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Local Competition and Impact of Entry by a Dominant Retailer*

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Abstract

This paper analyzes the competition between two spatially differentiated multi-product retailers who encounter entry from a dominant discount retailer. Our primary objective is to determine how entry affects the pricing and relative profits of the incumbent stores and the role played by the location of the entrant. The new entrant has partial overlap in product assortment with the incumbents and is assumed to have lower procurement costs for the common goods. Consumers are heterogeneous in their location, economic status (shopping costs and valuations), as well as purchase basket or the types of products demanded. Results show that in the post entry equilibrium, the prices for the products not offered by the discounter are higher than the pre entry prices. More interestingly, contrary to the conventional wisdom we find that the store that is closer to the new entrant is better off compared to the incumbent located further away. The intuition for these results is that the discounter with its low price draws away the poor consumers – the price sensitive segment – out of the market for the items it carries. This in turn softens price competition between the incumbents for these items. Furthermore, the new entrant's unique product offering attracts more consumers to visit the location it occupies, which introduces positive demand externalities to the neighboring retailer, leading to an increase in sales for the non-competing products. We provide empirical evidence for our results and discuss implications for retailers facing competition from large discount stores.

Keywords: Entry, Retail Competition, Agglomeration

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1. Introduction

The past decade or so has seen a tremendous growth in the mega retailers such as Wal-Mart, Home Depot, Staples, Costco, IKEA, and others, which has fundamentally changed the buying and spending patterns of consumers. The dramatic growth and success of these stores have garnered debates over the economic and social consequences of “big box” retailers. Commentators have argued about the pros and cons of the entry by these stores into the local markets. On the positive side, arguments have been presented on issues related to lower consumer prices, broader product availability, job creation, and increased tax revenues for the local economy. Critics have pointed out the negative aspects related to lower wages and job losses in the long run, unfair competition, and increased traffic and congestion resulting in negative impact upon the ”sociology” of the community.

Another issue that has received a lot of attention in the business press is the impact of these “big box” stores on the locally owned/operated small retailers. While a number of anecdotal reports have documented the negative effects of entry by such mega stores on the small retail establishments (Stone 1995, Shils and Taylor 1997), there is limited academic work on the issue. Past research has primarily focused on competition between symmetric retailers (e.g. Lal and Matutes 1989), or retail stores that differ only in pricing formats, for example, EDLP vs. Hi-Lo pricing (Bell and Lattin 1998, Lal and Rao 1997, Messinger and Narasimhan 1997). With minor exceptions (Fox et al. 2004, Singh et al., 2004, Dukes et al., 2005, Raju and Zhang 2005), limited attention has been given to the growth of alternative retail formats such as mass discounters.[4]

In this paper we investigate the impact of entry by a national discount store on local retail competition. We develop a spatial model of competition between two multi-product stores that encounter entry by a discount store into the market. Pre-competitor entry, our modeling approach parallels that used previously in the literature (e.g. Lal and Matutes 1994). The incumbent retailers are located at the end points of a Hotelling line and are assumed to carry two products. Consumers are heterogeneous in terms of their

[4] Fox et al. (2004) study store choice across retail formats, while Singh et al. (2004) provide an empirical study on the impact of entry by a Wal-Mart supercenter on a supermarket chain. Dukes et al. (2005) and Raju and Zhang (2005) study channel bargaining and coordination issues in the presence of dominant retailers such as those mentioned above.

location along the line as well as their economic status. In particular, we consider two types of consumers – rich and poor – that differ in terms of their transportation and shopping cost as well as their reservation value for the products.[5] Equilibrium prices and profits from this benchmark game are derived following the analysis presented in Lal and Matutes (1989).

We next consider entry by a discount store that locates at one of the end points, i.e. in the immediate location of one of the incumbents. The model incorporates many aspects of the retailing world such as differentiation in the product assortments and cost advantages for the discounter. In particular, we assume that the new entrant carries one of the products offered by the incumbent stores and also offers a unique product. Thus there is a partial overlap in the product offering of the incumbents and the new entrant. For instance, we can think of the incumbents as two grocery stores offering fresh produce and general merchandise, and the entrant as a Wal-Mart discount store offering general merchandise and durable electronics. Wal-Mart is assumed to have cost advantages in that it can procure the general merchandise items at a lower cost than the supermarkets.[6] Following competitor entry, we consider another dimension of consumer heterogeneity based on the difference of the purchase basket or the types of products consumers need. Since some products (such as durables) are bought less frequently than others, we assume some of the consumers need all three products, while other consumers only buy a subset of the available products.

Using the structure described above, our primary objective in this paper is to determine how entry by this differentiated competitor affects the pricing and profits of the incumbent stores. In particular, we analyze the multi-product pricing strategies employed by the incumbents and the role played by the location of the entering discounter. In general, one would expect the prices for the products to fall due to increased competition in the market and the impact of entry on profits to be higher for the store closer to the new competitor. However, once we incorporate differentiation of

[5] Similar heterogeneity in travel and search costs has been used previously in Narasimhan (1988), Raju et al. (1988), Lal and Rao (1997) among others.
[6] There are many other reasons such as non-unionized labor force, efficient supply chain, etc. why these stores (particularly Wal-Mart) have been able to keep their costs down vis-à-vis the smaller supermarket chains. See for example discussion in Singh et al. (2004).

product offerings by the entrant and consumer heterogeneity, we may get different results. In particular, our analysis shows that in the post-entry equilibrium, the prices for the products not offered by the discounter are higher than the pre entry prices. More interestingly, contrary to the conventional wisdom we find that the store that is closer to the new entrant is better off compared to the incumbent located further away.

The intuition for these results is as follows: In the before entry equilibrium, the two incumbent retailers earn equal profits and segment the market symmetrically, serving both poor and rich consumers. After entry by the discounter, however, its low price draws the poor consumers – the price sensitive segment – out of the market for the items it carries. This in turn fosters market segmentation and softens price competition between the incumbents for these items. Furthermore, the new entrant's unique product offering attracts more rich consumers to visit the location it occupies, which introduces positive demand externalities to the neighboring retailer. This encourages the nearby incumbent to abandon the poor segment altogether and focus exclusively on the price-insensitive segment. The distant retailer, on the other hand, is unable to attract this segment because of their high shopping and transportation costs. Hence, this incumbent focuses on the less lucrative, poor consumer segment.

We provide empirical evidence for our key finding. We use store level data from two supermarkets in a suburban Chicago market. This market saw entry by a discount store, which opened up in same shopping plaza as one of the supermarkets. For the second store the entrant located about 2 miles away and next to a competitor grocery store. Two years of sales (aggregate store level as well as for individual departments) are observed both pre and post discount store entry. We use a semi-log specification and regress store sales as function of an indicator variable representing competitor entry and other control variables. As predicted by the theory, we find the sales for dry grocery and general merchandise items to fall at both the incumbent supermarkets. However, the sales for several food products (such as meat, produce, and deli that are not offered by the discount store) are observed to rise after Wal-Mart's entry at the store located next to the entrant. On the other hand, sales of both general merchandise as well as the food items go down when the entrant is located far away and next to a competitor grocery store. The aggregate store sales and store traffic went down by 16% and 10% respectively for this store. In comparison, for the supermarket located in the same shopping plaza as the entrant the store sales went down by only 4%, and the store traffic showed a marginal *increase* post-competitor entry.

An important ingredient for our results is the demand externality generated by the entering discounter's alternative product. The result is similar to the findings in economic literature on agglomeration when consumers have search costs (Stahl 1982a, 1982b, Gabszewicz and Garella 1987) that justifies, for example, the casual observation that car dealers are often located near each other. In the current context, the tradeoff between the positive demand externality versus the losses due to competitor entry depends on the degree of overlap across the stores. For instance, if the entrant is a store like Home Depot or Barnes & Noble with little overlap with the incumbent grocery store, the positive externality could significantly outweigh any negative effects. On the other hand, if the entrant is a store like a supercenter (a discount store combined with a full supermarket), the store closer to the competitor is likely to be worse off. With this format, our results suggest that incumbent grocery stores should differentiate themselves by providing unique offerings such as ethnic and organic foods, and an emphasis on home meal replacements, deli, and so forth that are not found at supercenters. More generally our results have implications for retailers wishing to understand the changing distribution of their customers when a "feared" national discounter enters the market.

The rest of the paper is organized as follows. We describe our model and results in next section. Section 3 provides empirical evidence for some of the main findings, and we conclude in section 4 with a discussion of limitations of the current paper and directions for future research.

2. The Theory

Two stores A and B are located at the end points of a line, and consumers are uniformly distributed between the stores on this line. Both A and B carry two products, which we call 1 and 2.[7] Both stores face a constant marginal cost $K > 0$ of selling each product. This cost incorporates wholesale and marginal retailing costs.

[7] To help readers follow the model, we summarize the notation in Table 1.

Store C is a mass discounter, for example a Wal-Mart. It plans to enter the market by locating at the same location as an existing store.[8] Without loss of generality, we assume that the discounter is located alongside retailer A (see Figure 1). Store C carries product 2 and a third product, called product 3, which is not carried by the other retailers. Hence there is partial overlap of categories carried by the traditional retailers A, B and the new entrant C. Product 2 is the common product offered by all retailers, and the traditional retailers and discounter distinguish themselves by carrying product 1 and 3 respectively. It might be helpful to think of goods 1, 2, and 3 corresponding to produce, dry grocery goods, and some small appliance, respectively. Alternatively, we can think of product 1 as an offering more specific to local tastes and preferences.

Each consumer buys at most one unit of products 1, 2, and 3. We denote by v_i the reservation value for each product $i = 1,2,3$. Consumers are segmented in two dimensions: income and interest in product 3. Assume that α is the portion of high income consumers who have valuation $v_i = H$ for products $i = 1,2$. The remaining portion is the set of low income consumers who have valuation $v_i = L < H$ for products $i = 1,2$. For product 3, a portion β of consumers, whom we call *Big Basket* consumers, have positive valuation $v_3 > 0$ while the remainder $1-\beta$, referred to as *Small Basket* consumers, do not value product 3. Thus all consumers demand products 1 & 2, but only a fraction of consumers (large basket) demand product 3. The primary motivation for this assumption is to represent the difference of purchase frequency among categories – consumers buy foods and groceries once or twice a week, but buy durables less frequently.

Consumers also differ in terms of their shopping and transportation costs. Specifically, high income consumers incur transportation costs when visiting one of the stores. That is, a high income consumer located distance x from a store incurs a cost $t > 0$ per unit traveled. In addition these consumers incur a fixed shopping cost $s > 0$ for each store visited, where s is the opportunity cost of the consumer's time spent in the

[8] It may be possible to consider entry by the discounter at some other location. For example, the discounter could locate in the middle of the line, equally distant between the two retailers. However, our intention is to capture asymmetric effects on competition between A and B *post* entry and thus do not consider this case. For discounter locations off the endpoints, but favoring one of the retailers, we expect our analysis to lead to similar qualitative results.

store and may include the cost of finding the product, time spent in the line, etc. Low income consumers, on the other hand, have no transportation or shopping costs.[9] In this sense, low income consumers behave as "cherry pickers" because their shopping and transportation costs are zero. The segmentation of consumers is summarized in Table 2. In our later analysis, we explain how the existence of high and low income consumers influences firms' pricing strategies.

Table 1: List of Notations in the Model

Products	1	Produce – only available at incumbents (*A, B*).
	2	Groceries – available at all stores (*A, B* & *C*).
	3	Durables – only available at the entrant (*C*).
Stores	*A,B*	Two incumbents. Carry products 1 (produce) and 2 (grocery). A is closer to the discounter.
	C	The entrant. *C* carries product 2 (grocery) and 3 (durables).
	$K > 0$	Marginal cost of store *A* and *B*
Consumers	$L > 0$	Reservation value on products 1 & 2 for Low income consumers
	$H > L$	Reservation value on products 1 & 2 for High income consumers
	Big Basket	Consumers who demand products 1, 2 and 3
	Small Basket	Consumers who demand products 1 and 2 only
	$\alpha \in (0,1)$	The ratio of high income consumers
	$\beta \in (0,1)$	The ratio of Big Basket consumers
	$t > 0$	Transportation cost of High income consumers.
	$s > 0$	Shopping cost of High income consumers

Given this characterization of the market, we can now define the game of interest. We consider two games played by retailers *A* and *B*. In one game, the retailers compete in product prices in absence of the discounter *C*. In the second game, retailers compete after retailer *C* has entered and is located next to *A*. Note that the focus of our analysis is on the pricing strategies of the two traditional retailers and, as such, we do not model the discounter as a strategic actor.[10]

[9] We have labeled these consumer groups to reflect the common notion that high wage earners face higher shopping costs due to the higher opportunity costs of time. While this notion has empirical support for those above the poverty level (Frankel and Gould, 2001), we do not model income as a determinant of shopping behavior.

[10] This may be interpreted by the fact that national discount chains often have a centralized, rather than a local, objective, which reflects, among other things, the chain's image. (See Montgomery 1997.)

In both games, retailers A and B simultaneously set prices for products 1 and 2. Subsequently, each consumer learns these prices and then formulates a *shopping plan*, which specifies the stores from which they buy each product. Finally, consumers carry out their shopping plan.

In what follows, we derive the equilibrium in the game before discounter entry, as a benchmark, and compare it to the equilibrium of the game after entry. We restrict attention to equilibria in pure strategies.[11]

2.1 Before Entry

In this section we present the benchmark case in which the traditional retailers compete amongst themselves in absence of the discounter. A more complete analysis has been examined elsewhere and in more generality. (See Lal & Matutes 1989.) Our intention here, therefore, is to establish a set of conditions for properly comparing the equilibria *before* and *after* entry by the discounter.

Before entry, each retailer has some incentive to attract low income consumers by undercutting its rival by a small amount because these consumers buy product j from the store with the lowest price. Obviously, however, acting on this incentive erodes the ability to extract surplus from the high income consumers. Consequently, any possible equilibrium in which retailers are able to avoid ruinous price undercutting will involve some sort of segmentation – either by products or by income level. Segmentation on income level cannot be sustained as an equilibrium, however, if the surplus from poor consumers is low, relative to that from rich consumers. Suppose one retailer, say A, caters to poor consumers by setting prices uniformly low. Retailer B could profitably steal a portion of these consumers from A without losing any of its current rich consumers. The profitability of this strategy stems from the fact that rich consumers formulate their shopping plan based solely on the price of the total basket – product 1 plus product 2. Knowing this, retailer B can capture all poor consumers by lowering the price of one of its products to a level just below the price at its rival. Then, by raising the price of its

[11] Equilibria in non-trivial mixed strategies would involve distributions of order statistics since poor consumers are choosing the minimum of two probabilistically offered prices. Such an investigation may lead to rich interpretations of sales and promotions (Varian 1980, Narasimhan 1988), but is not our present focus.

other product by an offsetting amount – keeping the sum of its prices constant – it looses nothing from its rich customers.[12]

Rather than segment on consumer income levels, both retailers might alternatively segment the market by coordinating prices so that poor consumers are attracted to buy one product from each store, say product 1 at store *A* and product 2 at store *B*. Then, through higher prices on the other product, retailers capture surplus from a portion of the rich consumer segment, which is loyal to only one store. Such coordination by retailers, termed *reversed pricing* (Lal & Matutes 1989), is possible only if the surplus from the poor segment is sufficiently low, relative to the rich segment. We, therefore, impose the following limit on the potential surplus from low income consumers:

Assumption 1: $L - K < t/2$.

Without this assumption, equilibria may not exist. Note that Assumption 1 not only provides an upper bound on surplus from low income consumers, but it also relates the extent to which retailers can extract surplus from high income consumers, as reflected by the lower bound on transportation costs parameter *t*. Given this assumption, we have two lemmas that state what cannot occur in equilibrium. (All proofs can be found in the Appendix.)

Lemma 1 *Under Assumption 1, no equilibria exists in which one retailer serves all poor consumers with both products.*

As a consequence of this lemma, if an equilibrium exists, it must involve one retailer not selling at least one product to poor consumers. The next lemma rules out equilibria in which any retailer completely excludes poor consumers.

Lemma 2 *Under Assumption 1, no equilibrium exists in which a retailer does not serve poor consumers at least one product.*

In addition, it is necessary to impose a lower bound on the reservation value of high income consumers so that they remain active in the market. Specifically,

Assumption 2: $2K + t - L < H - s$.

Under this model formulation along with the above assumptions we now establish the *before (discounter) entry* equilibrium. Denote by p_{ij} the price of product *i* at store *j*

[12] A formalization of this argument establishes the results of Lemmas 1 and 2.

before entry by the discounter, and $\hat{p}_{ij}$ for the corresponding equilibrium price. The following proposition characterizes the prices in an equilibrium with retailers earning positive profits in absence of the discounter.

Proposition 1 *Under Assumptions 1 & 2, there is a threshold,* $\alpha_{BE} \in (0,1)$*, which depends on K, L, and t, such that for all* $\alpha \in (\alpha_{BE}, 1)$*, there exist equilibria characterized as follows:*

(i) $\hat{p}_{1i} = \hat{p}_{2j} = L;\ i \neq j$,

(ii) $\hat{p}_{1j} = \hat{p}_{2i} = 2K + t - L > L$,

(iii) Each retailer sells to exactly ½ of high income segment. All poor consumers visit retailer i for product 1 and retailer j for product 2.

(iv) Each retailer earns profits: $\hat{\pi}_j = (1-\alpha)(L-K) + \alpha \frac{t}{2}$.

This proposition establishes conditions guaranteeing two *reversed pricing* equilibria in which retailers alleviate competition by coordinating prices. In both equilibria, one retailer sets a low price on one product and a high price on the other product, while the other retailer mirrors this strategy.[13] These pricing strategies force low income consumers to shop in both stores and allow retailers to extract their entire surplus *L*. Furthermore, retailers enjoy duopoly (Hotelling) margins on the high income consumers.[14]

The threshold α_{BE} specified in Proposition 1 defines the minimum portion of high income consumers required to keep retailers from deviating to a *low price* strategy in an attempt to grab all low income consumers. A similar threshold α_{AE} is specified for the equilibrium after entry by the discounter. Hence, all comparisons of the equilibria before and after entry are valid as long the portion of low income consumers α exceeds the larger of α_{BE} and α_{AE}.

Before considering the model with the discounter, it is worthwhile to note at this point that both retailers' market shares among rich consumers are equal at ½ in the equilibria of Proposition 1. This is a result of the fact that rich consumers make their

[13] Note that the choice between the two equilibria of Proposition 1 is arbitrary for the comparison in §2.2. All other relevant properties of the equilibria are the same and, most importantly, do not depend on a retailer's location.

[14] It can be shown that these consumers shop at only one (1) store in equilibrium. See Lal & Matutes (1989) for a formal proof.

decision of which retailer to visit based solely on the price of a bundle – the sum of $p_{1k} + p_{2k}$, $k = A, B$ – which is the same at each retailer. At the same time, each retailer sells one category to the entire poor segment. Therefore retailer *A* and *B* share the similar consumer profiles. We return to this observation in section 2.3 where we use the theory to predict changes in consumers' shopping patterns as a result of entry by the discounter.

2.2 After Entry

In this section, we derive an equilibrium outcome after entry by the discounter. Our intention is to compare the outcome in this equilibrium with that of the previous section. Specifically, we make predictions regarding the movement of prices for products 1 and 2 at each retailer as a result of the discounter's entry. Also of interest is the consequent change in consumers' retailer choice. It is important to keep in mind, however, that for meaningful theoretical predictions, we must ensure consistency across the two scenarios. That is, any parameter restrictions, on α and β for example, imposed in this after-entry model, must still permit the restrictions imposed in the before-entry model. To this end, we maintain assumptions made in Section 2.1 and impose additional parameter restrictions here, as necessary.

We model entry by the discounter as follows. Retailer *C* locates next to retailer *A* on the line, as described previously. (See Figure 1.) Recall that this retailer carries product 2 as well as a second product, product 3, which is not offered by either *A* or *B*. In order to capture the discounter's influence, we assume that *C* offers product 2 at a price just at or below the other retailers' marginal cost. Furthermore, the surplus consumers get from product 3 is sufficiently high that all Big Basket consumers find it worthwhile to buy it.

Since there are three sellers in the market, and each consumer is going to buy multiple products, there is a large number of store choice combinations to be considered in order to write down each seller's demand function given prices. In the search for an equilibrium in the post entry model, it is convenient to rule out certain outcomes that are not sustainable in an equilibrium. It is already possible to eliminate a large set of consumers' shopping plans from consideration. Specifically, the following lemma characterizes this restricted set of possible equilibrium shopping plans.

Lemma 3 *In any equilibrium of the after-entry model, we have the following:*

(i) *No Big Basket rich consumer will shop at more than two (2) stores.*

(ii) *No Small Basket rich consumer will shop at more than one (1) store.*

The first part of Lemma 3 follows directly from our assumption that the discounter, retailer *C*, offers the lowest price for product 2: any consumer interested in product 3 necessarily visits *C* and, while there, buys product 2. Hence, this consumer need only visit one more store.

To understand part (ii), note that if a Small Basket consumer located at $\dot{x}$ shopped around by buying product 1 at *A* and product 2 at *C*, then all Small Basket consumers located at $x < \dot{x}$ would do the same, leaving *A* with no demand for product 2. Such a case cannot be part of an equilibrium since *A* would profitably deviate by lowering its price on product 2 just below $p_{2C} + s$. Therefore, any shopping plan of Small Basket consumers involving two stores would require travel across the entire distance of the line plus additional shopping time, which induces costs (transportation plus shopping) greater than any savings in price. (See the proof in the Appendix for a precise argument on why that is not possible.)

Given the above result, it is now possible to rule out certain pricing behavior in equilibrium, which allows us to concentrate on a smaller set of consumer purchase patterns. First, note that all low income consumers buy product 2 at the discounter. Therefore, as a consequence of the discounter's entry, retailers *A* and *B* can no longer sustain *reversed pricing*, as presented in Proposition 1, in equilibrium. Recall that reversed pricing was sustainable because poor consumers had to visit one of the traditional retailers to get product 2. That left exclusive sale of product 1, among poor consumers, to the other retailer. Post entry, however, the discounter corners the entire set of poor consumers in the sale of product 2.

The next observation concerns the post entry prices for product 1. Since all consumers, in particular Big Basket consumers, are assumed to travel to the discounter, there is a large portion of rich consumers in the neighborhood of retailer *A* who need product 1. Furthermore, these consumers have relatively low price elasticity for product 1 since they incur additional transportation costs by shopping at retailer *B*. Retailer *B*, on the other hand, has only its original local Small Basket customers. Intuitively, therefore, retailer A has an incentive to raise its price on product 1 in order to capture high surpluses coming from Big Basket consumers. The existence of such an incentive implies that retailer A will never have the lower price for product 1. This is formally stated in the following lemma.

Lemma 4 *No equilibrium exists in which* $p_{1A} \leq p_{1B}$.

Based on this lemma, we can conclude that the only possible equilibrium has retailer A setting the highest price for product 1. Hence, we shall suppose that this is the case and establish conditions for which an equilibrium exists with prices $p_{1A}^* > p_{1B}^*$. One such condition is that rich consumers' shopping cost s (the cost of entering an additional store) is sufficiently large so as to ensure retailer A positive demand for its common product with the discounter.

Assumption 3: $s > \frac{1}{3}\left(1 - \frac{1-\alpha}{\alpha\beta}\right)t$.

Without this assumption, no consumer entering retailer A would buy product 2 for any price above marginal cost leaving it no incentive to carry the common product.

In order to derive candidate equilibrium prices, we now compute retailers' profit functions. This requires a characterization of consumer shopping patterns given $p_{1A} > p_{1B}$. This price ordering implies that retailer B sells product 1 to all poor consumers. Because no single product is cheapest at A, it sells to rich consumers only. (Recall that all poor consumers visit the discounter, retailer C, for product 2.) For a rich Big Basket consumer, she will buy goods 2 and 3 at C. The decision of getting product 1 at A or B is based on her location as well as the prices of product 1. A rich Big Basket consumer will buy product 1 from A if p_{1B} is not sufficiently lower than p_{1A} to compensate her for additional travel cost she must incur. Formally, a rich Big Basket consumer located at x will buy product 1 from A if

$$p_{1B} > p_{1A} - (1-x)t.$$

Rich Small Basket consumers, who have no interest in product 3, have the same decision criterion as before entry by the discounter. Namely, these consumers form their shopping plan based purely on the price of the bundle. A consumer located at x buys products 1 and 2 from retailer A if and only if

$$p_{1A} + p_{2A} + xt < p_{1B} + p_{2B} + (1-x)t.$$

Hence, under the assumption that $p_{1B} < p_{1A}$, the two traditional retailers' profits can be written as

$$\pi_A = \alpha\beta(p_{1A} - K)x_1 + \alpha(1-\beta)(p_{1A} + p_{2A} - 2K)x_2 \quad (1)$$

$$\pi_B = (1-\alpha)(p_{1B} - K) + \alpha\beta(p_{1B} - K)(1-x_1) + \alpha(1-\beta)(p_{1B} + p_{2B} - 2K)(1-x_2), \quad (2)$$

where x_i represents the location of the consumer of type $i =$ (B)ig, (S)mall Basket who is indifferent between visiting retailer *A* and *B*. That is,

$$x_B = \frac{p_{1B} - p_{1A} + t}{t}, \qquad \text{and} \qquad x_S = \frac{(p_{1B} + p_{2B}) - (p_{1A} + p_{2A}) + t}{2t}. \quad (3)$$

Note that in equilibrium, prices p_{1k}^*, p_{2k}^* must optimize π_k. And, while Lemma 4 ensures us that $p_{1A}^* > p_{1B}^*$ is necessary in equilibrium, it does not allow us to conclude that these prices actually constitute an equilibrium. Suppose, for example, there are many poor consumers relative to rich Big Basket consumers. If $p_{1A} > p_{1B}$, then retailer 1 will prefer to abandon the high end of the market and go after the poor segment by undercutting retailer 2's price on product 1. Alternatively, if $p_{1A} < p_{1B}$, retailer *B* will have a similar incentive to undercut its rival on product 1. Because the poor segment is a relatively lucrative segment with respect to product 1, both retailers always have an incentive to undercut each other down to marginal cost. But joint marginal cost pricing can also not be an equilibrium since either retailer would unilaterally raise its product 1 price and gain a positive profit from the rich consumers. Summarizing, when the portion of rich Big Basket consumers is too small, we have an Edgeworth cycle in the price for product 1 among the two retailers and, therefore, no equilibrium. This problem goes away, fortunately, when the rich Big Basket segment of consumers is relatively large.

The size of the rich Big Basket segment depends on the two parameters α and β. In particular, sufficiently large values of either parameter ensure that an equilibrium exists in the after-entry game. To make this condition precise, we define $\alpha_{AE}(\beta)$ to be the lower bound on the portion of rich consumers α for a given portion β of Big Basket consumers. The function $\alpha_{AE}(\beta)$, which is specified in Proposition 2, is decreasing in β, which means that as the portion of Big Basket consumers decreases, a larger segment of rich consumers is required to prevent retailer *A* from deviating from its high product pricing strategy. Intuitively, as β decreases, retailer *A* has lower ability to leverage the traffic brought by retailer *C* and a higher portion of rich consumers will compensate for the lower positive externality from store traffic.

Proposition 2: *Suppose Assumptions 1-3 hold and let* $\beta \in (0,1)$.

(i) *There exists a threshold* $\alpha_{AE}(\beta) \equiv \frac{-10+5\beta+3\sqrt{5\beta}}{2(\beta^2+5\beta-5)}$ *between 0 and 1 such that for all* $\alpha \in (\alpha_{AE},1)$ *the following prices define an equilibrium:*

$$p_{1A}^* = \left(\frac{2}{3} + \frac{1-\alpha}{3\alpha\beta}\right)t + K, \qquad p_{2A}^* = \left(\frac{1}{3} - \frac{1-\alpha}{3\alpha\beta}\right)t + K,$$

$$p_{1B}^* = \left(\frac{1}{3} + \frac{2(1-\alpha)}{3\alpha\beta}\right)t + K, \qquad p_{2B}^* = \left(\frac{2}{3} - \frac{2(1-\alpha)}{3\alpha\beta}\right)t + K.$$

(ii) *The equilibrium market shares are defined by the following locations:*

$$\bar{x}_B = \frac{2}{3} + \frac{1-\alpha}{3\alpha\beta}, \qquad \bar{x}_S = \frac{1}{2}.$$

And the sales of product 1 and 2 at store A are B are

$$q_{1A} = \frac{1}{3} + \frac{1}{6}\alpha + \frac{1}{3}\alpha\beta, \quad q_{1B} = \frac{2}{3} - \frac{1}{6}\alpha - \frac{1}{6}\alpha\beta; \quad q_{2A} = q_{2B} = \frac{1}{2}\alpha\left(1-\beta\right).$$

(iii) *In equilibrium, each retailer earns profits expressed by*

$$\pi_A^* = \frac{\alpha^2(2+\beta-\beta^2)+\alpha(8\beta-4)+2}{18\alpha\beta}t, \tag{4}$$

$$\pi_B^* = \frac{\alpha^2(8+\beta-7\beta^2)+\alpha(8\beta-16)+8}{18\alpha\beta}t. \tag{5}$$

While Proposition 2 establishes the existence of an equilibrium in the after-entry game, it also summarizes the equilibrium outcome, which can be used in comparison with the equilibrium in the previous section to generate qualitative predictions about the direction of prices, profits, and market shares resulting from entry by the discounter.[15] We then use these theoretical predictions to derive hypotheses about post entry outcomes at retailers located near a Wal-Mart (retailer *A*) and those retailers located some distance to a Wal-Mart (retailer *B*).

[15] The comparison of equilibrium outcome before and after the discounter's entry is summarized in table 3.

Figure 2 shows how the sales of product 1 and 2 are divided among store *A*, *B* and *C*. Store *A* has a larger market share of product 1 even though product 2's price at store *A* is higher than that at store *B*. The larger sales of product 1 at store A is brought by the larger traffic of store *C*. Both store *A* and *B*'s sales of product 2 shrink dramatically after discounter *C*'s entry. Each of the traditional retailers sell product 2 only to those Small Basket high income consumers. After the discounter's entry, it is possible for retailer *A* and *B* to segment the consumers based on income level. The customer profiles are different in the two traditional stores. Retailer *A* has the ability to extract more surplus from consumers, since only high income consumers shop at store *A*. This leads to the central result, which is implied by the above analysis.

Proposition 3 *Under the conditions of Proposition 2, retailer A has higher profits than retailer B.*

This final result summarizes the paper's main message. From the perspective of a traditional retailer, if a large scale national discounter is entering the market, then it might be better off having it close by rather than next to a distant competitor. Crucial for this result is that the retailer carries some specialized products, (e.g. product 1 in our model), that the discounter does not carry. The discounter's low prices generate higher demand for the nearby retailer's unique offerings, enabling it to extract higher surpluses from those consumers with large shopping costs. In context of competitor entry under demand externalities, Xie and Sirbu (1995) find that incumbents' profits increase from compatible entry. Note, however, that according to our results, despite the benefits accruing to the nearby retailer, entry by the discounter does not improve the profits of this incumbent relative to pre entry. Three retailers, instead of two, share potential surpluses post entry. Instead, our results suggest that if entry by a large discounter is inevitable, then an incumbent store should prefer it locates next door instead of near the rival incumbent.

To understand the workings of the after-entry model, it is instructive to consider some comparative statics of prices with respect to α and β. With regard to the relative size of the rich consumers, first note that an increase in α has no *direct* effect on retailer *A*'s pricing strategies since it serves only this segment in equilibrium.[16] On the other hand, retailer *B* serves some rich and all poor consumers and, consequently, changes in

[16] The profit function in (1) is proportional to α .

α alter its pricing incentives. Through a strategic effect, this affects retailer A's prices in equilibrium. Specifically, an increase in α lowers retailer B's interest in its monopoly on the poor consumers for product 1, thereby encouraging it to lower p_{1B} in order to attract the rich consumers. And since retailer B serves product 2 only to rich consumers, an increase in α raises store demand for this product, making it optimal to raise p_{2B}, accordingly. Retailer A experiences positive strategic effects from retailer B's price changes. Hence, as can be seen in the expressions of Proposition 2 (i), an increase in α lowers the equilibrium prices for product 1 and raises them for product 2.

Alternatively, the parameter β can be interpreted as a measure of differentiation between the discounter and two traditional retailers. For example, as the portion β of consumers who value 3 grows, the two retailers are forced to compete more aggressively for their unique product, product 1. As shown in the equilibrium price expressions of Proposition 2, p_{1A}^* and p_{1B}^* are decreasing in β. Note, however, that because all poor consumers buy product 2 at the discounter, the traditional retailers compete for product 2 only among the rich Small Basket consumers, who make decisions based solely on the price of the bundle $p_{1i} + p_{2i}$, $i = A, B$. Moreover, changes in β do not affect competition over this segment of consumers and, consequently, neither retailer has an incentive to change the price of the bundle. Therefore, an increase in β leads to increases in p_{2i}^* that correspond to the decreases in p_{1i}^* as discussed above. Table 4 summarizes the comparative statics results. It is also interesting to observe that retailer B's price is more sensitive to the change of α and β.

3. Empirical Evidence

The model described above generates a number of relevant predictions about the behavior of the market before and after the discounter's entry. Specifically, we examine the change in sales for the two products at the incumbents. These predictions are stated below as hypotheses, which are tested against our data.

The first set of predictions relate to the changes in the sales for the two products at retailer A. As discussed above, retailer A enjoys a larger share of rich consumers after-entry because the rich Big Basket consumers who come to the discounter for the outside product, product 3, save shopping costs by buying product 1 at the nearby retailer. Intuitively, therefore, we expect retailer *A* to see an increase in sales for product 1 after entry by the discounter. One can see this formally by examining the non-price terms of (1). In the after-entry equilibrium, the amount of sales of product 1 retailer *A* makes is:

$$\text{After Entry Sales of product 1 at Retailer } A \quad = \quad \alpha\beta\bar{x}_1 + \alpha(1-\beta)\bar{x}_2 = \tfrac{\alpha}{6}(1+\beta) + \tfrac{1}{3},$$

which is greater than ½ under the conditions of Proposition 2.

The theory above also allows us to predict retailer *A*'s change in sales for product 2 after entry. The fierce competition for product 2 with the discounter removes any possibility of getting poor consumers to buy this product at retailer *A*. Furthermore, Big Basket consumers buy product 2 at the cheaper store. This intuition is supported by the theory. Using (1) again shows that

$$\text{After Entry Sales of product 2 at Retailer } A \quad = \quad \alpha(1-\beta)\bar{x}_2 = \alpha(1-\beta)\tfrac{1}{2},$$

which is obviously less than ½.

A similar analysis leads us to generate predictions about the sales at the distant retailer, retailer *B* in our model. Since retailer *A* gains in its sale of product 1 and the discounter dominates in the sale of product 2, we intuitively expect that the distant retailer *B* suffers sales losses on both products. Using the non-price terms in the profit equation (2), we can formally verify this:

$$\begin{aligned}\text{After Entry Sales of product 1 at Retailer } B \quad &= \quad (1-\alpha) + \alpha\beta(1-\bar{x}_1) + \alpha(1-\beta)(1-\bar{x}_2) \\ &= \quad \tfrac{2}{3} - \tfrac{1}{6}\alpha(1+\beta), \\ \text{After Entry Sales of product 2 at Retailer } A \quad &= \quad \alpha(1-\beta)(1-\bar{x}_2) = \alpha(1-\beta)\tfrac{1}{2},\end{aligned}$$

which are both less than ½ under the conditions of Proposition 2.[17] This leads us to the following set of hypotheses regarding the change in sales of the two products carried by the traditional retailers:

- *H1a:* For the traditional retailers **near** the discounter, the sales of its unique products are **higher** after the discounter's entry.

[17] Note that $\alpha(1+\beta) > 1$ is implied by $\alpha > \alpha_{AE}(\beta)$.

- *H1b:* For the traditional retailers **near** the discounter, the sales of its products common with the discounter **decrease** after entry.
- *H2a:* For the traditional retailers **far away** from the discounter, the sales of its unique products are **lower** after the discounter's entry.
- *H2b:* For the traditional retailers **far away** from the discounter, the sales of its products common with the discounter **decrease** after entry.

To test these hypotheses we use Dominick's Finer Food (DFF), which is a large supermarket chain in the Chicago metropolitan area.[18] For this study, we use data from two specific stores located in the suburbs of Chicago. One of these stores (Store # 28 in the database) is located in a shopping plaza in Mt. Prospect, and the second store (# 119) is located in Buffalo Grove. Both stores saw entry by a discount store (Wal-Mart) at approximately the same time (November 1991 for store #28 and January 1992 for store #119), but with one critical difference – the location of the new entrant. For store #28 in Mt. Prospect, the new entrant is located in the same shopping plaza right next door to the incumbent, while the entrant it is located 2.2 miles from store #119 and next to a competitor grocery store. Thus, these stores correspond to stores *A* (#28) and *B* (#119) in our theoretical model.

For both stores we observe more than two years of daily sales data both pre and post competitor entry.[19] In particular, our database includes total store level sales, total number of transactions at the store (store traffic), as well as sales at individual departments such as general merchandise, grocery, produce, and meat.[20] Note that while the incumbent supermarkets compete with the entrant discount store on certain items (general merchandise and grocery), the discount store does not offer perishable products such as fresh produce and meat. Before- and after-entry data for both competing and non-overlapping products, as well as location of the new entrant provide us with a unique opportunity to directly test our main finding in the paper (i.e. hypotheses 1a, 1b, 2a, 2b listed above). However, we should point out a major limitation in the data in that we do not observe any sales information from Wal-Mart.

[18] All of Dominick's data is publicly available at the University of Chicago Marketing group.
[19] These data are available at aggregate store level, i.e., we do not observe household level transactions.
[20] Grocery department includes packaged items such as detergents and paper towels.

For empirical estimation we use a semi-log specification (e.g. Blattberg and Neslin 1990) where daily sales in each department are regressed against an indicator variable representing the entry date of Wal-Mart. The regression model also includes a share weighted Divisia price index constructed from 29 product categories (see Montgomery and Rossi 1999), and indicator variables for holiday and weekends:

$$S_{dt} = \exp(\alpha + \beta_1 WM + \beta_2 \ln(PI_t) + \beta_3 Hol + \beta_4 Weekend)$$

where S_{dt} is the sales in department *d* on day *t*. Parameter estimates from the model above are presented in Table 5. The first two rows are sales from departments (general merchandise (GM) and grocery) that these stores compete with the entrant discount store, and the subsequent rows show sales from food products that are unique at the supermarkets. The left panel in the tables shows the estimates for Store #28, and the right panel presents the results for Store #119 (corresponding to Stores A & B respectively in our theoretical model).

Most of the price index coefficients are found to be insignificant, and we find the sales to be significantly higher during holidays and weekends. Looking at the coefficients of focal interest, i.e., those representing competitor entry (Wal-Mart), we find strong evidence for the main finding in the paper. In particular, we find that the sales for the two departments (GM and Grocery) that incumbents compete with the new entrant are significantly lower at both stores (in Table 6 we show the percentage change in sales at the two stores due to competitor entry). At the same time we find strong effects for the externalities generated by Wal-Mart for the store located close to it (Store #28) with sales for several of the food products increasing significantly after competitor entry. On the other hand, for Store #119 we find the sales to fall not only in the products they compete with Wal-Mart in, but also for the food products. Note that the entrant in this case locates 2.2 miles from this store and next to a competitor grocery store. These results are consistent with our theoretical predictions in hypothesis 1a, 1b, 2a, and 2b.

The last two rows in Tables 5 & 6 show the change in store traffic and total store sales for the two incumbents due to competitor entry. We find similar results at the store level with Store *B* showing significant loss in store traffic (11%) and overall sales (16%). In contrast, the total store sales go down by only 4% for the store where the entrant is located in the same shopping plaza, and this store in fact sees a marginal increase in store traffic. In general, the tradeoff between the positive demand externality versus the losses due to competitor entry depends on the degree of overlap across the stores. For instance, if the entrant is a store like Home Depot or Barnes & Noble with little overlap with the incumbent grocery store, the positive externality could significantly outweigh any negative effects. On the other hand, if the entrant is a store like a supercenter (a discount store combined with a full supermarket), the store closer to the competitor (Store *A* in our example) is likely to be worse off. Given the prominence of this format, our results suggest that incumbent grocery stores should differentiate themselves by providing unique offerings such as ethnic and organic foods and an emphasis on home meal replacements, deli, and so forth that are not found at supercenters.

4. Conclusion and Future Research

In this paper we investigate the impact of entry by a national discount store on local retail competition. We develop a model that analyzes the competition between two multi-product stores that face entry by a differentiated competitor. Pricing strategies followed by the incumbents for the two products and the impact of competitor entry on the incumbent profitability is analyzed. Our results show that in the post entry equilibrium, the prices for the products not offered by the discounter are higher than the pre entry prices. More interestingly, contrary to the conventional wisdom we find that the store that is closer to the new entrant is better off compared to the incumbent located further away. We also find empirical evidence for our main findings.

These results have managerial implications for traditional multi-product retailers. The first is that these retailers should recognize that if entry by a large national discounter is inevitable, then it might be better to have it nearby rather than next to a competing retailer. Generally, retailers do not wish to have efficient competitors close by, but if assortments are somewhat differentiated, then the discounter acts as a filter for the nearby retailer (*A* in our model) by screening out the highly price sensitive customers. As a result, this retailer can target its marketing efforts toward the more profitable, less price sensitive customers.

Our results and analysis come with several caveats. First, in our model setup, the discount store is not a strategic player. We focus our analysis on the pricing strategies of the two traditional retailers and do not model the discounter as a strategic actor. It would be interesting in future research to change the structure of the game to incorporate the pricing strategies of the discount store. This would lead to a richer set of conclusions regarding pricing strategies for the traditional retailers as well as for the discounter. Similarly, we treat the location and product choice of the players as exogenous. Given the differences in product purchase frequency, it will be interesting to consider a model where store location as well as product choice by the players are endogenous. For instance, it may provide some insights into breadth and depth of product assortment observed by different retail formats.

Finally, our results also lend several testable hypotheses for empirical work that we were unable to test due to data limitations. For example, we predict that poor consumers shift their purchases to the discount store, which can be directly tested with individual panel data where one observes the demographic information (including income) for the panelists. Similarly, our theory predicts the relative price differences across the two stores. However, as discussed above, both the incumbent stores in our data belong to the same chain that does not vary its price across stores falling in the same price zone. We leave the tests to these claims for future research.

Appendix

This appendix contains proofs of Lemmas 1-4 and Propositions 1, 2, & 3.

Proof of Lemma 1

Suppose by contradiction that all poor consumers go to *A*, in equilibrium. Then $p_{1A} < p_{1B}$ and $p_{2A} < p_{2B}$ with $p_{kA} \le L, k = 1,2$. Then the portion of (H)igh income consumers shopping at *A* is

$$x_H = \tfrac{1}{2t}[1 + (p_{1B} + p_{2B}) - (p_{1A} + p_{2A})],$$

which is larger than $\frac{1}{2}$ by virtue of the uniformly low prices at *A*. Therefore, profits accruing to *A* are

$$\pi_A = [(p_{1A} + p_{2A}) - 2K][\alpha x_H + (1-\alpha)].$$

If retailer *A* marginally increases its price for product *k*, then its net benefit is given by

$$\frac{\partial \pi_A}{\partial p_{kA}} = \alpha x_H + (1-\alpha) + \left(\tfrac{-\alpha}{2t}\right)(p_{1A} + p_{2A} - 2K) > 1 - \alpha\left(\tfrac{3}{2} - x_H\right),$$

if $p_{kA} < L$ and by

$$\Delta_{p_{kA}} \pi_A = \alpha x_H + \left(\tfrac{-\alpha}{2t}\right)(p_{1A} + p_{2A} - 2K) > \alpha\left(x_H - \tfrac{1}{2}\right),$$

if $p_{kA} = L$, where inequalities are a result of Assumption 1. In either case, the net benefit from this deviation can be shown to be positive, since $x_H > \frac{1}{2}$. Q.E.D.

Proof of Lemma 2

By contradiction, suppose in equilibrium retailer *A* does not sell either product to poor consumers. By Lemma 1, retailer *B* has a price above *L*, say $\hat{p}_{1B} > L$. Profits to each retailer are

$$\pi_A = \alpha x_H [\hat{p}_{1A} + \hat{p}_{2A} - 2K]$$
$$\pi_B = (1-\alpha)(\hat{p}_{2B} - K) I_{\{p_{2B} \le L\}} + \alpha(1 - x_H)[\hat{p}_{1B} + \hat{p}_{2B} - 2K],$$

which are subject to the first order conditions for profit maximization with respect to p_{1A} and p_{1B}. These conditions imply that $\hat{p}_{1j} + \hat{p}_{2j} = 2K + t$, for $j = A, B$, and that $x_H = \frac{1}{2}$. Consider a deviation by retailer *A* that involves serving poor consumers. Set $\tilde{p}_{1A} = L$ and $\tilde{p}_{2A} = 2K + t - L$. This is profitable since profit from rich consumers remains the same, but now *A* earns $(1-\alpha)(L-k) > 0$ from low incomes types. Q.E.D.

Proof of Proposition 1

By Lemmas 1 and 2 the only possible equilibria has low income consumers shopping at both retailers. Hence, we can restrict attention to outcomes yielding the following profits:

$$\pi_A = (1-\alpha)(p_{1A} - K) + \alpha\, x_H (p_{1A} + p_{2A} - 2K)$$
$$\pi_B = (1-\alpha)(p_{2B} - K) + \alpha\, x_H (p_{1B} + p_{2B} - 2K),$$

where we assume without loss of generality, $p_{1A}, p_{2B} \le L$. Solving $\max_{p_{1A}, p_{2A}} \pi_A$ subject to $p_{1A} \le L$, and $\max_{p_{1B}, p_{2B}} \pi_B$ subject to $p_{2B} \le L$, leads to the system of equations

$$\frac{\partial \pi_A}{\partial p_{2A}} = \alpha\left(\frac{t + p_{1B} + p_{2B} - p_{1A} - p_{2A}}{2t}\right) - \alpha\left(\frac{p_{1A} + p_{2A} - 2K}{2t}\right) = 0 \qquad \text{(A.1)}$$

$$\frac{\partial \pi_B}{\partial p_{1A}} = \alpha\left(1 - \frac{t + p_{1B} + p_{2B} - p_{1A} - p_{2A}}{2t}\right) - \alpha\left(\frac{p_{1B} + p_{2B} - 2K}{2t}\right) = 0 \tag{A.2}$$

$$\frac{\partial \pi_A}{\partial p_{1A}} = (1-\alpha) + \alpha\left(\frac{t + p_{1B} + p_{2B} - p_{1A} - p_{2A}}{2t}\right) - \alpha\left(\frac{p_{1A} + p_{2A} - 2K}{2t}\right) \geq 0 \tag{A.3}$$

$$\frac{\partial \pi_B}{\partial p_{2B}} = (1-\alpha) + \alpha\left(1 - \frac{t + p_{1B} + p_{2B} - p_{1A} - p_{2A}}{2t}\right) - \alpha\left(\frac{p_{1B} + p_{2B} - 2K}{2t}\right) \geq 0\,. \tag{A.4}$$

There is no solution such that (A.1)-(A.4) are satisfied with equality. However, under Assumption 2, (A.1) and (A.2) are satisfied with $\hat{p}_{1A} + \hat{p}_{2A} = \hat{p}_{1B} + \hat{p}_{2B} = 2K + t$. Then (A.3) and (A.4) hold with strict inequality, suggesting the corner solution in which $\hat{p}_{1A} = \hat{p}_{2B} = L$. Solving for $\hat{p}_{2A}$ and $\hat{p}_{1B}$ gives the prices as stated in the proposition. Assumptions 1 and 2 imply $L < \hat{p}_{2A,}\, \hat{p}_{1B} < H - s$. This solution constitutes an equilibrium, so long as there is no profitable deviation. We can rule local deviations by virtue of the maximization. However, we must check whether it is profitable for one retailer, say *A*, to undercut *B* with the price $p_{2A} = \hat{p}_{2A} - \varepsilon = L - \varepsilon$, for small $\varepsilon > 0$. The payoff in this deviation is

$$(2L - \varepsilon - 2K)(1-\alpha) + \alpha(2L - \varepsilon - 2K)\left(\frac{1}{2} + \frac{2K + t - 2L - \varepsilon}{2t}\right),$$

because all poor consumers buy both products from *A*. This payoff is clearly decreasing in ε, so we let $\varepsilon \downarrow 0$ and derive the net benefit from this deviation:

$$\delta = -\frac{2\alpha}{t}(L-K)^2 + (1+\alpha)(L-K) - \frac{\alpha t}{2}\,.$$

It can be shown that $\delta < 0$ if

$$L - K < f(\alpha) \equiv \frac{1 + \alpha - \sqrt{(1+\alpha)^2 - 4\alpha^2}}{4\alpha} t\,.$$

Since $f(\alpha)$ is increasing in α and $\lim_{\alpha \to 0} f(\alpha) = 0 < f(\alpha) < \frac{t}{2} = \lim_{\alpha \to 1} f(\alpha)$, there exists $\alpha_{BE} \in (0,1)$ so that $0 < L - K = f(\alpha_{BE})$. Hence, there is no profitable deviation (i.e. $\delta < 0$) for any $\alpha \in (\alpha_{BE}, 1)$. Q.E.D.

Proof of Lemma 3

(i) Since Big Basket rich consumers visit store *C* to buy product 3, the assumption that store *C* has the lowest price for product 2 implies that these consumers will buy it there while buying product 3. Therefore, they will visit exactly one more store (either *A* or *B*) for product 1. (ii) Since no consumer will visit a number of stores greater than the number of products demanded, it is sufficient to show that Small Basket rich consumers will not visit two stores. Define a *two-store shopping plan* as a pair (s_1, s_2), $s_i \in \{A, B, C\}$, $s_1 \neq s_2$, which prescribes the consumer to buy product i from store s_i. Since *C* does not offer product 1, we have four possible two-store shopping plans: (*A*,*B*), (*B*,*A*), (*A*,*C*) or (*B*,*C*). First, we show that shopping plans (*A*,*B*) and (*B*,*A*) cannot be an equilibrium shopping plan for Small Basket rich consumers because they are dominated by either (*A*,*C*) or (*B*,*C*). Denote $c_x(s_1, s_2)$ as the cost incurred by a consumer located at *x* carrying out the shopping plan inclusive of price. Since $p_{1A},\ p_{1B} > K$, then for any x,

$$\begin{aligned}\min\{c_x(A,B), c_x(B,A)\} &= \min\{p_{1A}, p_{1B}\} + \min\{p_{2A}, p_{2B}\} + t + s \\ &> \min\{p_{1A}, p_{1B}\} + p_{2C} + t + s \\ &= \min\{c_x(A,C), c_x(B,C)\}.\end{aligned}$$

Next, we exclude (*A*,*C*). Suppose this plan were part of an equilibrium. Then we must have $p_{2C} + s < p_{2A}$. But then no one will buy product 2 at *A*. Hence, there is a profitable deviation for *A* to lower its price to $p_{2A} = p_{2C} + s = K + s$ and receive positive profits. It remains to show that (*B*,*C*) cannot arise in equilibrium. Suppose prices p_{1A}, p_{2A}, p_{1B}, p_{2B} yielded (*B*,*C*) as the optimal shopping plan for some Small Basket rich consumers. We show that such pricing behavior yields a contradiction. The hypothesis implies that $p_{1B} < p_{1A}$. And since $p_{2C} < p_{2A}$, no poor consumers will patronize *A*. A Small Basket rich consumer located at *x* will buy the bundle from *A* if it is cheaper then buying the bundle from *B*

$$p_{1A} + p_{2A} + xt + s < p_{1B} + p_{2B} + (1-x)t + s$$

and cheaper than (*B*,*C*)

$$p_{1A} + p_{2A} + xt + s < p_{1B} + p_{2C} + t + 2s\ .$$

Let x_2 and x_{2A} be defined, respectively, as satisfying the above two conditions with equality, then

$x_2 = \frac{1}{2t}\left[(p_{1B} + p_{2B}) - (p_{1A} + p_{2A}) + t\right]$ and $x_{2A} = \frac{1}{t}\left[(p_{1B} + p_{2C}) - (p_{1A} + p_{2A}) + t + s\right]$. Hence, Small Basket rich consumers with $x < x_2$ prefer the bundle at *A* to the bundle at *B* and with $x < x_{2A}$ prefer the bundle at *A* to (*B,C*). Similarly, Small Basket rich consumers at *x* prefer the bundle at *B* over (*B,C*) if $p_{1B} + p_{2B} + (1-x)t + s < p_{1B} + p_{2C} + t + 2s$, or equivalently, if $x > x_{2B} = \frac{1}{t}\left[p_{2B} - p_{2C} - s\right]$. We observe that $x_2 = (x_{2A} + x_{2B})/2$, which implies that x_2 lies between x_{2A} and x_{2B}. Thus, there are two possibilities to consider. First, $x_{2B} < x_2 < x_{2A}$ implies that all Small Basket rich consumers prefer buying the bundle at either *A* or at *B* to shopping around (i.e. to (*B,C*)), which contradicts the hypothesis that (*B,C*) is optimal for some Small Basket consumers. Hence, $x_{2A} < x_2 < x_{2B}$. Big Basket rich consumers located a *x* will shop at *A* (for product 1) and *C* (for products 2 and 3) if it is cheaper than shopping at *B* (for product 1) if

$$p_{1A} < p_{1B} + (1-x)t,$$

or equivalently if $x < x_1 = (p_{1B} - p_{1A} + t)/t$. Thus profits to each store can be written as

$$\pi_A = \alpha(1-\beta)(p_{1A} + p_{2A} - 2K)x_{2A} + \alpha\beta(p_{1A} - K)x_1, \text{ and}$$

$$\pi_B = \alpha(1-\beta)(p_{1B} + p_{2B} - 2K)(1 - x_{2B}) + \left[(1-\alpha) + \alpha\beta(1-x_1) + \alpha(1-\beta)(x_{2B} - x_{2A})\right](p_{1B} - K).$$

Prices must be mutually optimal for the two firms. Therefore, interior optima must satisfy the first order conditions for profit maximization, which imply the following prices:

$$p_{1A} = K + \frac{1+\alpha}{3\alpha}t - \frac{1-\beta}{3}s, \qquad p_{2A} = K + \frac{s}{2},$$

$$p_{1B} = K + \frac{2-\alpha}{3\alpha}t - \frac{1-\beta}{3}s, \qquad \text{and} \qquad p_{2B} = K + \frac{t+s}{2}.$$

It follows that

$$x_{2B} - x_{2A} = \frac{(-2-\alpha)t - \alpha(5+\beta)s}{6\alpha\beta t} < 0,$$

or equivalently $x_{2B} < x_{2A}$, which is a contradiction. Note that if $H > \frac{1}{4}(5K + 3L) + t + \frac{3}{2}s$, then the following corner solution is mutually optimal for both firms:

$$p_{1A} = \frac{1}{2}(K + L + t), \qquad p_{2A} = K + \frac{s}{2},$$

$$p_{1B} = L, \qquad p_{2B} = K + \frac{t+s}{2}.$$

This leads to $x_{2B} - x_{2A} = (K - L - 2s)/t$, which is less than 0 since $L > K$. Hence, $x_{2B} < x_{2A}$, again a contradiction. Q.E.D.

Proof of Lemma 4

Suppose product 1 is cheaper at *A*: $p_{1A} < p_{1B}$. Then all Big Basket consumers will shop at retailer *C* for good 3. While there, these consumers also buy product 2 at *C*. Furthermore, all Big Basket consumers buy product 1 from *A*: poor Big Basket consumers since it has the lowest price; rich consumers since they, already at retailer *C*, do not benefit from incurring costs traveling to *B*. Now consider Small Basket consumers. Poor Small Basket consumers shop at *A* and *C* for products 1 and 2, respectively. Rich Small Basket consumers shop either at *A* or at *B* and buy both products at one of these stores. (Recall that rich consumers visit no more than one store for two products, by Lemma 1.) A rich Small Basket consumer located at *x* will shop at *A* if

$$x < x_S \equiv \frac{(p_{1B} + p_{2B}) - (p_{1A} + p_{2A})}{2t}.$$

(As noted previously, these consumers make their retailer choice based solely on the price of the bundle of the items.) The consumer behavior described above generates the following profit functions for each retailer:

$$\pi_A = (1-\alpha)(p_{1A} - K) + \alpha\beta(p_{1A} - K) + \alpha(1-\beta)(p_{1A} + p_{2A} - 2K)x_S$$

$$\pi_B = \alpha(1-\beta)(p_{1B} + p_{2B} - 2K)(1 - x_S).$$

We now show that there exists a profitable deviation whenever $p_{1A} < p_{1B}$. First suppose $p_{1A} > K$. Then *B* can always lower its price on product 1 and raise its price on product 2 so that $p_{2A} + p_{2B}$ does not change, but $K < p_{2A} < p_{1A}$. In such a deviation, retailer *B* retains the same rich Small Basket consumers and steals all poor consumers buying product 2. Hence, this is a profitable deviation for *B*. Next, suppose $p_{1A} = K < p_{1B}$. Then clearly *A* can raise its price on product 1 slightly and lower its price on product 2 while preserving the sum $p_{1A} + p_{2A}$. This is profitable since it retains the same customers, but extracts positive revenues from its poor customers. Hence, it is not possible to have an equilibrium with $p_{1A} < p_{1B}$. Finally, we consider the case when $p_{1A} = p_{1B}$ and show there always exists a profitable deviation. Note that this implies the following profits for the two retailers:

$$\pi_A = \frac{(1-\alpha)}{2}(p_{1A} - K) + \alpha\beta(p_{1A} - K)x_B + \alpha(1-\beta)(p_{1A} + p_{2A} - 2K)x_S$$

$$\pi_B = \frac{(1-\alpha)}{2}(p_{1B} - K) + \alpha\beta(p_{1B} - K)(1-x_B) + \alpha(1-\beta)(p_{1B} + p_{2B} - 2K)(1-x_S),$$

where $x_i \in (0,1)$ is the portion of consumers with basket size $i = B, S$ shopping at *A*. If $p_{1A} = p_{1B} = K$, then either retailer, say *A*, can earn more profits by slightly raising its price on product 1 since it would loose no revenue from the poor segment and improve revenues from the rich segment. If $p_{1A} = p_{1B} > K$ then either retailer, say *A*, can be profitable by lowering p_{1A} by a small amount (some $\varepsilon > 0$, sufficiently small) while raising p_{2A} so that $p_{1A} + p_{2A}$ remains constant since it experiences a discrete gain in poor consumers and no loss from the rich consumers. Q.E.D.

Proof of Proposition 2

(i) The first order conditions of (1) with respect to (p_{1A}, p_{2A}) and (2) with respect to (p_{1B}, p_{2B}) imply interior maxima, as presented in part (i). To validate that these prices are, in fact, an equilibrium, we verify that that the outcome is

(a) consistent with our assumptions on consumer behavior
(b) not subject to profitable deviations by either retailer,
for all α and β sufficiently large.

(a) The conditions $p_{1B}^* \le L$ and $p_{1B}^* < p_{1A}^*$ were assumed in our formulation of profit functions (1) and (2). The first is implied by Assumption 1 if $\alpha > \frac{1}{1+\beta/4}$. The second holds if and only if $\alpha > \frac{1}{1+\beta}$. Since $\alpha_{AE} > \frac{1}{1+\beta/4} > \frac{1}{1+\beta}$, both conditions hold for $\alpha > \alpha_{AE}$. Finally, Assumption 3 ensures positive demand for product 2 at retailer *A* from Small basket rich consumers since $p_{2A}^* \le K + s$. Hence, prices (p_{1A}^*, p_{2A}^*), (p_{1B}^*, p_{2B}^*) are consistent with our assumptions on consumer behavior. (b) To check for profitable deviations, first note that the profits at these prices can be expressed as in (4) and (5). Local deviations cannot be profitable by the maximization conditions on (1) and (2). We now check "jump" deviations. First consider a deviation by B with some $\tilde{p}_{1B} > p^*_{1A}$. In this case, retailer B looses all poor consumers as well as all rich Big Basket consumers ($x_B > 1$). This leaves B with profits

$$\tilde{\pi}_B = \alpha(1-\beta)(\tilde{p}_{1B} + \tilde{p}_{2B} - 2K)(1-\tilde{x}_S),$$

where, $\tilde{x}_S = \left[(\tilde{p}_{1B} + \tilde{p}_{2B}) - (p^*_{1A} + p^*_{2A}) + t\right]/(2t) < \frac{1}{2}$. This deviation is not profitable, since

$$\begin{aligned} \max_{\tilde{p}_{1B},\tilde{p}_{2B}} \tilde{\pi}_B &= \alpha(1-\beta)(t+2K) \\ &= \alpha(1-\beta)(p^*_{1B} + p^*_{2B} - 2K)(1-\bar{x}_S) < \pi^*_B, \end{aligned}$$

where the inequality can be seen by comparing this expression with (2) at (p^*_{1B}, p^*_{2B}). Now suppose retailer A deviates by undercutting B for product 1. That is, consider the deviation by A with $\tilde{p}_{1A} = p^*_{1B} - \varepsilon$, for small $\varepsilon > 0$. Any such deviation is most profitable if A sets $\tilde{p}_{2B}$ in order to maintain the bundled price $\tilde{p}_{1A} + \tilde{p}_{2A} = t + 2K$. This yields profits of in the limit, with $\varepsilon \downarrow 0$.

$$\begin{aligned} \tilde{\pi}_A &= \alpha\beta(\tilde{p}_{1A} - K) + \alpha(1-\beta)(p_{1A} + p_{2A} - 2K)\tilde{x}_S + (1-\alpha)(\tilde{p}_{1A} - K) \\ &= \left[\left(\frac{2(1-\alpha)}{3\alpha\beta} + \frac{1}{3}\right)(\alpha\beta - \alpha + 1) + \frac{\alpha(1-\beta)}{2}\right]t. \end{aligned}$$

Using the above and comparing with the profits in (4), we can express the direct gain from deviation:

$$\pi^*_A - \tilde{\pi}_A = \frac{\alpha^2(\beta^2 + 5\beta^2 - 5) + 5\alpha(2-\beta) - 5}{9\alpha\beta}t. \tag{A.8}$$

For any $\beta \in (0,1)$, (A.8) is positive for $\alpha > \alpha_{AE}(\beta)$. (ii) follows from direct substitution of equilibrium prices into (3). Q.E.D.

Proof of Proposition 3

Consider the difference in retailer's equilibrium profits, as expressed in (4) and (5):

$$\pi^*_A - \pi^*_B = \frac{\alpha^2(\beta - 1) + 2\alpha - 1}{3\alpha\beta}t.$$

This difference is positive for $\frac{1}{1+\sqrt{\beta}} < \alpha < \frac{1}{1-\sqrt{\beta}}$. These conditions, however, are implied by the assumed conditions in Proposition 2. Q.E.D.

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Table 2: Illustration of Four Consumer Segments

	α $(t > 0, s > 0, v_i = H, i = 1,2)$	$1-\alpha$ $(t = 0, s = 0, v_i = L < H, i = 1,2)$
β $(v_3 > 0)$	high income consumers who need product 1,2 and 3	low income consumers who need product 1,2 and 3
$1-\beta$ $(v_3 = 0)$	high income consumers who need product 1,2 only	low income consumers who need product 1,2 only

Table 3: Summary of the Results from Proposition 2

	After Entry($\alpha > \alpha_{AE}$) Store A	Store B	Before Entry
p_1	$K + \frac{(1-\alpha)}{3\alpha\beta}t + \frac{2}{3}t$	$K + \frac{2(1-\alpha)}{3\alpha\beta}t + \frac{1}{3}t$	L or $2K + t - L$
p_2	$K - \frac{(1-\alpha)}{3\alpha\beta}t + \frac{1}{3}t$	$K - \frac{2(1-\alpha)}{3\alpha\beta}t + \frac{2}{3}t$	$2K + t - L$ or L
q_1	$\frac{1}{3} + \frac{1}{6}\alpha + \frac{1}{6}\alpha\beta$	$\frac{2}{3} - \frac{1}{6}\alpha - \frac{1}{6}\alpha\beta$	$1 - \frac{1}{2}\alpha$ or $\frac{1}{2}\alpha$
q_2	$\frac{1}{2}\alpha(1-\beta)$	$\frac{1}{2}\alpha(1-\beta)$	$\frac{1}{2}\alpha$ or $1 - \frac{1}{2}\alpha$
π	$\frac{\alpha^2(2+\beta-\beta^2)+\alpha(8\beta-4)+2}{18\alpha\beta}t$	$\frac{\alpha^2(8+\beta-7\beta^2)+\alpha(8\beta-16)+8}{18\alpha\beta}t$	$(L-K)(1-\alpha) + \frac{1}{2}\alpha t$

Table 4: Comparative Statics

	Store A α	Store A β	Store B α	Store B β
p_1	$\downarrow^*$	$\downarrow$	$\Downarrow^{**}$	$\Downarrow$
p_2	$\uparrow$	$\uparrow$	$\Uparrow$	$\Uparrow$
q_1	$\uparrow$	$\uparrow$	$\downarrow$	$\downarrow$
q_2	$\uparrow$	$\downarrow$	$\uparrow$	$\downarrow$

* is interpreted as when α goes up, p_1 at store A decreases.

** is interpreted as when α goes up, p_1 at store B decreases, and the marginal effect is stronger for the price at store B than that for store A.

Table 5: Regression Results

	Store 28					Store 119				
	Intercept	Wal-Mart	Price Index	Holiday	Weekend	Intercept	Wal-Mart	Price Index	Holiday	Weekend
GM	7.554	-0.398	-0.042	0.071	0.393	7.738	-0.434	-0.054	0.065	0.412
	(0.056)	(0.012)	(0.087)	(0.013)	(0.013)	(0.033)	(0.010)	(0.039)	(0.011)	(0.011)
Grocery	9.416	-0.071	-0.028	0.042	0.273	9.671	-0.194	-0.014	0.032	0.312
	(0.046)	(0.010)	(0.073)	(0.011)	(0.011)	(0.023)	(0.007)	(0.028)	(0.008)	(0.008)
Dairy	8.058	0.018	0.029	0.058	0.251	8.304	-0.165	0.017	0.045	0.294
	(0.050)	(0.011)	(0.078)	(0.012)	(0.012)	(0.026)	(0.008)	(0.030)	(0.009)	(0.009)
Bakery	6.742	0.066	-0.021	0.051	0.295	6.930	0.031	-0.023	0.032	0.342
	(0.052)	(0.011)	(0.082)	(0.012)	(0.013)	(0.026)	(0.008)	(0.031)	(0.009)	(0.009)
Deli	6.845	0.067	-0.083	0.020	0.379	7.215	-0.058	-0.085	0.020	0.418
	(0.056)	(0.012)	(0.088)	(0.013)	(0.014)	(0.032)	(0.010)	(0.039)	(0.011)	(0.011)
Fish	5.323	0.224	-0.026	0.162	0.052	5.312	-0.013	-0.020	0.142	0.088
	(0.131)	(0.028)	(0.205)	(0.031)	(0.031)	(0.084)	(0.026)	(0.100)	(0.028)	(0.028)
Meat	7.950	-0.042	-0.064	0.084	0.337	8.066	-0.229	-0.049	0.051	0.378
	(0.067)	(0.015)	(0.105)	(0.016)	(0.016)	(0.035)	(0.011)	(0.041)	(0.012)	(0.012)
Produce	7.859	0.024	-0.218	0.000	0.274	8.139	-0.118	-0.175	-0.006	0.297
	(0.053)	(0.011)	(0.083)	(0.013)	(0.013)	(0.033)	(0.010)	(0.039)	(0.011)	(0.011)
Frozen Food	7.773	0.005	-0.012	-0.015	0.258	8.033	-0.174	-0.064	-0.011	0.311
	(0.051)	(0.011)	(0.080)	(0.012)	(0.012)	(0.027)	(0.008)	(0.033)	(0.009)	(0.009)
Cheese	3.832	0.318	-0.137	0.105	0.372	4.181	0.029	-0.106	0.067	0.454
	(0.105)	(0.023)	(0.164)	(0.025)	(0.025)	(0.069)	(0.021)	(0.082)	(0.023)	(0.023)
Conven Food	3.932	0.151	-0.139	-0.078	-0.026	4.861	-0.121	-0.035	-0.014	-0.077
	(0.093)	(0.020)	(0.145)	(0.022)	(0.022)	(0.052)	(0.016)	(0.062)	(0.017)	(0.018)
Bulk Food	5.614	0.126	-0.062	0.068	0.184	6.314	-0.260	0.080	0.073	0.232
	(0.077)	(0.017)	(0.121)	(0.019)	(0.019)	(0.041)	(0.013)	(0.049)	(0.014)	(0.014)
Traffic	7.505	0.011	-0.005	0.014	0.091	7.729	-0.109	-0.045	0.008	0.164
	(0.025)	(0.005)	(0.039)	(0.006)	(0.006)	(0.015)	(0.005)	(0.018)	(0.005)	(0.005)
Store Sales	10.289	-0.0412	0.08626	0.041	0.28659	10.601	-0.1764	0.03762	0.036	0.32547
	(0.045)	(0.010)	(0.071)	(0.011)	(0.011)	(0.023)	(0.007)	(0.028)	(0.008)	(0.008)

Table 6: Sales Changes after Wal-Mart's Entry

Department	% Change(Store A)	% Change(Store B)
GM	-32.6%	-35.2%
Grocery	-6.4%	-17.4%
Dairy	1.3%	-14.9%
Bakery	7.4%	3.3%
Deli	7.4%	-5.7%
Fish	25.7%	-1.6%
Meat	-3.4%	-20.3%
Produce	2.8%	-11.6%
Frozen Food	0.8%	-16.0%
Cheese	39.1%	3.2%
Conven Food	16.4%	-11.5%
Bulk Food	14.0%	-22.2%
Traffic	0.9%	-10.4%
StoreSales	-4.0%	-16.2%

Figure 1: The locations of the stores

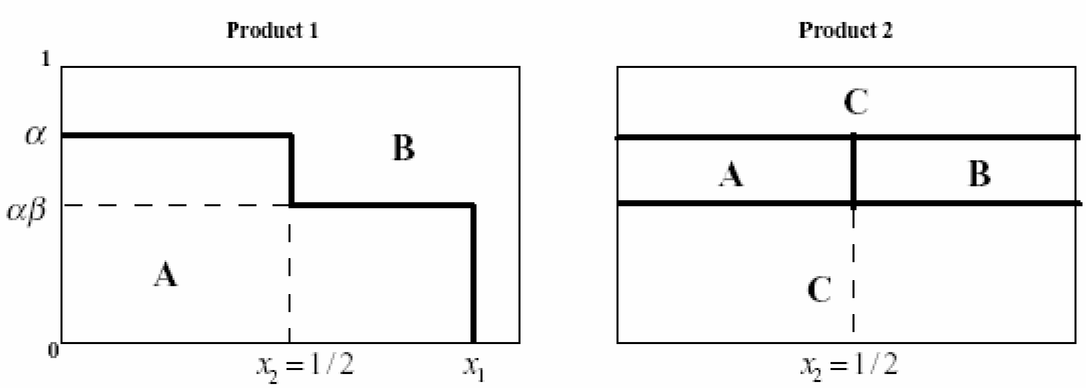

Figure 2: Market Share of Each Store