint the welfare effects of slotting contracts on product variety as opposed to their well known impact on retail prices (Shaffer, 1991).

In models of retail competition, there are a number of potential sources of demand elasticity faced by producers. Product demand can be price sensitive due to inter-product competition within a product category (raising one product's price shifts demand away to other products within the category), or due to inter-retailer competition (raising product price at one retailer shifts demand away to other retailers). Our model allows for both of these sources of elasticity. Cross-product demand externalities within a product category are internalized by each of our retailers, while cross-retailer demand externalities are explicitly incorporated in the calculus of retail competition. However, we assume that all customers who can be served are served in the market equilibrium (pricing is not so excessive that some customers opt out of the market altogether), and that each consumer's demand is fixed across a broad product category (such as breakfast cereals or shoes). Although broad product categories give rise to much lower consumer demand elasticities than do narrower categories (as consumers need shoes, for example), some non-zero intra-consumer price sensitivity is likely to be present in most cases in practice (as consumers wear shoes longer when overall price levels are higher, for example).[8]

Non-zero consumer demand elasticities add a clear welfare cost to slotting contracts. Loosely speaking, this cost will rise as the absolute price elasticity rises further above zero, and the welfare-triangle loss of given (slotting induced) price distortions rises in tandem. However, many of our qualitative conclusions plausibly extend to settings with elastic demands. For example, if consumer utility is separable in product quantity and product variety, and the price elasticity of demand is constant (in a relevant range of prices), then slotting contracts lead to the increased market provision of product variety, which is otherwise under-supplied. However, the presence of vertical contracts will not support optimal resource allocations, both because they produce higher retail prices that deplete welfare and because product variety will no longer be optimally determined.[9]

6. Summary and Conclusion

Much attention has been focused on the strategic role of slotting allowances in facilitating higher retail prices. In this paper we have shown that slotting allowances that lead to higher retail prices also serve to increase the provision of retail product variety by raising retail margins in the category. Moreover, slotting allowances reconcile the market

[8] Andreyeva, Long, and Brownell (2010) provide a meta-survey of food category demand elasticities, finding mean elasticities that range from .27 to .81. For example, the mean estimate for sweets and sugars is .34, .44 for cheese, .58 for vegetables, and .60 for cereals.
[9] In our working paper, we present a numerical analysis that illustrates potential effects of slotting contracts with different levels of demand elasticity. In the illustration, slotting fees produce increasingly excessive variety as the absolute demand elasticity rises higher, while higher elasticities also lead to greater (but still deficient) variety provision when there are no slotting contracts. The result is a monotonic depletion of the welfare benefits of slotting fees as the elasticity rises, with the fees becoming welfare-depleting at an elasticity of .9 or greater (for our chosen parameters).

equilibrium with the socially optimal resource allocation when consumers have inelastic demands for their desired brand in the product category.

The beneficial welfare effects of slotting contracts withstand a number of extensions. For example, if consumers who have a stronger preference for variety are more likely to have a stronger preference for a given retailer, and/or if the retail entry game produces a less-than-optimal number of outlets, and/or if retailers choose their capacity for variety before slotting contracts are negotiated, then slotting contracts will continue to enhance social welfare by increasing variety provision in the market.

However, other circumstances can muddy the waters. If consumers who have a stronger preference for product variety are more likely to have a weaker preference for a given retailer, then the market will tend to over-provide variety as retailers compete for the high-variety-preference / low-retail-preference consumers; hence, the variety promoting effect of slotting contracts will no longer enhance social welfare. Alternately, if the retail entry game produces an excessive number of outlets, then slotting contracts will have competing welfare effects: They will enhance welfare by promoting an efficient level of product variety (conditional on the extent of entry), but reduce welfare by increasing retail profits and thereby increasing the extent of excess retail penetration.

To clarify the efficiency implications of slotting allowances on product variety, we have couched our analysis in a setting where prices have no effect on resource allocations. If instead consumer demands for a product category are price sensitive, then slotting allowances cause offsetting welfare effects by simultaneously increasing both retail prices and product variety. This trade-off between price and variety effects suggests the need for empirical analysis to examine the relative importance of each effect.

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