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BEYOND PROMOTION-BASED STORE SWITCHING: ANTECEDENTS AND CONSEQUENCES OF SYSTEMATIC MULTIPLE-STORE SHOPPING

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Abstract

In this paper, we demonstrate that single-purpose multiple store shopping is not only driven by opportunistic, promotion-based motivations, but may also be part of a longer term shopping planning process based on stable store characteristics. Starting from a utility-maximizing shopping behavior model, we find that consumers systematically visit multiple stores to take advantage of two types of store complementarity. With 'fixed cost complementarity', consumers alternate visits to highly preferred but high fixed cost-stores, with in-between trips to less appealing, low fixed cost- stores. This compromise strategy allows them to balance transaction and holding costs against acquisition costs. 'Category preference complementarity' occurs when different stores offer the 'best value' for different product categories. It is found to be an important driver of multiple store shopping, and a necessary condition for combined (chained) shopping trips. Tying these multiple store shopping motivations to characteristics of different grocery store formats leads to interesting new insights into the nature of retail competition and the strategic role of more quality-oriented retail marketing mix instruments.

1. Introduction

One of the most important trends characterizing today's grocery retail business is the massive rise in multiple store patronage (Kahn and McAlister 1997). Rather than passively revisiting the same store – out of habit or due to an aversion to change - consumers actively exploit the opportunities offered by a differentiated retail environment, by visiting two or more stores on a regular basis. In fact, strictly store loyal consumers have become the exception rather than the rule. A recent survey by Progressive Grocer indicates, for instance, that "75% of all grocery shoppers report regularly shopping more than one store each week" (Stassen et al. 1999). Similar figures are reported in Drèze and Vanhuele (2003) and Fox and Hoch (2004).

The marketing literature has typically viewed grocery store switching as evidence of *opportunistic* or cherry picking behavior, consumers switching stores to benefit from temporary promotional offers (see e.g. Lal and Rao 1997, Bell and Lattin 1998, Drèze 1999, Fox and Hoch 2003). There is a growing belief, however, that multiple store shopping cannot be ascribed to price promotions alone (see e.g. Popkowski-Leszczyc and Timmermans 1997, Krider and Weinberg 2000). First, the stability and regularity of multiple store shopping patterns reported in recent papers does not fit in with the picture of cherry picking consumers selecting stores on the basis of temporary 'best deals' (Galata et al 1999, Rhee and Bell 2002). Second, the fraction of consumers who decide where to shop on the basis of feature ads or store fliers, is found to lie in the 10-35% range (see e.g. Urbany et al. 1996, FMI 1993)- far below the fraction of shoppers who regularly visit multiple stores (about 75%, see above). Empirical evidence that sales promotions induce store switching and enhance store sales also remains limited (see e.g. Rhee and Bell 2002, Srinivasan et al 2001)[i]. This suggests that consumers may *systematically* visit multiple stores for reasons *other than promotional offers*.

In this paper, we study non-promotional motives for multiple store shopping. To improve our understanding of systematic multiple store shopping (SMS) and its implications, we develop a formal model of consumer shopping behavior. The model integrates insights from the geographical and the marketing literature on shopping behavior, providing a more comprehensive representation of the benefits and costs that drive shopping decisions. In addition to store choice, we incorporate decisions on shopping frequency, category allocation, and trip organization.

Our paper – which has a conceptual focus - contributes to the available literature in several ways. We offer two main *substantive* insights. First, we show that, even in the absence of temporary promotional offers, consumers may have good reasons to patronize more than one store format. In particular, we find that SMS only occurs among 'complementary' stores, the two types of complementarity being: (i) *fixed cost complementarity* (store difference in fixed shopping costs such as transportation and in-store costs) and/or (ii) *category preference complementarity* (stores providing superior price/quality position for a different subset of categories). Second, we link consumers' motives for visiting multiple stores with their shopping trip organization, i.e., whether different stores are visited on the same or separate shopping trips. This, in turn, will strongly affect how category purchases are allocated across stores.

From a *managerial* perspective, we shed new light on the nature of competition between retail store formats and its marketing strategy implications. We show that the type and degree of store complementarity may determine whether it is more beneficial to strive towards customer loyalty or towards a higher penetration and share of wallet among multiple store shoppers. In addition, using a set of realistic simulations, we illustrate how price as well as more quality oriented marketing instruments can be used to achieve these objectives.

The discussion is organized as follows. We first present a conceptual framework describing the shopping decision process. Building on this framework, section 3 specifies a mathematical shopping decision model, with its implied shopping pattern alternatives and the conditions under which they prevail. Section 4 uses these general insights to characterize the competition *between* grocery store formats. To clarify the strategic implications of SMS, we also simulate the outcomes (shopping patterns, store choice and category allocation decisions) of alternative marketing strategies. Section 5 provides some empirical evidence confirming the importance of SMS, its underlying motivations, and implications for retail competition. Section 6, presents conclusions, limitations, and areas for future research.

2. Related literature and Conceptual Framework

Our paper builds upon two main streams of literature: the marketing-based literature on store choice models, and the predominantly geographical oriented literature on multipurpose shopping and spatial interaction models.

Marketing papers on store choice mostly concentrated on *single purpose* shopping, where consumers face a choice between *competitive* stores that offer essentially similar assortments. These papers model the consumer's selection of a retail outlet at a given point in time, typically assuming that consumers select the store that provides the maximum (fixed and variable) shopping utility, and that they assign their entire shopping basket to this store (see e.g. Messinger and Narasimhan 1997, Bell et al. 1998). Within this setting, shifts in store patronage over time are especially related to changes in the consumer's shopping list and other situational factors - such as promotions – that affect the consumers' variable shopping costs.

More recent marketing papers have somewhat relaxed this focus on single store selection. Lal and Rao (1997), Bell and Lattin (1998), and Galata et al (1999), for instance, developed predictive and normative models of how promotional price cuts affect consumers' selection of store formats, either alone or in combination. In this framework, multiple store shopping is triggered by consumers' search for bargains, multiple store shoppers being time rich, price sensitive consumers. However, as specials are typically offered at random points in time, and given that empirically observed store switching effects are not overwhelming, other forces must underlie systematic multiple store visits for groceries. In an exploratory analysis of consumers' shopping behavior across and within retail formats, Fox et al. (2004) find that - besides promotions – stable store format features such as assortment and accessibility do affect multiple store patronage. Their results also suggest that consumers' preferences for alternative formats are interrelated. Based on these findings, the authors call for research that sheds more light on the complementarity and substitutability of stores in different formats, accounting for consumers' 'higher-order shopping strategies'.

The latter issues received widespread attention in the geographically oriented literature on spatial interaction models (see e.g. Ghosh and McLafferty 1984, Ingene and Ghosh 1990, Dellaert et al. 1998). In these papers, multiple store shopping is seen as the outcome of shopping location choices, taking into account more than one shopping purpose or need. Often, not all locations can satisfy the full set of purchase needs (e.g. groceries as well as shoe repair services). In such cases, needs may be systematically allocated to different shopping locations depending on whether other, *complementary* shopping tasks have to be fulfilled on the shopping trip. For instance, consumers will buy their groceries on a different (often more remote) location when they also need to visit a shoe repair shop. Buying frequently purchased products such as groceries at different locations allows to reduce transportation and holding costs, and hence minimize overall shopping costs.

A key question is to what extent these insights from multipurpose studies remain relevant when consumers have only a single purpose – buying groceries. It should be recognized that, in the above-mentioned papers, multiple store shopping arises because some locations only carry a subset of product categories. While this assumption is valid for multi-purpose shopping trips, it may not hold for the single-purpose grocery shopping trips. An interesting study by Krider and Weinberg (2000) *does* analyse single purpose grocery shopping in two different store formats. Yet, in this study, store formats take on similar price positions in each category. As a result of this restriction, multiple store patronage is driven by storage cost differences between categories, other motivations underlying SMS remaining uncovered.

In sum, while providing relevant insights, the literature to date leaves us with a challenging research issue: to explore the reasons behind, and the strategic consequences of, systematic multiple store shopping in a single purpose context (grocery shopping), where consumers face a variety of store formats with the same categories but with a different price/quality positioning.

Figure 1 summarizes our conceptual framework, which extends the available literature in several ways. In line with Bell et al. (1998), we start from the premise that consumers strive to maximize overall (fixed and variable) shopping utility when making their shopping decisions. However, while Bell et al. (1998) focus on store choice, we extend their analysis by including additional shopping decisions affecting the attained utility level (see right panel of Figure 1):

- The selection of the *type of shopping trip* or *trip organization*, where we distinguish between the following three generic patterns:
  - (I) *Single Store* Shopping Pattern: here, the consumer always visits the same store

- (II) *Separate Store* Shopping Pattern: the consumer patronizes multiple stores, but visits only one store on each shopping trip. A trip refers to one displacement by a consumer to buy groceries, usually starting from and returning to his home.
- (III) *Combined Store* Shopping Pattern: the consumer patronizes more than one store on each shopping trip.

- The *selection of the specific store(s)* to be visited.
- The determination of the number of shopping trips for each store, i.e. store specific *shopping frequency*.
- The *allocation of category purchases* over stores.

When making these decisions, consumers trade off several types of shopping benefits and costs (see central box in Figure 1). Based on the spatial interaction model literature (see e.g. Ghosh and McLafferty 1984, Bawa and Ghosh 1999), we specify the consumer's shopping decision process as a cost minimization problem, and include three types of *costs*: (i) acquisition costs or variable shopping costs (the amount to be paid to acquire the products), (ii) handling and holding costs (costs of handling and storing the products at home), and (iii) transaction costs or fixed shopping costs incurred each time a shopping trip is made and consisting of transportation and in-store costs. Transportation costs stem from the time and effort to go to the store, typically related to store distance. In-store costs refer to time costs of walking through the aisles and waiting at the checkout.

In addition, building upon the marketing-oriented shopping studies (see e.g. Tang et al. 2001), we account for variable and fixed shopping *benefits:* (i) consumption benefits (the utility of consuming the products), and (ii) fixed in-store benefits (the pleasure derived from the shopping act which, for instance, is enhanced by store ambience and service level, see e.g. Berman and Evans 1999).

Given our interest in systematic multiple store shopping, we focus on *equilibrium* shopping patterns, based on *regular* benefits and costs (see Krider and Weinberg 2000, Galata et al. 1999, Ghosh and McLafferty 1984, Ingene and Ghosh 1990, and Bawa and Ghosh 1999 for a similar approach). As indicated in the left panel of Figure 1, the level and importance of these benefits and costs will depend on a combination of store and product category characteristics. Consumption benefits may, for instance, differ across stores as a result of differences in assortment quality and variety for the required categories. Concentrating on these *stable* shopping factors allows us to isolate the phenomenon of SMS.

3. Shopping behavior model

In this section we model the consumer's shopping cost function (3.1), and derive conditions under which alternative shopping patterns are optimal (3.2).

3.1. Shopping Cost Function

Let s be a store indicator, and p a product category indicator. Like Ghosh and McLafferty (1984), we assume that a consumer's shopping pattern includes *at most* two stores (s=s1,s2). For simplicity of exposition, we also present our model and results for two product categories (p=p1,p2). Yet, we relax the assumption that one of the product categories can be purchased in one store only, and generalize to more than two product categories in section 4. Building on Ghosh and McLafferty's (1984) spatial interaction model, we propose the following expressions for the consumer's total shopping cost during a specified planning horizon (to avoid notational burden, we omit the consumer superscript[ii]):

For shopping patterns involving a single store s1 only (pattern I):

[1a] $$TC_{I,s1} = \sum_p [VC_{p,s1}D_p + S_p D_p / 2N_{s1}] + t_{s1}N_{s1}$$

For consumers visiting two different stores (s1 and s2) on separate shopping trips (pattern II):

[1b] $$TC_{II} = [\sum_{s=s1,s2} (\sum_p (\alpha_{p,s} VC_{p,s} D_p + \alpha^2_{p,s} S_p D_p / 2N_{s,p}) + t_s N_s)]$$

For shopping patterns involving combined trips to stores s1 and s2 (pattern III):

[1c] $$TC_{III} = [\sum_p (\alpha_{p,s1} VC_{p,s1} D_p + \alpha_{p,s2} VC_{p,s2} D_p) + \sum_p S_p D_p / 2N_{s1s2} + t_{s1s2} N_{s1s2}]$$

where

TC = total shopping cost per period (i.e., the consumer's planning horizon)

$\alpha_{p,s}$ = the fraction of category p's demand per period, purchased in store s

$VC_{p,s}$ = net variable shopping cost per unit for category p in store s

D_p = demand per period for category p

S_p = storage cost per unit of category p per period

N_s (N_{s1s2}) = number of shopping trips per period to store s (combined trips to stores s1 and s2)

$N_{s,p}$ = number of shopping trips per period to store s on which category p is purchased

$t_s(t_{s1s2})$= net fixed shopping cost per trip to store s (per combined trip to stores s1 and s2)

In each of these expressions, three cost types intervene:

- The first is the *total net variable shopping cost* over the planning period, which depends on the consumer's category demand (D_p) and on how category purchases are allocated across stores ($\alpha_{p,s,}$). The net variable shopping cost for a *unit* of category p in store s ($VC_{p,s}$) is specified as the difference between price ($P_{p,s}$) and quality/consumption benefits ($Q_{p,s}$) per unit of category p bought in store s.
- The second term captures the total *holding costs* over the planning period. If all category purchases are made in a single store s (strategy I), the average inventory level is equal to $D_p/2N_s$ and the total holding cost for the category amounts to S_p * ($D_p/2N_s$) [iii]. With combined shopping patterns (strategy III), all categories are still purchased during the same shopping *trip*, such that the holding cost expression remains the same as for the single store strategy. In case of separate store visits, however, the holding cost function becomes more complex. Specifically, when only a fraction $\alpha_{p,s}$ of category p's demand is purchased in store s, holding costs for these purchases have to be corrected for (i) the lower amount bought in store s ($\alpha_{p,s}$* D_p instead of D_p), and (ii) the fact that the acquired products have to be stored during only a fraction $\alpha_{p,s}$ of the planning period. Like Ghosh and McLafferty (1984), we further rely on the assumptions that (i) customers who visit different stores on separate shopping trips deplete the inventory of one store's products before making purchases of the same product category in a different store, and (ii) the number of store visits to one store is an integer multiple of the number of visits to the other. Under these assumptions, holding costs per category and store in the separate store shopping strategy (II) amount to $\alpha^2_{p,s}$* S_p * D_p /$2N_{s,p}$ [iv](see Ghosh and McLafferty 1984).
- The third term represents *the total net fixed shopping costs*, specified as the number of trips (N_s) times the net fixed costs incurred per trip (t_s). The latter is obtained by subtracting the in-store benefits from the transportation and in-store cost of one visit. The fixed cost of a combined trip to stores s1 and s2 (t_{s1s2}) is a function of the fixed cost of a trip to each of the separate stores.

Given that the transportation cost for a combined trip comprises the cost of a 'one-way journey' to s1 and s2 plus the cost of travelling from s1 to s2, combined shopping trips may allow to reduce transportation costs, especially when the distance between both stores is small.

In brief, shopping cost functions [1a-c] have three distinguishing features. First, they combine variable and fixed costs into 'net costs', thereby generalizing previously used cost functions in the spatial interaction model literature. Second, they allow for single as well as multiple store shopping in a single purpose context. Third, in case of multiple store shopping, they allow for category purchases to be allocated to different stores, which may be visited on separate or combined shopping trips[v].

Henceforth, we use the shorter terms 'fixed costs' and 'variable costs' to denote the *net* cost level obtained after subtraction of in-store and consumption benefits. Moreover, whenever confusion is possible, we use '*unit* fixed cost' to denote the fixed cost per shopping trip to a store, and '*total* fixed cost' to denote the fixed costs over the planning horizon. Similarly, the terms '*unit* variable cost' and '*unit* holding (or storage) cost' refer to the cost for one unit of a category in a store, and '*total* variable cost' and '*total* holding cost' to the costs over the entire planning period.

3.2. Optimal shopping pattern selection

We assume that consumers select the shopping pattern with the lowest total shopping cost as specified in [1]. To identify this optimal shopping pattern, we proceed in three steps. First, we specify the optimal category purchase allocations $\alpha_{p,s}$ conditional on the number of trips N_s to the selected store format(s), for each shopping pattern. Next, knowing these underlying optimal allocations, we identify the trip frequencies (N_s or N_{s1s2}) minimizing each shopping pattern's total cost. In a third step, we compare these 'minimum' costs across shopping patterns.

The results are summarized in Table 1 (appendices providing more detailed information on the derivations can be consulted on the Journal's website). This table presents optimal category purchase allocations (third column), optimal store visit frequencies (second column), and minimum total costs (first column). In these 'minimal cost' expressions, the first term captures the fixed plus holding costs, while the remaining terms cover the total variable shopping costs. These analytical expressions for optimal costs allow to identify under what circumstances different types of SMS may prevail[vi].

Before presenting the analytical results on optimal shopping pattern selection, we introduce the following definitions.

Definition 1: *'Category specific store preference' (for category p1, and store s1 compared to store s2), or the degree to which store s1 is preferred over the other store s2 for category p1, is specified as:*

$$[2] \qquad I_{p1,s1-s2} = \frac{(VC_{p1,s2} - VC_{p1,s1})}{S_{p1}},$$

The numerator is the difference in unit variable cost, for category p1, between the two stores. The denominator is the category's unit holding cost[vii]. If $I_{p1,s1-s2}$ is positive, store s1 is said to be preferred over store s2 for category p1, as it yields a lower unit variable cost.

When the difference in unit variable costs is sufficiently large - and the number of shopping trips to the preferred store sufficiently high - such that

$$[3] \qquad I_{p1,s1-s2} > 1/N_{s1}^{*}$$

category p1 will be exclusively bought in store s1, even if store s2 is also visited by the consumer. The proof can be found in Appendix 1. We refer to this condition as '*strong* store preference'. In equation [3], N_{s1}* represents the optimal number of trips per period to store s1, in a multiple store-separate visit shopping pattern[viii].

Definition 2: *category preference complementarity exists between stores s1 and s2 when s1 is preferred (according to definition 1) for one category (p1) and s2 for the other category (p2) , i.e. if*

$$[4] \qquad I_{p1,s1-s2}.I_{p2,s1-s2} < 0$$

Category preference complementarity thus requires that the sign of expression [2] is different in categories p1 and p2, each store having the lower unit variable cost in one category.

Definition 3: *category preference asymmetry exists between stores s1 and s2 when one store is the preferred store (according to definition 1) for both categories, but the degree of preference differs between the categories, i.e. if*

$$[5] \quad \begin{array}{l} [5a] \quad I_{p1,s1-s2} . I_{p2,s1-s2} > 0 \\ and \\ [5b] \quad I_{p1,s1-s2} \neq I_{p2,s1-s2} \end{array}$$

Category preference asymmetry thus requires that expression [2] has the same sign for categories p1 and p2, but that the expressions differ in magnitude, the preferred store offering a bigger advantage for one category than for the other.

Using the concepts in [2] to [5], three core results emerge from our derivations on optimal category allocation and store visit frequency.

Result 1: *If stores have no category preference complementarity and the same unit fixed cost, then consumers will always prefer a single store shopping pattern.*

Proof: Let store s1 be preferred over s2 for both categories, such that $I_{p1,s1-s2} > 0$ and $I_{p2,s1-s2} > 0$, and let unit fixed cost be equal for both stores ($t=t_{s1}=t_{s2}$). Since s1 is preferred for both categories, variable shopping costs of separate or combined shopping strategies can never be lower than the variable shopping costs when only s1 is visited. Moreover, based on Table 1, holding plus fixed shopping costs when only store s1 is visited, will always be lower than

(i) those with separate visits to s1 and s2:

$$\sqrt{2t\ (S_{p1}D_{p1} + S_{p2}D_{p2})} \leq \sqrt{2t\ (S_{p1}D_{p1}\alpha^2{}_{p1,s1} + S_{p2}D_{p2}\alpha^2{}_{p2,s1})} + \sqrt{2t\ (S_{p1}D_{p1}(1-\alpha_{p1,s1})^2 + S_{p2}D_{p2}(1-\alpha_{p2,s1})^2}$$ and,

(ii) those with combined visits to these stores:

$$[\sqrt{2t\ (S_{p1}D_{p1} + S_{p2}D_{p2})} \leq \sqrt{2t_{s1,s2}(S_{p1}D_{p1} + S_{p2}D_{p2})}$$

as $t_{s1s2} > t$ when stores are situated on different locations.

Hence, if one store is preferred over the other for all categories, buying all products in this store provides the lowest total variable costs, and - given that both stores have equal unit fixed costs- allows to minimize total shopping costs.

Result 2: *If stores have no category preference complementarity but differ in unit fixed cost, then consumers may find it optimal to engage in a SMS strategy with separate store visits (strategy II). Necessary conditions are (i) a 'total cost conflict': the high fixed cost store must have the lower* *variable costs per unit, and (ii) preference asymmetry: one category (that with the lowest holding cost potential $S_{p1}D_{p1}$) being more strongly preferred in the high unit fixed cost store than the other.*

The proof is given in Appendix 2. The intuition is as follows. Let store s1 be preferred over s2 for both categories ($I_{p1,s1-s2} > 0$ and $I_{p2,s1-s2} > 0$). If store s1 also has lower fixed costs per trip than store s2, it follows from the cost expressions in Table 1 that the optimal strategy is to visit store s1 only. If, however, fixed shopping costs are higher for store s1 than for store s2 ($t_{s1} > t_{s2}$), consumers are facing a 'total cost conflict'. Exclusively visiting store s1 would imply lower total variable costs, but higher total fixed costs plus holding costs than a single store strategy involving store s2. As indicated in result 3b below, combined visits will never occur in the absence of category preference complementarity. Consumers thus have to weigh the two single store strategies against one another, and against the separate multiple store visits strategy (II).

Appendix 2 shows that in this case, the separate store strategy constitutes an 'intermediate' option between both single store strategies. This strategy derives its interest from category preference asymmetries (see definition 3). Its total variable shopping costs hold the middle between those for the single store s1 and the single store s2 strategy. Its total fixed plus holding costs will certainly exceed those of store s2 when visited alone. On the other hand, these costs *may* be lower than those for the single strategy with store s1. A necessary requirement is that the category with the higher holding cost potential ($S_{p1}D_{p1}$) is less strongly preferred in store s1 (the store with the higher fixed cost per trip). In this case, visiting both stores – instead of s1 or s2 alone - may allow to reduce total variable costs (compared to visiting store s2 only, by transferring part of the basket to store s1) without excessive increases in total fixed plus holding costs (compared to visiting store s1 only, by visiting the low unit fixed cost store s2 for purchases of the category with the weakest store preference for s1)[ix]. Henceforth, we refer to the conditions in result 2 (total cost conflict and preference asymmetry) as conditions for 'fixed cost complementarity'.

<u>Result 3a:</u> *If stores exhibit category preference complementarity, each of the three shopping strategies may become optimal, whether fixed costs are the same or different*

The proof is given in Appendix 2. Let stores be such that s1 is preferred for category p1 ($I_{p1,s1-s2} > 0$) and s2 for p2 ($I_{p2,s1-s2} < 0$). We first consider the case where fixed shopping costs per trip are the same for both stores (t_{s1} = t_{s2}=t). The best *single store strategy will be* that with the lower total variable cost. This best single store strategy then has to be evaluated against the *multiple store alternatives*. Based on Table 1, it is clear that when both stores have the same fixed costs per trip, the single store strategy implies lower total holding plus fixed costs than any multiple store alternative. However, as the stores are preference complements, patronizing them both allows to purchase at least part of each category's demand in the preferred store, thereby reducing the total variable cost component. Deciding upon single versus multiple store strategies therefore requires a trade off between the increase in total fixed plus holding costs and the decrease in total variable costs, from the multiple store strategy.

When both stores are visited on combined shopping trips, we show under 3b that each product is purchased exclusively in the most preferred store. For the separate store strategy, *allocation of category purchases* will depend on the strength of category specific store preferences. Based on condition [3], strong store preference will lead to exclusive category purchases. In the absence of strong store preference, consumers will purchase some portion of their category demand in the non-preferred store when that store is visited. This allows them to reduce total fixed plus holding costs – be it at the expense of higher total variable costs.

When fixed shopping costs differ between stores ($t_{s1} \neq t_{s2}$), the motives for selecting single, separate or combined visits become a mixture of the previous motivations. The introduction of differences in unit fixed costs will reinforce the appeal of strategy II if the high storage cost category (e.g. perishables) is more strongly preferred in the store with the lower unit fixed cost. Conversely, if the high holding cost category is more strongly preferred in the high fixed cost store, the single and combined strategies become relatively more appealing.

<u>Result 3b:</u> *Category preference complementarity is a necessary condition for two stores to be combined on one and the same shopping trip (pattern III).*

Proof: This is a direct result of the fact that - when both stores are visited on the same shopping trip - category purchases will exclusively be made in the most preferred store. Optimal category allocations are found by computing the first order derivative of the total cost function (equation [1c]) with respect to $\alpha_{p,s1}$, leading to:

$$[6] \qquad VC_{p,s1}D_p - VC_{p,s2}D_p \ .$$

As this expression does not depend on $\alpha_{p,s1}$, boundary solutions are optimal. Hence, products for which variable costs are lower in store s1 will be exclusively bought in this store ($\alpha_{p,s1}$ =1), and vice versa. Or, $\alpha_{p,s1} = 1$ if $I_{p,s1-s2}>0$, and $\alpha_{p,s1} = 0$ otherwise. It follows that, unless there is category preference complementarity ($I_{p1,s1-s2}\ I_{p2,s1-s2}<0$), both categories would be assigned to the same store, and there would be no point in patronizing two stores on combined visits.

The result states that stores s1 and s2 may only co-occur on combined shopping trips if each store is preferred over the other for one category. Note that this condition is different from stating that the stores should have different overall price-quality positions. It is not sufficient (nor, for that matter, necessary) that one store has lower prices, and the other store higher quality levels, in both categories. What is needed are preference *reversals*. Store offerings must be such that the unit variable cost of store s1 exceeds that of store s2 in one category, and is lower than that of store s2 in another category. Whether and why such preference reversals occur in practice, will be discussed in section 4.

<u>Result 3c</u>*: The combined strategy (III) will certainly be preferred over the separate strategy (II) if the stores*

- *have strong category preference complementarity, and*
- *have the same unit fixed costs t, and*
- *are located sufficiently close such that* $\sqrt{\dfrac{t}{t_{s1s2}}} > \dfrac{\sqrt{S_{p1}D_{p1}+S_{p2}D_{p2}}}{\sqrt{S_{p1}D_{p1}}+\sqrt{S_{p2}D_{p2}}}$ *[7]*

Proof: Let stores be such that s1 is preferred for category p1 ($I_{p1,s1-s2} > 0$) and s2 for p2 ($I_{p2,s1-s2} < 0$), and that unit fixed costs are equal ($t_{s1} = t_{s2}=t$). With strong preference complementarity ($I_{p1,s1-s2} > 1/N^*_{s1}$ and $I_{p2,s1-s2} < -1/N^*_{s2}$), we know that $\alpha_{p1,s1} = 1$ and $\alpha_{p2,s1} = 0$ for each multiple store strategy. Substituting this in the cost expressions from Table 1, we find that the separate store (II) and combined store (III) strategies yield identical total variable costs. The choice between these strategies is now completely driven by fixed and holding cost efficiencies. Specifically, a sufficient condition for the combined store strategy to be preferred over the separate store strategy is that $\sqrt{2tS_{p1}D_{p1}} + \sqrt{2tS_{p2}D_{p2}} > \sqrt{2t_{s1s2}(S_{p1}D_{p1} + S_{p2}D_{p2})}$, which is equivalent to [7]. We conclude that with strong preference complementarity, equal unit fixed costs and [7] satisfied, strategy III dominates strategy II – which proves result 3c.

Note that [7] is more likely to hold if the distance between the stores is small relative to their fixed in-store costs – implying that t_{s1s2} is small relative to t. The condition further reveals that with strong store preference complementarity, the separate store visit pattern (II) can never prevail if categories have the same 'holding cost potential'. Indeed, if $S_{p1}D_{p1} = S_{p2}D_{p2}$, condition [7] becomes: $2t>t_{s1s2}$, a requirement that always holds.

4. Shopping Pattern Selection and Store Format competition: Some key implications

The previous section showed that (i) consumers only visit multiple stores when these stores are complements in terms of fixed and/or variable shopping costs and (ii) the choice of SMS strategy will also affect the allocation of category purchases to stores. While store complementarities may occur between outlets of a given format, they are more prevalent *across* store formats. In this section, we therefore highlight the implications of our results for between-format competition [x].

4.1. Store format types and complementarity

Store Formats. Previous research has identified two major dimensions underlying the competitive structure of the (grocery) retail market: price/quality level and store size/service level (see e.g. Kahn and McAlister 1997, Sinha 2000, Popkowski-Leszczyc et al. 2000, González-Benito 2004). Together, they lead to four stylized types of grocery store formats: (i) small & quality-oriented *supermarkets*, (ii) large & quality-oriented *superstores*, (iii) small & price-oriented *hard discounters*, and (iv) large & price-oriented *large discounters* (in the discussion below, we adopt the terms in italics to represent all store types in the corresponding quadrant).

Store size is closely related to unit fixed costs (shopping and waiting times, search effort), which will typically be higher for superstores and large discounters than for supermarkets and hard discounters. Hence, *fixed cost complementarity* is more likely to prevail between supermarkets and hard discounters on the one hand, and superstores and large discounters on the other. Whether stores are fixed cost-complements will also depend on their accessibility (transportation costs, or distance between the stores and the customer's home e grocery stores[xi]). The impact of distance is explicitly taken up in section 4.2.

Similarly, the store formats' price-quality position affects their variable shopping costs. Yet, differences in fixed cost or overall variable shopping cost are not sufficient for SMS to occur: stores must also exhibit complementary - or at least asymmetric - preferences for *specific categories* (results 2 and 3). To see how prototypical grocery store formats compete, one thus needs to zoom in on the distinct types of categories that are part of a grocery basket[xii].

Grocery Product Categories. Previous studies show that grocery products are characterized by different (i) levels of demand (see e.g. Sprott et al 2003, Dhar et al 2001), (ii) importance of quality and perceived quality differences, and (iii) degrees of perishability/storability (see Fox et al. 2002). Based on these dimensions, a natural grocery category classification is that into *staples* (high demand, and low perceived quality differences and perishability), *necessities* (low demand, perceived quality differences and perishability), *specialties* (low demand, and perishability, high perceived quality differences) and *fresh products* (high demand, perceived quality differences and perishability) (Fader and Lodish 1990, Dhar et al 2001)[xiii].

A core question is, then, how prevailing store formats differ in their offer for these category types. Consistent with their strategic focus on quality, superstores and supermarkets tend to offer superior value over hard discounters for quality sensitive products like specialties and fresh products (Kahn and McAlister 1997, Krider and Weinberg 2000, ACNielsen 2004,). In these categories, they offer more A brands, broader assortments, and better intrinsic quality. Yet, they have a price disadvantage for staples and necessities compared to hard discounters (Krider and Weinberg 2000). The situation is different for large discounters, which have continuously been driving up their quality level - while keeping prices down (see, e.g., Kahn and McAlister 1997, Progressive Grocer 2004). This has resulted in net price/quality advantages over the whole line compared to supermarkets (price advantage) and hard discounters (quality advantage), and to a lesser extent, superstores. Based on these observations, category preference *reversals* are most likely to occur between supermarkets and especially superstores on the one hand, and hard discounters on the other. For other store format combinations, category specific store preferences may be *asymmetric*. The price/quality advantage of large discounters over superstores may, for instance, be stronger for staples than for fresh products, a category for which superstores typically provide high quality (see e.g. Berman and Evans 1999, Kahn and McAlister 1997) and have a smaller price disadvantage than for staples.

Table 2 summarizes the characteristics of store formats (upper left panel), product categories (lower right panel) and their interactions (upper right panel). Combining these characteristics with the insights from our shopping behavior model (section 3.2) sheds new light on the nature of non-promotion based retail competition between store formats – an issue taken up in the next section.

4.2. Towards a typology of spatial store format competition

To get a picture of the spatial competition between store formats, we conduct a number of simulations. We first translate the store and category characteristics into a set of cost parameters – displayed in Table 2. Given that the store format and product category categorizations are broad, and that some cost types (such as storage cost or absence of store service) are hard to measure, these parameters can only be rough approximations. Even so, the figures in Table 2 (ii) build on the information available from previous academic papers to set reasonable 'base' values for the different cost and benefit types, while (i) maximally exploiting data from syndicated sources on store format price indices (GfK consumer surveys, Consumer Association reports), average category spending levels (FMI reports), and consumer store and category evaluations (GfK consumer surveys) to adjust these levels to different store formats and product categories. Next, we consider market areas in which consumers are uniformly distributed, and have access to two store outlets of a different format. Using the parameters in Table 2 as inputs for models [1], we then determine consumers' optimal shopping patterns as a function of their distance to the stores[xiv]. Figures 2a through 2c illustrate the optimal shopping pattern distributions for different format pairs, based on the nature of their complementarity. The results reveal three different types of retail competition.

Case (i): 'Winner takes all' competition (Figure 2a). This type of competition prevails among formats that both involve high in-store costs (no fixed cost complementarity) and have a low likelihood of category preference complementarity – typically superstores and large discounters. Consumers tend to patronize only one of both formats. The spatial pattern is such that each format is the preferred alternative in its surrounding area, fighting for the complete wallet of consumers in the border zone.

Case (ii): Partial Eclipse Competition (Figure 2b). This competitive pattern occurs among store formats that differ in fixed cost, but exhibit no reversals in category preferences (only preference asymmetries: supermarkets-superstores, supermarkets-large discounters, hard discounters-large discounters). The typical picture is that - within a concentric area around the smaller format outlet - consumers allocate their entire grocery basket to that outlet. Conversely, customers located out of that area will prefer single format patterns to the larger outlet. An exception are consumers in the 'shield' or 'partial eclipse' zone between the formats. Those consumers may engage in SMS with separate visits to each store. This allows them to economize on total fixed plus holding costs by purchasing high demand or perishable categories from the small format during fill-in visits. At the same time, they allocate a large part of their basket to the format with the most favorable price/quality positioning, keeping total variable costs low. Hence, each format may compete for (i) an extension of its 'exclusive' trading area and/or (ii) a larger share of wallet from consumers in the SMS zone.

Case (iii): Jig-Saw Competition (Figure 2c). This type of competition is characteristic for store formats with category preference complementarity, either with the same (supermarkets – hard discounters) or with different in-store costs (superstores and hard discounters). As a result of their category preference complementarity, a larger variety of shopping strategies occurs when these formats compete for the same customer base. Considering, for instance, the superstore - hard discounter competition (Figure 2c), we see that the stores' immediately surrounding area mainly comprises single store shoppers. Separate store strategies are observed in the area situated in-between the two store sites. Customers living farther away from the superstore (right-hand area of the graph) tend to visit both stores on combined shopping trips, implying that category purchases will be exclusively allocated to one of both stores. Depending on the degree of complementarity, this segment of combined store shoppers may become smaller or larger.

4.3. Managerial implications of SMS

The previous section demonstrates that SMS has important implications for retail competition. In this section, we further explore how SMS may affect retail strategies and the impact of retail marketing instruments. Faced with multiple store shoppers, retailers may attempt to establish *complete loyalty* - convincing consumers to visit only *their* store. Or, they may settle for consumers visiting multiple formats (*co-habitation)* and aim for optimal performance within the boundaries of that reality. Depending on the objective pursued, different strategies will be more appropriate.

To illustrate this, and indicate how our results may guide strategic retailer decisions, we concentrate on the competition between a superstore or supermarket, and a hard discounter. Not only does this setting involve a multitude of shopping patterns ('Jig-Saw competition'), the issue of how traditional retailers should keep hard discounters at bay is a key area of interest in current retail practice (see, e.g., Europanel 2003, GFK 2002). Like in section 4.2, simulations are used to assess the effect on store performance. In turn, we consider two cases: one involving the choice of location, the other pertaining to the store's price/quality positioning.

Location decisions. Consider a hard discounter (HD), planning to open a new outlet in a shopping area with one superstore and one supermarket. Using - again - the store format profiles from Table 2, we simulate the following three scenarios: (i) HD location isolated – but at equal distance - from both existing stores, (ii) HD location close to the supermarket (with which it has category preference complementarity only), and (iii) HD location close to the superstore (a fixed cost and category preference-complementary format). Table 3, panel a, summarizes some key results for the store formats under each scenario.

In an isolated position, all shopping patterns occur. The majority of consumers, however, tend to be loyal to the most nearby store. Positioning the HD more closely to the supermarket, and especially to the superstore, substantially reduces the HD's loyal customer base. Yet, at the same time, it stimulates multiple store shopping, thereby increasing the HD's penetration and market share. Especially a position near the superstore – leading to a sharp increase in combined HD-SS shopping trips – substantially improves the HD's store performance, and this at the expense of the superstore *as well as* the supermarket's market share. In line with current location practices, the results thus confirm that - rather than striving towards complete store loyalty by selecting an isolated position - a HD is better off in a 'close neighbor' position which stimulates MSS and leads to higher market shares. From the superstore's perspective, the cluttered configuration with a HD should best be avoided[xv], and when it occurs, be countered by marketing actions.

Marketing mix decisions: quality versus price adjustments. To respond to a HD's competitive threat, a superstore can either reinforce its strengths through quality-oriented actions, or reduce its weaknesses by lowering prices. Moreover, price/quality adjustments can be implemented 'across the board' or for selective product categories only.

Some results of the quality-oriented approach are given in panel b of Table 3. The first column provides performance indicators for the 'base' configuration (format profiles as in Table 2) already depicted in Figure 2c. An across-the-board change in quality positioning by increasing *in-store benefits by, say, 10%* (second column in Table 3, panel b), allows the superstore to convert multiple store shoppers into superstore loyals. Overall though, the increase in market share remains quite small. Improving the *quality of the offer, in high quality categories* only, by only 5% (column 3), generates a much stronger effect. HD loyals now visit both the HD and superstore, on separate or combined shopping trips, and the superstore's market share increases substantially.

A similar effect is observed if the superstore, again starting from the base case, initiates a 5% *price decrease across the board* (panel c of Table 3). Except for a few customers, HD loyals are now converted into multiple store shoppers, while consumers who previously visited both stores on combined shopping trips now purchase their entire basket in the superstore. The result is a dramatic increase in the superstore's market share. Selective (5%) price reductions on *quality-insensitive* products (where the superstore's quality advantage is lower) generate a similar shift from multiple store shopping on combined trips to single store patronage of the superstore. However, a sizable portion of the market remains loyal to the HD. *Decreasing prices of high quality* products by this same percentage, in contrast, stimulates multiple store shopping by previously HD loyals. Interestingly, while the superstore's customer penetration is now higher than under the previous scenario, its market share remains lower, pointing to a trade off between both objectives in this illustration. More generally, the example demonstrates that the superstore can enhance its competitive position not only by (i) dissuading consumers from visiting multiple stores , but also by (ii) encouraging multiple store shopping, or (iii) striving for both .

5. Empirical support

Even though the competitive patterns revealed in section 4.2. are based on realistic figures characterizing store formats and their shopping costs, they are still conditional on the specification in model [1], and its normative implications. We therefore supplement the previous findings with empirical evidence from two data sets. *Data set 1* is based on a survey among 339 consumers in two geographical areas and contains stated shopping patterns, shopping motivations and socio-demographic characteristics. *Data set 2* consists of GfK panel data with revealed shopping patterns from 1412 consumers[xvi]. Given the limited nature of the datasets (in terms of variables available: Data set 2, or number of observations: Data set 1) and the conceptual focus of the paper, we limit ourselves to some simple analyses that – nevertheless - provide strong support on the following key issues.

Importance of SMS. According to the survey, 64% of the consumers visit two or more stores, these multiple store visits being organized into separate (36%) or combined (28%) shopping trips. The panel data show a somewhat similar distribution (71 % MSS, of which 55% on separate visits).

Stability of SMS behavior. Consistent with recent findings, the panel data further confirm the stability of these shopping patterns: over 80 % of consumers selected the same shopping pattern in the first and second half of the one-year data period. For the remaining 20% of the cases, consumers change from one multiple store shopping pattern to the other (i.e., from a predominantly separate to a predominantly combined shopping pattern, or vice versa). Again, this suggests that shopping pattern and store format choice are not entirely driven by response to feature promotions.

Motivations for SMS. Based on the survey results, product and price differences between stores clearly are the dominant motivations to visit multiple stores (42 and 30% of the respondents resp.), at some distance followed by sales promotions (14%). This not only confirms that multiple store shopping is to a large extent planned rather than opportunistic shopping behavior. It also suggests that category preference complementarity indeed plays an important role in the consumers' decision to visit multiple stores. Situational factors other than price promotions (e.g. whether consumers leave from home or from work for a particular trip) appear of minor importance (6%).

Nature of Store format competition. A breakdown of the panel members' shopping pattern distributions (Data set 2) indicates that store formats expected to exhibit category preference or fixed cost complementarity co-occur systematically more in multiple store shopping patterns. Category preference complements (Superstores-Hard Discounters, and Supermarkets- Hard discounters) account for the large majority of shopping patterns with combined visits (65%) –an observation consistent with results 2 and 3b. Stores that are fixed cost complements, like supermarkets-superstores, and supermarkets-large discounters, more often co-occur in separate store visit shopping patterns – featuring in 46% of these strategies. This is in line with result 2. However, these findings may be affected by store format accessibility – which influences the transportation part of fixed shopping costs. We therefore verify their robustness using Data set 1, for which store distance information is available. Specifically, we estimate an MNL model across the survey respondents, with shopping pattern (single, separate or combined) as the dependent variable. As explanatory variables, we include (i) fixed effects for store formats and shopping patterns, (ii) store distance, and (iii) - of focal interest - dummies indicating whether the store formats in the shopping pattern are either category preference complements only, fixed cost ánd category preference complements, or neither of both. The model also allows for parameter heterogeneity across (three) segments of consumers. The estimation results[xvii] confirm that store formats that are preference complements appear significantly more in multiple store shopping patterns -especially in SMS with combined trips. Store formats with neither fixed cost nor category preference complementarity appear significantly less in multiple store patterns.

6. Discussion and areas for future research

6.1. Substantive insights

In line with previous indications in the literature, we find that (i) the majority of consumers regularly visits more than one store format for grocery purchases, (ii) sales promotions alone do not explain why consumers engage in multiple-store format shopping, and (iii) most store 'switches' appear to be a rather regular sequence of multiple store visits. To our knowledge, this paper is the first to provide a comprehensive and formal analysis of why and how customers divide their grocery purchases over different stores on a systematic basis. By considering (i) shopping benefits as well as costs, (ii) store choice as well as related shopping decisions, and (iii) overall as well as category-specific store format positioning, we provide a more complete and more accurate account of systematic multiple store shopping motivations and shopping patterns.

Motives for systematic (non-promotion based) multiple store shopping. Our research reveals that - even in the absence of promotions - consumers may have good reasons for shopping multiple grocery stores. In particular, we find that grocery outlets may only become part of a multiple store strategy if they exhibit fixed cost complementarity or category preference complementarity.

First, patronizing stores with *different fixed shopping costs* may be an appealing compromise strategy between exclusively shopping in either of these stores alone. This is true even if one store offers better value on all categories, provided that (i) there is preference asymmetry –the degree of store preference differs across categories and (ii) there is a 'total cost conflict'- the low unit variable cost store having the higher unit fixed cost. We refer to this case as 'fixed cost complementarity'. By purchasing the lower holding cost /more strongly preferred categories primarily in the high fixed cost store, but organizing in-between visits for the other categories in the low fixed cost store, the consumer may achieve the 'best of both worlds'.

Second, we show that multiple store shopping may also be triggered by *category preference complementarity* - each store being preferred for at least one of the product categories. By systematically buying products in the store where they are most attractive, consumers can minimize their total variable shopping costs.

SMS trip organization. Our research establishes a link between these motives and the way shopping trips are organized. With fixed cost-complementarity, stores are always visited on separate shopping trips. With category preference complementarity, consumers may also engage in combined shopping trips, and the choice between separate versus combined store visits presents an interesting trade off between fixed and variable shopping costs. On the one hand, combined visits allow the consumer to save on transportation costs per trip and purchase each product exclusively in the store where it is preferred. When the store formats are visited on separate trips, however, the number of trips per store can differ, and trips to different stores can be spread in time. This allows the consumer to purchase high holding cost categories on a more frequent basis, shifting some portion of the categories' purchases to the less preferred store. Given the difference in category allocation they entail, the distinction between separate or combined shopping strategies is of crucial importance for an accurate assessment of the managerial implications.

6.2. Managerial insights

Our broader view on SMS leads to new insights for retailers into the nature of their competition with other grocery formats, and helps to guide their strategic actions.

Patterns of Spatial Competition between grocery retail formats. Combining our substantive model-based results with the characteristics of prevailing grocery retail formats, we identify three prototypical types of store format competition. Superstores and large discounters are largely engaged in 'Winner Takes All' competition - each consumer being loyal to one store. Supermarkets-Superstores, Supermarkets- Large discounters and Hard Discounters-Large discounters, are more likely to confront one another in 'Partial Eclipse Competition', where at least a fraction of consumers - situated between the stores - will patronize both stores on separate visits. The most complex competitive patterns ('Jig-Saw Competition') are observed with Hard Discounters-Supermarkets and Hard Discounters-Superstores, with designated zones of consumers engaging in single store shopping, separate store shopping and combined store shopping strategies. Empirical results from two data sources provide support for our findings.

Retailer strategies. These competitive patterns have important implications for retailer strategies. First, they shed new light on the interplay between retailer objectives like share of customers (market penetration) and share of wallet (market share). Depending on the store's characteristics and locations, the retailer may find it more appropriate to pursue complete loyalty among a subset of consumers, or to make the most out of ‘cohabiting’ with other retailers by even encouraging SMS shopping.

Second, in line with this, insights into SMS motivations and shopping patterns may guide strategic retail decisions like outlet location and price/quality positioning. This is illustrated for the situation where a hard discounter enters a superstore and supermarket’s trading area. Consistent with current practice, hard discounters are shown to best position themselves in very close vicinity of superstores, thereby encouraging multiple store visits to the advantage of the hard discounter’s share-of-wallet. We also demonstrate how the threatened superstore can best defend itself depending on whether market share or market penetration is high on its priority list. Reinforcing its strengths (quality position) or reducing its weaknesses (high prices), on an overall (store level) or selective basis (for part of the product categories only), yields quite different implications in terms of customer penetration, customer loyalty and market share.

Third, our insights are valuable for multi-format retailers, trying to strike a balance between ‘occupying’ the marketplace with complementary store formats and keeping cannibalism between their outlets low. Our paper identifies the type of complementarity that can be pursued, together with the shopping trip organizations and category allocations this entails.

6.3. Future Research

Clearly, this research exhibits limitations, and leaves ample opportunities for future research. First, our formal model is stylised, allowing consumers to visit two types of store formats at most. Even though we do not expect this to invalidate our findings, analysing patterns involving three or more formats may be an interesting research avenue.

Second, the store formats considered are prototypes of primarily food-oriented retail formats, which essentially carry the same assortment. Considering a broader set of retail formats may add to the complexity of the shopping decision process – which may become single as well as multiple purpose – yielding additional insights into multiple store shopping motivations.

Third, our shopping model describes consumers as fully informed, rational decision makers, with fixed category demand and able to perfectly plan their consumption ahead. Interesting extensions of our model would be to include the possibility of category consumption expansion, impulse purchases, and urgent/unplanned trips. These will add to the realism of our model, and may uncover additional motives for multiple store shopping.

Fourth, given our focus on *systematic* multiple store shopping, we consider a ‘stable’ setting where stores do not offer temporary promotions. This allows us to isolate non-promotional motives triggering multiple store shopping. Adding the effect of promotional strategies to our equilibrium model will lead to an even richer representation of consumer shopping behavior, indicating how opportunistic - promotion-based - store switching interacts with SMS.

Fifth, like most previous store choice papers, we use simple cost specifications. Introducing thresholds/nonlinearities like storage space constraints, the purchase of discrete package sizes, and time-dependent transaction costs would be a fruitful extension of our model.

Another important limitation is that, while we present optimal shopping patterns from the consumer’s viewpoint, our analyses of retail marketing implications are illustrative rather than normative. To fully appreciate the consequences of our study for retail strategies, a formal model of retail competition is needed that accounts for consumers’ SMS shopping behavior.

Finally, our paper leaves room for interesting empirical analyses. Future research could study, for instance, to what extent consumers’ stable shopping patterns affect their propensity to react to temporary price cuts offered by stores that are/are not included in their basic choice set.

Figure 1: Conceptual Framework

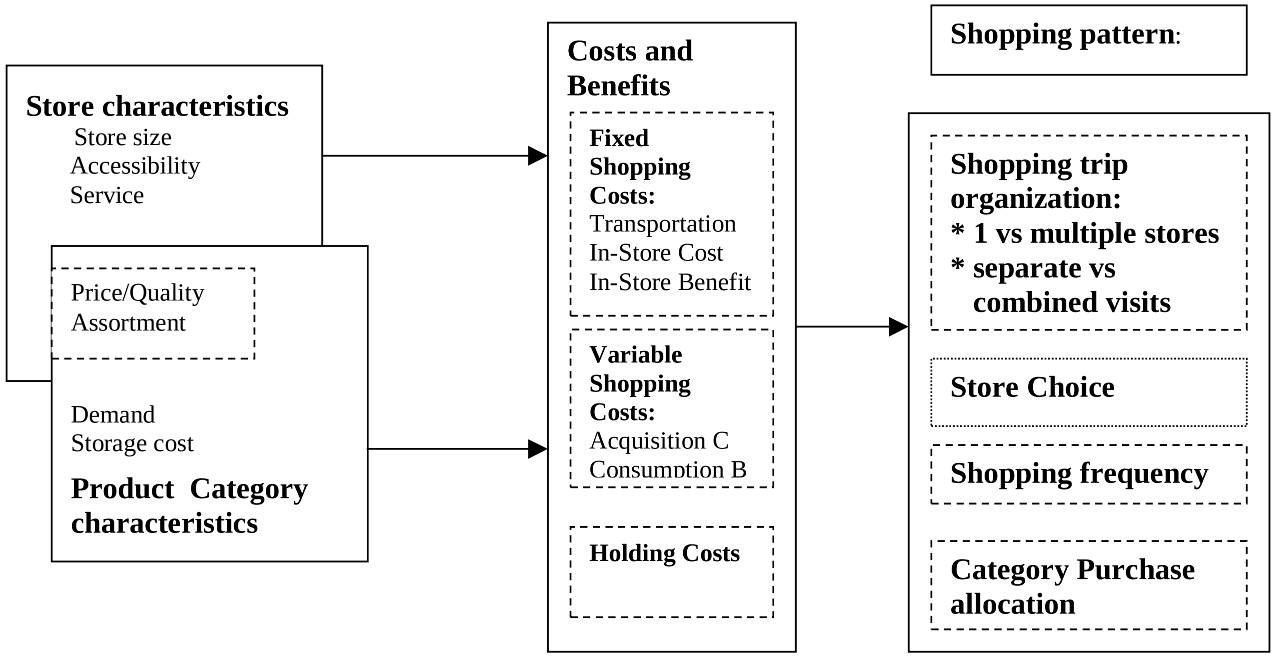

Figure 2: Optimal shopping pattern as a function of available store formats

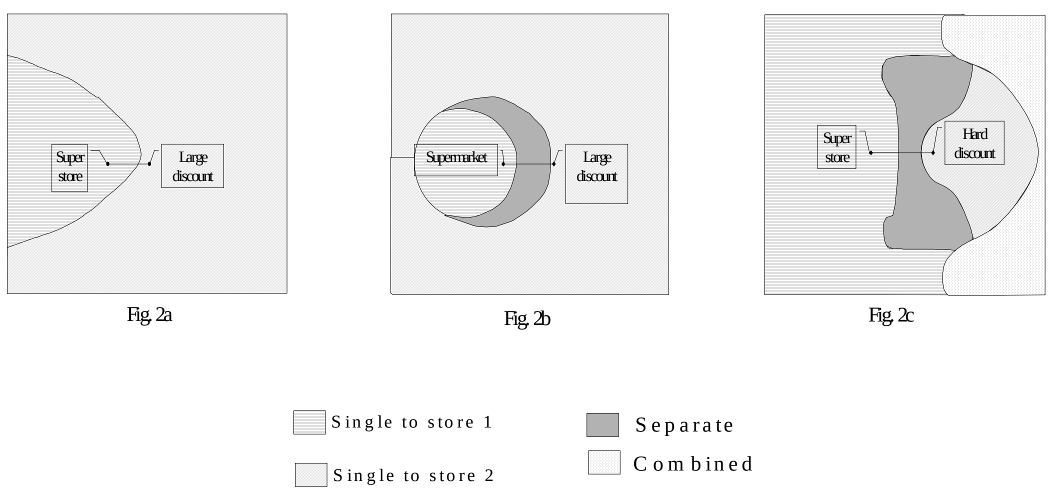

Table 1: Minimum Total Cost and Optimal decisions

Pattern	Total Cost*	Number of Trips	Category Allocation
Single Store (I)	$TC^*_{I,s1*} = \sqrt{2t_{s1}(S_{p1}D_{p1} + S_{p2}D_{p2})}$ $+ D_{p1}VC_{p1,s1} + D_{p2}VC_{p2,s1}$	$N_{s1} = \sqrt{(S_{p1}D_{p1} + S_{p2}D_{p2})/2t_{s1}}$	$\alpha_{I,p1,s1} = 1$ $\alpha_{I,p2,s1} = 1$
Separate Stores (II), stores s1 and s2	$TC^*_{II,s1-s2} = \sqrt{2t_{s1}(S_{p1}D_{p1}\alpha^2{}_{II,p1,s1} + S_{p2}D_{p2}\alpha^2_{II,p2,s1})} +$ $\sqrt{2t_{s2}(S_{p1}D_{p1}(1-\alpha_{II,p1,s1})^2 + S_{p2}D_{p2}(1-\alpha_{II,p2,s1})^2)} +$ $D_{p1}(VC_{p1,s1}\alpha_{II,p1,s1} + VC_{p1,s2}(1-\alpha_{II,p1,s1}))$ $D_{p2}(VC_{p2,s1}\alpha_{II,p2,s1} + VC_{p2,s2}(1-\alpha_{II,p2,s1}))$	$N_{s1} = \sqrt{(S_{p1}D_{p1}\alpha^2{}_{II,p1,s1} + S_{p2}D_{p2}\alpha^2_{II,p2,s1})/2t_{s1}}$ $N_s = \sqrt{\left.\begin{matrix}(S_{p1}D_{p1}(1-\alpha_{II,p1,s1})^2 + \\ S_{p2}D_{p2}(1-\alpha_{II,p2,s1})^2)\end{matrix}\right/ 2t_{s2}}$	$\alpha_{II,p1,s1} = 1\ if\ I_{p1,s1-s2} > 1/N_{s1}$ $\alpha_{II,p1,s1} = 0\ if\ I_{p1,s1-s2} < -1/N_{s2}$ $\alpha_{II,p1,s1} = \dfrac{I_{p1,s1-s2} + 1/N_{s2}}{1/N_{s1} + 1/N_{s2}}$ *otherwise*
Combined Stores (III)	$TC^*_{III,s1-s2} = \sqrt{2t_{s1s2}(S_{p1}D_{p1} + S_{p2}D_{p2})}$ $+ D_{p1}(\alpha_{III,p1,s1}VC_{p1,s1} + (1-\alpha_{III,p1,s1})VC_{p1,s2})$ $+ D_{p2}(\alpha_{III,p2,s1}VC_{p2,s1} + (1-\alpha_{III,p2,s1})VC_{p2,s2})$	$N_{s1s2} = \sqrt{(S_{p1}D_{p1} + S_{p2}D_{p2})/2t_{s1s2}}$	$\alpha_{III,p1,s1} = 1$ if $I_{p1,s1-s2}>0$, and $\alpha_{III,p1,s1} = 0$ otherwise. $\alpha_{III,p2,s1} = 1$ if $I_{p2,s1-s2}>0$, and $\alpha_{III,p2,s1} = 0$ otherwise.

Table 2: Parameters used in the Simulations

	Fixed cost per trip		*Variable cost (per unit of the category)*				
	In-store cost	*In-store benefit*	*Price*[1]	*Consumption benefit*[2]			
Store Formats:							
Superstore	H (40)	H (18)	M (3.7)		H (6.0)		H (10)
Supermarket	L (20)	H (18)	H (4.0)		M (5.7)		M (9)
Large discounter	H (40)	L (6)	L (3.0)		M (5.8)		M (9.5)
Hard Discounter	L (20)	L (6)	L (2.7)		L (5.5)		L (7.7)
			Demand[3]	L (10)	H (15)	L (10)	H (15)
			Storage cost per unit	L (2)	L (2)	L (2)	H (5)
			Categories:	**Necessity**	**Staple**	**Specialty**	**Fresh**

L= low, M= medium, H= high level

[1] Order based on consumer surveys (GFK) and on price indices recorded by consumer associations.

[2] Order based on consumer surveys (GFK)

[3] Category demand over the planning horizon, based on FMI figures (2003)

Table 3: Performance implications of location, quality and price changes

Panel a: Location changes for HD in Superstore- Supermarket-HD competition									
	Isolated location			**HD close to supermarket**			**HD close to superstore**		
	MS[1]	LCB	PEN	MS	LCB	PEN	MS	LCB	PEN
Superstore	.54	.44	.59	.60	.48	.66	.48	.14	.74
Supermarket	.29	.23	.31	.22	.15	.27	.27	.21	.26
Hard Discounter	.17	.15	.28	.18	.11	.33	.25	.04	.60
Panel b: Quality increases by Superstore in Superstore-HD competition									
	Base (no change)			**Across-the-board**[2]			**High-quality products**		
	MS	LCB	PEN	MS	LCB	PEN	MS	LCB	PEN
Superstore	.73	.49	.79	.75	.57	.79	.86	.59	1.00
Hard Discounter	.27	.20	.51	.25	.21	.43	.15	.00	.41
Panel c:Price decreases by Superstore in Superstore-HD competition									
	Across-the-board			**Low-quality products**			**High-quality products**		
	MS	LCB	PEN	MS	LCB	PEN	MS	LCB	PEN
Superstore	.95	.85	.98	.85	.76	.83	.79	.55	.89
Hard Discounter	.05	.02	.15	.15	.17	.25	.21	.11	.45

[1] MS=Market share (% of market sales), LCB=Loyal Customer Base (% of consumers exclusively visiting the format, in single store shopping pattern), PEN=Penetration (% of consumers visiting the format, in either single or multiple store shopping patterns)

2 Except for 'across the board' quality changes (increases in in-store benefits of 10%), all quality (price) changes are 5% deviations from the Base Case.

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Endnotes

[i] One possible explanation is that consumers select a set of stores based on the expected basket price (including promotions) and then visit these stores repeatedly, (re)allocating their actual purchases over these stores at a given point in time depending on deals available at that time. Even so, this explanation would require consumers to figure out what is on deal in each store prior to shopping, and should lead to promotion-based shifts in category sales across stores.

[ii] In this expression, we assume that the consumer considers stores s1 and s2. In fact, a similar expression can be formulated for any pair of stores in the set R, consumers then (i) for each store pair {s1,s2}, deciding upon the best shopping pattern (optimal levels of N_{s1}, $N_{s2,}$ N_{s1s2} and α_{s1}, $\alpha_{s2,}$ and α_{s1s2} minimizing expression [1] for that pair) and (ii) comparing these 'best patterns' across store pairs. In the remainder of the mathematical derivations, we will focus on the cost expressions involving a store pair {s1,s2}.

[iii] Like Krider and Weinberg (2000), we specify unit holding cost as independent of purchase price. For groceries, this seems like an acceptable assumption, since (i) price differences between stores and (ii) financial investments in these products (absolute price levels) are low. Note that our S_p does vary by product category. Allowing holding costs to vary with store price differences would make the derivations more complex, but would not alter the essence of our findings.

[iv] Unlike Ghosh and McLafferty, we use $N_{s,p}$ (the number of visits to store s on which category p was purchased) rather than N_s (total number of visits to store s) in the denominator of the expression. The reason is that when purchases of several categories are allocated to more than one store (a situation not considered by Ghosh and McLafferty), consumers must align the timing of store visits across the different categories, and may find it optimal not to purchase the category on each visit to the store. This will be discussed in more detail below.

[v] Note that our model does not exclude 'mixed' shopping patterns, in which consumers visit multiple stores on separate ánd combined shopping trips. To illustrate this, integration of the three cost functions and replacement of $\alpha_{p,s1}$ by $\delta_{p,s1}$ (based on the proof of result 3b below) leads to the following overall cost function:

$$TC = [\sum_s \sum_p \alpha_{p,s} VC_{p,s} D_p + \sum_s \sum_p \alpha^2_{p,s}\, S_p D_p \Big/ 2N_s + \sum_s t_s N_s\,] +$$

$$\sum_p \alpha_{p,s1s2}(\delta_{p,s1} VC_{p,s1} D_p + (1-\delta_{p,s1}) VC_{p,s2} D_p) + \sum_p \alpha^2_{p,s1s2} S_p D_p / 2N_{s1s2} + t_{s1s2} N_{s1s2}$$

where

$\delta_{p,s1}$ = indicator variable, equal to 1 if – on a combined trip to stores s1 and s2 - category p is bought in store s1, and equal to 0 if bought in store s2.

$\alpha_{p,s1s2}$ = the fraction of category p's demand per period purchased on combined shopping trips to s1 and s2. Values of $\alpha_{p,s1s2}$ between 0 and 1 correspond to mixed shopping strategies, in which a fraction $\alpha_{p,s1s2}$ of category purchases are made on combined shopping trips, and a fraction (1-$\alpha_{p,s1s2}$) on separate visits to store s1 or s2. Yet, in order not to overly complicate the analysis and given our focus on dominant or equilibrium shopping patterns, the following discussion concentrates on 'pure' shopping strategies ($\alpha_{p,s1s2}$=0 or 1), i.e. single store, multiple stores/separate visits and multiple stores/combined visits strategies. Similar analyses for mixed shopping patterns point out that the results are a combination of separate and combined shopping pattern findings. Details can be obtained from the authors on request.

[vi] When considering the cost expressions in detail, two points have to be made on the separate visit strategy. First, for our model to be meaningful, the number of shopping trips for one store must be an integer multiple of that for the other store (see Ghosh and McLafferty for a similar requirement) – a condition that may require deviations from the number of shopping trips in column 2. Second, the optimal category allocations in the third column of Table 1 are obtained for each product category independently (see Appendix 1.1 for details). If, however, these results indicate that purchases of both categories should be spread across stores (situation IIc in the table), further adjustments are needed to align the timing of store visits and the associated purchase allocations across categories. It follows that, for the separate store strategy, especially for the case where each category is adopted in both stores, the costs in Table 1 constitute a lower bound on the true optimal costs of the separate visit strategy. This is of no consequence for the remainder of this section, where we mainly focus on necessary conditions for this strategy to be optimal. In our simulation analyses in the next section, we will explicitly incorporate these regularity conditions when comparing cost levels across shopping strategies.

[vii] As will be discussed in more detail below, the choice between single and multiple shopping strategies often comes down to a trade-off between holding (and fixed shopping) costs on the one hand and variable shopping costs on the other hand. At the category level, this implies that differences in variable costs become more important when storage costs are low.

[viii] Note that expression [3] is not a closed form expression, since the right side, in turn, depends on the level of $I_{p1,s1\text{-}s2}$. However, as N^*_{s1} can increase independently of $I_{p1,s1\text{-}s2}$, the expression is informative, and provides intuitive insights into the conditions driving shopping pattern choice and category purchase allocation.

[ix] Note that Krider and Weinberg's (2000) results can be considered to be a special case of this SMS situation. Indeed, although Krider and Weinberg do not account for category preference complementarity (in their analysis, one store – the discounter – has lower net variable costs for all categories), category preference asymmetries are built in into their model through the holding costs. The higher storage cost for perishable products implies that with $VC_{p1,s1} - VC_{p1,s2} = VC_{p2,s1} - VC_{p2,s2}$, $I_{p2,s1\text{-}s2}$ can still be smaller in absolute value than $I_{p1,s1\text{-}s2}$ when $S_{p2} > S_{p1}$, p2 being the perishable product and s2 the more expensive regular store. As demonstrated by Krider and Weinberg and in line with result 2, this may lead consumers to buy part of their purchases in the preferred store s1 (in their case, the discounter), while making fill-in trips for the higher storage cost good (the perishable product) in the 2nd preference store (the regular store).

[x] The competitive patterns revealed by this analysis may also apply to stores of the same format, with similar – but less pronounced – differences in fixed and variable shopping costs.

[xi] Obviously, household location will not be the only consumer characteristic with an impact on shopping pattern and category allocation decisions. As indicated in section 3 – and as can be derived from the shopping utility model in equation [1] - shopping costs also vary with the customer's (i) level of *demand* (determining variable shopping and holding costs), (ii) *price and quality sensitivity* (influencing variable shopping costs and perceived in-store benefits), (iii) *time constraints* (leading to higher fixed shopping costs) and (iv) *storage costs* (holding costs being, for instance, higher for certain types of dwellings, such as small apartments).
To examine the impact of these characteristics on shopping pattern selections, individual importance weights could be introduced into equation [1]. A higher/lower sensitivity to price could, for instance, be incorporated by multiplying price levels with a factor greater/smaller than one (a weight of one – like in equation 1, - reflecting the 'average' consumer's position). Although such an analysis could provide interesting additional insights into the driving factors of SMS, we leave this research avenue for future research in view of space constraints.

[xii] Definitions 1 and 2 are specified for the case of two categories. With more than two categories, they generalize as follows (i) category preference complementarity occurs as soon as there are at least two categories for which expression [4] holds, and (ii) category preference asymmetry prevails when [5a] holds for all category pairs, and [5b] holds for at least one category pair.

[xiii] An advantage of this classification (which is also in line with the typology of the FMI 1995) is that it is based on intrinsic category and consumer characteristics, and not on more endogeneous measures that refer to the outcome of the shopping pattern choice process – such as purchase frequency or exclusive store patronage /destination shopping. This is important, as we wish to *derive* optimal shopping patterns and store selection processes as outcomes of a given grocery setting. Given this objective, starting from a shopping behavior-based classification would be problematic.

[xiv] In doing so, we rely on the optimal cost expressions in Table 1, performing a grid search on integer levels of numbers of store visits. For the separate store visit strategy, category purchase allocations – if needed – are further adjusted to fit into a coherent strategy. Appendix 3 comments in detail on these adjustments.

[xv] Except in the presence of a strong third competitor like a large discounter, in which case the superstore can benefit from the presence of a complementary HD to fend off this large discounter.

[xvi] Details, including the questionnaire, can be obtained from the authors on request.

[xvii] Details can be obtained from the authors on request.

Appendix 1: Derivation of optimal category purchase allocations, number of trips, and optimal total cost

A.1.1. Optimal Category Purchase Allocations
In a first step, we derive – for each (multiple) shopping pattern – the optimal allocation of category purchases over stores given store visit frequency.

Shopping Pattern II: separate visits to store s1 (N_{s1} visits) and store s2 (N_{s2} visits).
Computing the first order derivative of total costs in equation [1b] wrt $\alpha_{p,s1}$ and setting it equal to zero leads to the following expression:

[A1] $$\partial TC / \partial \alpha_{p,s1} = VC_{p,s1}D_p - VC_{p,s2}D_p + 2\alpha_{p,s1} S_p D_p / 2N_{s1} - 2(1-\alpha_{p,s1})S_p D_p / 2N_{s2} = 0$$

implying that:

$$\alpha^*_{p,s1} = \left[(-VC_{p,s1} + VC_{p,s2})/S_p + 1/N_{s2}\right] / (1/N_{s1} + 1/N_{s2})$$

or, letting $I_{p,s1-s2} = \dfrac{(VC_{p,s2} - VC_{p,s1})}{S_p}$,

[A2] $$\alpha^*_{p,s1} = \left[I_{p,s1-s2} + 1/N_{s2}\right] / (1/N_{s1} + 1/N_{s2})$$

From the above expression [A1] , it is clear that the second derivative wrt $\alpha_{p,s1}$ is positive – such that the second order optimality condition is satisfied. Furthermore, given the requirement that $0 \le \alpha^*_{p,s1} \le 1$, a necessary condition for this allocation to be meaningful is

[A3a] $\left[(-VC_{p,s1} + VC_{p,s2})/S_p = I_{p,s1-s2} < 1/N_{s1}\right]$ and

[A3b] $\left[(-VC_{p,s1} + VC_{p,s2})/S_p > -1/N_{s2}\right]$

If [A3a] is violated, it follows that $\alpha^*_{p,s1}=1$: it is optimal to purchase all of category p in store s1. Conversely, violation of [A3b] implies that $\alpha^*_{p,s1}$ must be set at the lower boundary ($\alpha^*_{p,s1}=0$), such that all of D_p is bought in store s2.

A.1.2. Optimal Trip Planning
Knowing the optimal category purchase allocations, we can now derive – for each shopping pattern - the cost-minimizing number of shopping trips to the selected stores.

Pattern I (single store shopping)
The simplest case is that where only one store –say, store s1- is selected and visited repeatedly (*pattern I*). Setting the first order derivative of total costs (equation [1a]) wrt N_{s1} equal to 0, and noting that the second order derivative is positive, immediately implies the following cost-minimizing number of trips to store s1:

$$N^*_{s1} = \sqrt{(S_{p1}D_{p1} + S_{p2}D_{p2})/2t_{s1}}$$

Substituting this expression in the total cost function and rearranging terms yields the minimum total cost for pattern I:

$$\mathrm{TC}^*_{\mathrm{I,s1}} = \sqrt{2\mathrm{t_{s1}}(\mathrm{S_{p1}D_{p1}} + \mathrm{S_{p2}D_{p2}})} + \mathrm{D_{p1}VC_{p1,s1}} + \mathrm{D_{p2}VC_{p2,s1}}$$

where the first term is the sum of the optimal total holding and fixed cost, and the second term indicates the total variable cost. It is interesting to note that, like in the classical "Economic Order Quantity" model, consumers set their shopping frequency and category purchase allocation in such a way that the optimal total holding and fixed cost are equal- an observation that will continue to hold in the multiple store shopping patterns II and III discussed below.

Pattern II (multiple store shopping with separate visits)
Next, consider the case of *separate visits to stores s1 and s2 (pattern II),* where optimal values for N_{s1} and N_{s2} have to be determined.
Let us first consider the case where the optimal category purchase allocations are given by:

$\alpha^*_{p1,s1} = \left[I_{p1,s1-s2} + 1/N_{s2}\right] / (1/N_{s1} + 1/N_{s2})$ and $\alpha^*_{p2,s1} = \left[I_{p2,s1-s2} + 1/N_{s2}\right] / (1/N_{s1} + 1/N_{s2})$.

The derivative of [1b] wrt N_{s1} then becomes:

[A4]

$$\partial TC \Big/ \partial N_{s1} = \sum_{p=p1,p2} (\partial \alpha_{p,s1} \Big/ \partial N_{s1} . [VC_{p,s1} - VC_{p,s2}] D_p$$

$$+ \partial \alpha_{p,s1} / \partial N_{s1} . [\alpha_{p,s1} S_p D_p / N_{s1} - (1-\alpha_{p,s1}) S_p D_p / N_{s2}] - \alpha_{p,s1}{}^2 S_p D_p / 2 N_{s1}{}^2) + t_{s1}$$

It is easy to show that under the conditions just specified:

$$\partial \alpha_{p1,s1} / \partial N_{s1} = (\alpha_{p1,s1} / N_{s1}).((1/N_{s2})/(1/N_{s2} + 1/N_{s1}))$$

Moreover, we can write:

$$[VC_{p1,s1} - VC_{p1,s2}] D_{p1} = -D_{p1} S_{p1} I_{p1,s1-s2} = -D_{p1} S_{p1} (\alpha_{p1,s1} (1/N_{s1} + 1/N_{s2}) - 1/N_{s2})$$

Substituting both of these expressions in [A4] and setting the result to zero leads – after some tedious calculations- to the following first order condition:

$$\sum_{p=p1,p2} \left[-S_p D_p \alpha_{p,s1}{}^2 \Big/ 2N_{s1}^2 \right] + t_{s1} = 0$$

implying that the optimal number of trips to store s1 is given by

$$N^*{}_{s1} = \sqrt{(S_{p1} D_{p1} \alpha_{p1,s1}^2 + S_{p2} D_{p2} \alpha_{p2,s1}^2) \big/ 2t_{s1}}$$

The computations for N^*_s are completely similar.

Substitution of these optima in expression [A6] then yields:

$$\mathrm{TC}_{\mathrm{II}}^* = \sqrt{2\mathrm{t}_{\mathrm{s1}} (\mathrm{S}_{\mathrm{p1}} \mathrm{D}_{\mathrm{p1}} \alpha_{\mathrm{p1,s1}}^2 + \mathrm{S}_{\mathrm{p2}} \mathrm{D}_{\mathrm{p2}} \alpha_{\mathrm{p2,s1}}^2)} + \sqrt{2\mathrm{t}_{\mathrm{s2}} (\mathrm{S}_{\mathrm{p1}} \mathrm{D}_{\mathrm{p1}} (1-\alpha_{\mathrm{p1,s1}})^2 + \mathrm{S}_{\mathrm{p2}} \mathrm{D}_{\mathrm{p2}} (1-\alpha_{\mathrm{p2,s1}})^2)} +$$

$$(\mathrm{VC}_{\mathrm{p1,s1}} \alpha_{\mathrm{p1,s1}} + VC_{\mathrm{p1,s2}} (1-\alpha_{\mathrm{p1,s1}})) \mathrm{D}_{\mathrm{p1}} + (\mathrm{VC}_{\mathrm{p2,s1}} \alpha_{\mathrm{p2,s1}} + VC_{\mathrm{p2,s2}} (1-\alpha_{\mathrm{p2,s1}})) \mathrm{D}_{\mathrm{p2}}$$

where the first two terms now indicate the total fixed plus holding costs incurred through the visits to stores s1 and s2, resp.

Note that the optimal category allocations in [A3] were derived for each category independently - assuming that store visit timing can be tailored to each separate category. With two product categories, this is true as long as $\alpha_{p1,s1}$=1 for at least one category and store. In that case, the optimal cost expressions reduce to:

$$\mathrm{TC}_{\mathrm{II}}^* = \sqrt{2\mathrm{t}_{\mathrm{s1}} (\mathrm{S}_{\mathrm{p1}} \mathrm{D}_{\mathrm{p1}} + \mathrm{S}_{\mathrm{p2}} \mathrm{D}_{\mathrm{p2}} \alpha_{\mathrm{p2,s1}}^2)} + \sqrt{2\mathrm{t}_{\mathrm{s2}} (\mathrm{S}_{\mathrm{p2}} \mathrm{D}_{\mathrm{p2}} (1-\alpha_{\mathrm{p2,s1}})^2)} +$$

$$\mathrm{VC}_{\mathrm{p1,s1}} \mathrm{D}_{\mathrm{p1}} + (\mathrm{VC}_{\mathrm{p2,s1}} \alpha_{\mathrm{p2,s1}} + (1-\alpha_{\mathrm{p2,s1}}) \mathrm{VC}_{\mathrm{p2,s2}}) \mathrm{D}_{\mathrm{p2}}$$

if category p1 is bought exclusively in store s1 while category p2 is spread across stores,
or to:

$$\mathrm{TC}_{\mathrm{II}}^* = \sqrt{2\mathrm{t}_{\mathrm{s1}} \mathrm{S}_{\mathrm{p1}} \mathrm{D}_{\mathrm{p1}}} + \sqrt{2\mathrm{t}_{\mathrm{s2}} \mathrm{S}_{\mathrm{p2}} \mathrm{D}_{\mathrm{p2}}} + \mathrm{VC}_{\mathrm{p1,s1}} \mathrm{D}_{\mathrm{p1}} + VC_{\mathrm{p2,s2}} \mathrm{D}_{\mathrm{p2}}$$

if p1 is bought exclusively in s1, and p2 exclusively in s2.

However, if the optimal expressions in [A3] are strictly between zero and one for both categories (purchases for each category are spread across stores), these optima may not be simultaneously implementable or reconcilable into one shopping strategy. The reason is that, unless $\alpha_{p1,s1} = \alpha_{p2,s1}$, each 'optimal' category allocation would correspond to a different timing of (the same N_{s1} and N_{s2}) shopping trips. Under those circumstances, the shopping costs derived above constitute a lower bound on the true (optimal) costs of a separate store visit strategy. Moreover, for the separate visit strategy to become implementable, adjustments need to be made in the categories' purchase allocation and in the corresponding timing of store visits (an issue likely to become more important as the number of categories increases). The need for, and nature of these adjustments, is taken up in Appendix 4.

Pattern III (multiple store shopping with combined visits)

It is easy to see that the derivations for *pattern III (combined visits only*) are completely comparable to those for the single store pattern but where, now, the unit fixed cost is that of the combined trip (t_{s1s2} instead of t_{s1}), and categories are purchased in their preferred store (e.g. category p1 in store s1, category p2 in store s2):

$$N^*{}_{s1s2} = \sqrt{(S_{p1} D_{p1} + S_{p2} D_{p2}) \big/ 2t_{s1s2}}$$

After substitution in the total cost expression, the corresponding minimal cost is easily found to be:

$$TC^*_{III} = \sqrt{2t_{s1s2}(S_{p1}D_{p1} + S_{p2}D_{p2})} + D_{p1}VC_{p1,s1} + D_{p2}VC_{p2,s2}$$

Appendix 2. Optimal shopping pattern selection

Proof of Result 2.

Let store s1 be preferred over s2 for both categories ($I_{p1,s1-s2} > 0$ and $I_{p2,s1-s2} > 0$), but have fixed shopping costs t_{s1} that are different from store s2 (t_{s2}). We prove below, in result 3b, that without store preference complementarity, pattern III cannot be optimal. The consumer's choice is limited to visiting store s1 alone, store s2 alone, or both stores on separate visits.

Let us, first, consider the case where $t_{s1} < t_{s2}$.
It is clear that the cost of visiting store s1 alone is lower than that of visiting only store s2:

$$TC^*_{I,s1} = \sqrt{2t_{s1}(S_{p1}D_{p1} + S_{p2}D_{p2})} + D_{p1}VC_{p1,s1} + D_{p2}VC_{p2,s1}$$

$$< TC^*_{I,s2} = \sqrt{2t_{s2}(S_{p1}D_{p1} + S_{p2}D_{p2})} + D_{p1}VC_{p1,s2} + D_{p2}VC_{p2,s2}$$

and lower than that of visiting both stores on separate trips:

$$TC^*_{I,s1} = \sqrt{2t_{s1}(S_{p1}D_{p1} + S_{p2}D_{p2})} + D_{p1}VC_{p1,s1} + D_{p2}VC_{p2,s1} <$$

$$TC^*_{II} = \sqrt{2t_{s1}(S_{p1}D_{p1}\alpha^2_{II,p1,s1} + S_{p2}D_{p2}\alpha^2_{II,p2,s1})} + \sqrt{2t_{s2}(S_{p1}D_{p1}(1-\alpha_{II,p1,s1})^2 + S_{p2}D_{p2}(1-\alpha_{II,p2,s1})^2)} +$$

$$(VC_{p1,s1}\alpha_{II,p1,s1} + VC_{p1,s2}(1-\alpha_{II,p1,s1}))D_{p1} + (VC_{p2,s1}\alpha_{II,p2,s1} + VC_{p2,s2}(1-\alpha_{II,p2,s1}))D_{p2}$$

since

$I_{p1,s1-s2} > 0$ implies that $\mathrm{VC}_{p1,s1} < \mathrm{VC}_{p1,s2}$ and $I_{p2,s1-s2} > 0$ implies that $\mathrm{VC}_{p2,s1} < \mathrm{VC}_{p2,s2}$

So: in the absence of a 'total cost conflict' ($I_{p1,s1-s2} > 0$ and $I_{p2,s1-s2} > 0$ and $t_{s1} < t_{s2}$), the separate store strategy is ruled out. The optimal strategy remains a single store strategy with store s1.

Second, consider the situation where $t_{s1} > t_{s2}$,. In this case, there is a 'total cost conflict', the low variable cost store s1 having the higher unit fixed cost. The consumer must now weigh the two single store strategies (I) (only visit store s1 or store s2), and the separate multiple store visits strategy (II), against one another.

⇒ Comparing the two *single store strategies*, we know from Table 1 that store s1 will be selected as long as:

[A5] $$(\sqrt{t_{s1}} - \sqrt{t_{s2}})\sqrt{2(D_{p1}S_{p1} + D_{p2}S_{p2})} < D_{p1}S_{p1}I_{p1,s1-s2} + D_{p2}S_{p2}I_{p2,s1-s2}$$

This condition may or may not hold, depending on the specific levels of t_{s1}, t_{s2}, $I_{p1,s1-s2}$ and $I_{p2,s1-s2}$. The choice of the best single store strategy involves a trade off between the fixed plus holding cost increase (left side of [A5]), and the variable cost decrease (right side of [A5]) from visiting store s1 rather than s2.

⇒ For the *separate store strategy* to be selected, we must have that

[A6] $TC^*_{II,s1-s2} < TC^*_{I,s1}$ and $TC^*_{II,s1-s2} < TC^*_{I,s2}$. Whether these conditions hold depends on the levels of $I_{p1,s1-s2}$ and $I_{p2,s1-s2}$.

If store preference is the same for both categories ($I_{p1,s1-s2} = I_{p2,s1-s2}$), strategy II will never be retained.

Indeed, under those conditions, we have $\alpha_{II,p1,s1} = \alpha_{II,p2,s1} = \alpha_{s1}$, and –based on Table 1-

$TC^*_{II,s1-s2} = \alpha_{s1}TC^*_{I,s1} + (1-\alpha_{s1})TC^*_{I,s2}$.

The total cost of the separate store strategy II, being a weighted average of the total costs of single strategies involving stores s1 and s2, can never be lower than each of these costs (condition [A6]). Hence, with the same level of category preferences for store s1 in both categories, the separate store strategy is not selected.

In the more general case with $I_{p1,s1-s2} > 0$, $I_{p2,s1-s2} > 0$ and $I_{p1,s1-s2} \neq I_{p2,s1-s2}$, the total variable costs for strategy II hold the middle between those for the single store s1 and the single store s2 strategy:

$$D_{p1}VC_{p1,s2}+D_{p2}VC_{p2,s2}>D_{p1}VC_{p1,s1}\alpha_{II,p1,s1}+D_{p1}VC_{p1,s2}(1-\alpha_{II,p1,s1})$$

$$D_{p2}VC_{p2,s1}\alpha_{II,p2,s1}+D_{p2}VC_{p2,s2}(1-\alpha_{II,p2,s1})>D_{p1}VC_{p1,s1}+D_{p2}VC_{p2,s1}$$

The total fixed plus holding costs for the multiple store strategy will certainly exceed those of store s2 when visited alone:

$$\sqrt{2t_{s1}(S_{p1}D_{p1}\alpha^2_{II,p1,s1}+S_{p2}D_{p2}\alpha^2_{II,p2,s1})}+\sqrt{2t_{s2}(S_{p1}D_{p1}(1-\alpha_{II,p1,s1})^2+S_{p2}D_{p2}(1-\alpha_{II,p2,s1})^2)}$$
$$>\sqrt{2t_{s2}(S_{p1}D_{p1}+S_{p2}D_{p2})},$$

yet they *may* be lower than those for the single strategy with store s1

$$\sqrt{2t_{s1}(S_{p1}D_{p1}\alpha^2_{II,p1,s1}+S_{p2}D_{p2}\alpha^2_{II,p2,s1})}+\sqrt{2t_{s2}(S_{p1}D_{p1}(1-\alpha_{II,p1,s1})^2+S_{p2}D_{p2}(1-\alpha_{II,p2,s1})^2)}<$$
$$\sqrt{2t_{s1}(S_{p1}D_{p1}+S_{p2}D_{p2})}$$

if the category with the higher holding cost potential (say, e.g. category p2) is less strongly preferred in the store with the higher unit fixed cost : $D_{p2}\ S_{p2}> D_{p1}\ S_{p1}$ and $I_{p2,s1-s2}<I_{p1,s1-s2}$ with $t_{s1}>t_{s2}$. In this case, the increase in total variable costs (from transferring part of the basket to store s2), may be more than compensated by the reduction in total fixed plus holding costs (by visiting the low unit fixed cost store s2 for purchases of the category with the weakest store preference for s1). This completes the proof of result 2.

Proof of result 3a: Let stores be such that s1 is preferred for category p1 ($I_{p1,s1-s2}>0$) and s2 for p2 ($I_{p2,s1-s2}<0$).

We first consider the case with *equal unit fixed costs* ($t_{s1}=t_{s2}=t$).

⇒ Comparing the two single store strategies with one another, we see from Table 1 that the consumer will select store s1 if

$$D_{p1}VC_{p1,s2}+D_{p2}VC_{p2,s2}>D_{p1}VC_{p1,s1}+D_{p2}VC_{p2,s1}$$

and store s2 in the opposite case.

⇒ Comparing the single store strategies with the multiple store strategies leads to the following insights. The single store strategies will imply lower total fixed plus holding costs than any of the multiple store alternatives. Indeed, with $t_{s1}=t_{s2}<t_{s1s2}$, we have:

$$\sqrt{2t(S_{p1}D_{p1}+S_{p2}D_{p2})}$$
$$<\sqrt{2t(S_{p1}D_{p1}\alpha_{II,p1,s1}{}^2+S_{p2}D_{p2}\alpha^2_{II,p2,s1})}+\sqrt{2t(S_{p1}D_{p1}(1-\alpha_{II,p1,s1})^2+S_{p2}D_{p2}(1-\alpha_{II,p2,s1})^2)}$$
$$<\sqrt{2t_{s1s2}(S_{p1}D_{p1}+S_{p2}D_{p2})}$$

where the comparisons are those with patterns II, and III, resp[xvii].

However, as the two stores are preference complements, patronizing both stores will allow to reduce total variable cost. So, the selection of a single or a multiple store strategy depends on a trade off between lower total fixed plus holding costs, and lower total variable costs, resp.

⇒ Comparing the costs of strategies II and III, we find that as long as category p1 is preferred in store s1 and p2 in s2, the total variable costs of strategy II are higher than those of strategy III:

$$D_{p1}VC_{p1,s1}+D_{p2}VC_{p2,s2}<D_{p1}VC_{p1,s1}\alpha_{II,p1,s1}+D_{p1}VC_{p1,s2}(1-\alpha_{II,p1,s1})$$
$$+D_{p2}VC_{p2,s1}\alpha_{II,p2,s1}+D_{p2}VC_{p2,s2}(1-\alpha_{II,p2,s1})$$

However, the total fixed plus holding costs of strategy II, given by:

$$\sqrt{2t(S_{p1}D_{p1}\alpha_{II,p1,s1}{}^2+S_{p2}D_{p2}\alpha^2_{II,p2,s1})}+\sqrt{2t(S_{p1}D_{p1}(1-\alpha_{II,p1,s1})^2+S_{p2}D_{p2}(1-\alpha_{II,p2,s1})^2)}$$

may or may not be lower than those of the combined strategy:

$\sqrt{2t_{s1s2}(S_{p1}D_{p1}+S_{p2}D_{p2})}$

depending on how category purchases are spread across the separate store visits. Hence, the selection between strategies II and III comes down to a trade off between (possibly) higher total fixed plus holding costs (for the combined strategy III) and higher total variable costs (for the separate store strategy II).
So, with category preference complementarity and equal unit fixed costs, none of the three shopping strategies (single store, multiple store-separate and multiple store-combined) can be ruled out a priori.

Second, in the more general case where the stores' unit fixed costs differ, the motives for selecting single, separate or combined strategies become a mixture of the motives underlying result 2 (no preference complementarity and different unit fixed costs) and those described above (category preference complementarity and the same unit fixed cost). Introducing differences in unit fixed costs in the expressions above will reinforce the appeal of strategy II if the category with the higher holding cost potential is preferred in the store with the lower unit fixed cost. Conversely, if the category with the higher $S_{p1}D_{p1}$ is preferred in the high unit fixed cost store, the single (I) and combined (III) shopping patterns become relatively more appealing.

Appendix 3. Aligning category purchase allocations and store visit timing

To illustrate the 'alignment' problem with separate store visits, and several categories purchased in different stores, consider the following example.
Let N_{s1}=1, and N_{s2}=2. Assume (like in the simulations) that there are four categories, for which the independently optimal allocations (based on [A3]) amount to $\alpha_{1,s2}$= 0, $\alpha_{2,s2}$= 0.5, to $\alpha_{3,s2}$= 0.75 and to $\alpha_{4,s2}$= 0.25. It is easy to see that these optima are not reconcilable. Indeed, for category 2, visits to store s2 would have to take place as follows : if a visit to s1 occurs at time t=0, then store s2 would be visited at time .5 (=1-$\alpha_{2,s2}$) and .75 (store s2 visits being uniformly spread over the remaining period $\alpha_{2,s2}$ =.5, hence with inter-visit interval of .5/ N_{s2}=.25). For category 3, however, of which a larger portion is bought in store s2, the first visit to s2 would have to occur at time .25 already, and the second at time .625. Store timing for category 4 , in contrast, would require visits to s2 at time .75 and .875. Obviously, as long as N_{s2}=2, these patterns are not reconcilable. We hypothesize that, to align store visit patterns across categories (and adjust purchase allocations accordingly), the consumer considers one of two options.

A first possibility is to let the most 'restrictive' category (of which most is bought in store s2) determine the timing of store s2 visits. In our example, this would be category 3. In that case, adjustments will have to be made to the purchase spread of categories 2 and 4 (note that category 1 is bought in store s1 only, its purchase pattern remains unaffected). For these categories, the following options remain:

(i) buy enough in store s1 to get by till the next visit to s2, then buy equal amounts on each visit to s2. This would come down to an allocation similar to that of category 3, with .25 of category needs bought in s1,

(ii) skip one visit to s2, that is, buy enough in store s1 to last till the second visit to store s2, then purchase the remaining portion in store s on this second visit. The units bought in s1 would then have to cover a period equal to (1-$\alpha_{3,s2}$) + $\alpha_{3,s2}$/ N_{s2}, where the first term represents time till the first visit to s2, the second term time between the first and the second visit to s2, leading to an 'adjusted' allocation to store s1 of 0.625.

(iii) skip two visits to s2 which, in our example, results in purchasing everything from store s1

Which adjustment is optimal for category 2 (4), will depend on the revised acquisition cost associated with the adjusted allocation , plus the revised holding cost implied by it. For category 2, the competing options seem to be (i) and (ii), while for category 4, options (ii) and (iii) are the best candidates. Note that – given N_{s1}=1 - the holding cost for the second option now comes down to$(1-\alpha_{3,s1})^2$ S_p D_p/(2*(N_{s2}-1))+$(\alpha_{3,s1})^2$ S_p D_p/(2), where the denominator of the first term indicates that one visit to store s2 is skipped.

A second possibility is that the consumer, in revising his allocation, determines a 'jointly optimal' alpha for all categories bought in store s2. (Such an alpha would be obtained by setting the derivative of the acquisition plus holding costs for categories 2, 3 an 4 to zero, with respect to a joint alpha s1, similar to the step in Appendix 1.1. The formula is given below).
For instance, such a joint alpha for store s1 could amount to .4 (implying an alpha of .6 for store s2), in which case visits to store s2 would occur at time .4 and and .7. For each of the three categories (2,3 and 4), and using a similar logic as before, the options would now be to

(i) allocate .4 to store s1, and spread the remaining .6 over the two visits to s2

(ii) allocate .7 to store s1, skip the first visit to s2, and purchase the remaining .3 on the last visit to s2

(iii) buy everything in store s1

Again, for each product category, the best of these options will determine the adjusted purchase allocation for that category.

The consumer will then settle for the heuristic (either let the most restrictive category, or the joint alpha, determine store timing) that yields the lowest total cost.

In general, we adopt the following 'procedure' in our simulations. Let N_{s1} be the number of visits to store s1, and N_{s2} (> N_{s1}) the number of visits to s2, per period. Based on equation [A3], let the (unadjusted) category allocations be such that $\alpha_{p,s1}<1$ for a subset of categories (in set Q1) and $\alpha_{p,s1}=1$ for the remaining categories. We need to decide upon one (common) timing for the visits to store s2 (between subsequent visits to s1). Moreover, for all p in Q1, we need to adjust the levels of $\alpha_{p,s1}$ such that they are consistent with this store timing. Our procedure comprises the following steps:

(1) For all categories in set Q1: determine a 'common α_{s2} –candidate' : α^c_{s2}. Time visits to store s2 as follows: The first visit occurs $(1-\alpha^c_{s2})/N_{s1}$ periods after store s1 is visited, followed by $(N_{s2}/N_{s1})-1$ visits with inter-trip time of $\alpha^c_{s2}/(N_{s2})$

(2) For each category in set Q1:

a. Consider all integer values x such that $\alpha^c_{p,s1|x}= (1-\alpha^c_{s2}) +x\, (N_{s1}/N_{s2})\, \alpha^c_{s2} \in [0, 1]$. Note that x represents the number of visits to store s2 that are 'skipped', see also the example above.

b. For each category: determine the level of x (x') for which $D_p[VC_{p,s1}\alpha^c_{p,s1|x}+(1-\alpha^c_{p,s1|x})VC_{p,s2}]+(1-\alpha^c_{p,s1|x})^2\, S_p\, D_p/(2(N_{s2}-xN_{s1})) +(\alpha^c_{p,s1|x})^2\, S_p\, D_p/(2N_{s1})$ is the lowest. Set $\alpha^c_{p,s1}=\alpha^c_{p,s1|x'}$, and

$TC_p= D_p[VC_{p,s1}\alpha^c_{p,s1}+(1-\alpha^c_{p,s1})VC_{p,s2}]+(1-\alpha^c_{p,s1})^2\, S_p\, D_p/ (2(N_{s2}-x' N_{s1}))+(\alpha^c_{p,s1})^2\, S_p\, D_p/ (2N_{s1})$

(3) Sum TC_p across categories.

(4) Repeat this procedure for the following α_{s2} –candidates':

- The maximum over categories in Q1, of their unadjusted $\alpha_{p,s2}$
- A 'jointly optimal' level computed as:

$$\alpha^c{}_{s2} = (1-\alpha^c{}_{s1}) = (1 - \frac{\dfrac{1}{N_{s2}} + \dfrac{\sum_{p\in Q_1}(VC_{p,s2}-VC_{p,s1})D_p}{\sum_{p\in Q_1} S_p D_p}}{\dfrac{1}{N_{s2}}+\dfrac{1}{N_{s1}}})$$

and select the 'common α_{s2} –candidate' that yields the lowest $\Sigma_p TC_p$. Implement the associated levels of $\alpha^c_{p,s1}$ and timing of visits to s2.

If $N_{s2}=N_{s1}$, repeat the procedure replacing s1 by s2. Then, select the adjusted strategy with the lowest $\Sigma_p TC_p$.