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ASSESSING THE IMPORTANCE OF CONTEMPORANEOUS AND TEMPORAL VARIATION IN PURCHASING BEHAVIOR: A MULTIPLE PURCHASE MODEL

by

Katia CAMPO
Els GIJSBRECHTS

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1. Introduction

The literature on buying behavior models has witnessed a growing interest in the dynamics of brand choice decisions. It is generally accepted by now that purchase history may have a substantial impact on subsequent purchases (see e.g. McAlister et.al. 1991, Trivedi, Bass and Rao 1994). While the first dynamic choice models concentrated mainly on *positive* purchase feedback or preference reinforcement (see, e.g., Massy , Montgomery and Morrison, 1970), recent contributions acknowledge the possibility of *negative* purchase feedback or variety seeking behavior, and of 'hybrid' forms of behavior. At the same time, the realism and accuracy of dynamic buying behavior models have been improved by incorporating marketing mix effects and correcting for heterogeneity in choice sets (see, e.g., Andrews and Srinivasan, 1995), intrinsic preferences (see e.g. Kamakura and Russell, 1989, and Chintagunta, Jain and Vilcassim, 1991) and promotional response (see, e.g., Bucklin and Gupta, 1992). Yet, a common drawback of most dynamic choice models to date is their assumption that a respondent selects only one item (one or more units) on every single shopping occasion. Recent empirical evidence suggests that this assumption is often untenable. As pointed out by Harlam and Lodish(1995), multiple item purchases[1] account for a high percentage of observations in various product categories[2]. Existing choice models have typically either dropped observations (purchases or purchase histories) where several items were bought simultaneously, or have broken these purchases up into a series of sequential observations. Both approaches reveal problematic for several reasons. Dropping multiple purchases could significantly reduce the size of the data set but, more importantly, could lead to a biased picture of dynamic behavior in the product category under study since consumers engaging in multiple purchases have been shown to exhibit different purchase dynamics (Gijsbrechts et al, 1996). Splitting multiple purchases up into single item choices is not

[1] Multiple item purchases, or multiple purchases, are defined here as the simultaneous purchase of two or more different items. Buying multiple units of the same item is not regarded as a 'multiple purchase', because this definition would lead to the confusion of choice and quantity decisions, and to difficulties in the interpretation of model assumptions and results.

[2] Similar figures were reported by Gijsbrechts et.al.(1996).

without problems either: it assumes that an order be imposed on the unobserved purchase sequence, and/or disregards potential differences in the purchase dynamics between and within purchase occasions. As demonstrated by Simonson (1990) in a experimental and Walsh (1995) in a theoretical context, the dependency among simultaneous purchase decisions partly results from motives similar to those underlying the temporal dependency relationships, but may also be inspired by totally different motives. For one, consumers buying less frequently but in larger quantities face a stronger 'separation in time' of purchases and consumption and, in view of the resulting uncertainty about future preferences at the time of consumption, may be tempted to buy more varied sets (Simonson, 1990, Walsh, 1995). At the same time, though, factors like search costs, handling costs, and in store promotions, may counteract this tendency to purchase different items from the category on a single shopping occasion. In brief, given the frequency with which multiple purchases occur *and* the particular nature of the dynamics involved, it seems only logical that dynamic choice models account for this phenomenon.

The model presented by Harlam and Lodish (1995) is a first and important step in this direction. Harlam and Lodish explicitly account for situations where consumers buy different items in a product category on a given purchase occasion. Their choice model therefore incorporates two 'types' of choice dynamics: interdependencies between purchases on subsequent buying occasions, and interrelationships between items bought simultaneously. The authors clearly demonstrate that including simultaneous choice dependencies adds to the descriptive and predictive power of the choice model. Harlam and Lodish's model, though, implies some restrictions that warrant further attention. First, it is assumed that all consumers exhibit similar 'patterns' of dynamics; in particular, their model suggests that the feedback among sequential purchase decisions is always positive (loyalty) and that there is a tendency to seek variety in simultaneous choices. While this finding may well be valid for an 'average' consumer in the product category under study, it is probably not generalizable to other product categories, and does not necessarily hold for all consumers. To illustrate, for many frequently purchased products, a high percentage of consumers has been shown to seek variety in purchases over time (Givon, 1984). Recent contributions also suggest that even within a product category consumers may widely differ in their reinforcement or variety seeking tendencies. A second limitation of Harlam and Lodish's approach is their assumption that multiple purchase decisions involve strictly sequential choices conditioned by item preferences. This assumption, while debatable, is found to affect the estimation results.

In this paper, a dynamic choice model is presented that explicitly includes the dependency among both sequential and simultaneous purchase decisions and as such builds upon the insights of the Harlam and Lodish model, while relaxing some of its assumptions. The model presented here allows for negative, zero order and positive purchase event feedback between as well as within purchase occasions, and anticipates potential consumer heterogeneity in the direction of the feedback (positive or negative). An additional advantage of the proposed model is that, unlike Harlam and Lodish's approach, no assumptions have to be made on the nature (sequential or simultaneous) and order of the evaluation process for multiple purchase decisions.

The discussion is organized as follows. The next section contains a review of buying behavior models that incorporate variety seeking behavior. Section 4 elaborates on the link between multiple purchases and choice dynamics. In section 5, the multiple purchase model is presented. Empirical results, obtained with purchase data collected in a realistic computer experiment, are reported in section 6. Section 7, finally, summarizes the main conclusions, and discusses the limitations of the present research as well as topics for future research.

2. Literature review.

The first buying behavior models that explicitly accounted for variety seeking behavior were introduced in the late 70's. Jeuland (1978) was the first to recognize that 'experience with the brand' (previous purchases) could have a negative effect on the (current) brand's utility, and introduced a model that allowed for such negative purchase event feedback. A number of subsequent models, often referred to as 'deterministic' variety seeking models, attempted to conceptualize and explain the dependency among simultaneously chosen items. Notable contributions are the model introduced by Farquar and Rao(1976), and those of Mc Alister(1979, 1982) and Mc Alister and Pessemier(1982) who put forward the notions of 'satiation' and 'ideal' attribute levels as factors underlying (within purchase set) variety. These notions were recently refined by Johnson et. al.(1995), whose model measures satiation at the 'feature' level, features being defined as meaningful value ranges of an attribute (for example nonfruity, fruity and very fruity beverages) that act as independent dimensions along which consumers seek variety. Though conceptually very revealing, none of the above models were applied to describe or predict actual (panel or scanner panel) purchase data[3]. Yet, the insights offered by the deterministic models increasingly found their way to stochastic choice models, the purpose of which is to quantify consumers' choice probabilities , often based on empirical purchase information. Whereas the evolution in deterministic models is characterized by an increasingly accurate and refined measurement of the 'satiation effect', stochastic choice models have typically evolved with respect to (i) the aggregation level, (ii) the types of dynamic behavior included, (iii) the incorporation of marketing mix variables interacting with the driving forces of choice dynamics. Table 1 provides an overview of the major stochastic models that incorporate variety seeking. These stochastic models can be classified as either Markov-type models, or as Multinomial (Logit or Probit) choice models[4]. While Markov models predict the switching or 'transition' probabilities from item i in period t-1 to item j in period t, logit or probit choice models are founded on the assumption that a consumer will select the alternative that maximizes utility, utility being a function of one or more explanatory variables (deterministic utility) and an error term (stochastic component). From table 1, we observe the following evolutions in both model types. The first *Markov models* concentrated on the two-brand case and positive preference reinforcement (e.g. brand loyal and last purchase loyal model of Massy, Montgomery and Morrison 1970), Givon (1984) extended the model to the n-brand case, and accounted for both preference reinforcement and variety seeking behavior. A further extension was made by Kahn et.al.(1986), who in addition to the 'pure' reinforcement and 'pure' variety seeking behavior cases, introduced second-order models capturing 'hybrid behavior'. Kahn and Raju (1991) developed a model that distinguishes between switching due to promotions and intrinsic switching due to variety seeking by incorporating a price discount

[3] The models mentioned above are validated on experimental data sets. The contribution of Johnson et. al. is an exception in that it uses a (small) set of 'real' panel data, but the analysis is limited to only one product attribute.

[4] The distinction between Markov and Logit models has become smaller with the introduction of conditional logit models that estimate switching probabilities (see e.g. Carpenter and Lehmann 1985).

variable. Like Markov brand switching models, the first dynamic *logit/probit models* focused on positive purchase feedback or loyalty (e.g. Guadagni and Little, 1983). Several other types of dynamic choice behavior have been modelled since, ranging from preference reinforcement/variety seeking models (e.g. Lattin, 1987) to models incorporating 'hybrid' behavior (Bawa, 1990, Papatla and Krishnamurthi, 1992), and two-stage decision processes (Winter and Rossiter 1989, Ansari et.al., 1995). Like in deterministic models, the measurement of the variation effect has been refined from the brand to the attribute level (e.g. Lattin, 1987, Harlam and Lodish, 1995). In addition, several marketing mix variables have been included in the utility function to increase the models' descriptive and predictive ability, and to analyze the impact of dynamic choice behavior on the response to marketing variables (e.g. Ansari et.al., 1995, Harlam and Lodish, 1995).

< Insert Table 1 here>

Despite all these refinements and extensions, buying behavior models to date share a common limitation: they *either* concentrate exclusively on simultaneous choices (see the deterministic models of Farquar and Rao, 1976, and Mc Alister, 1979) thereby ignoring the consumer's purchase history, *or* do account for choice dependencies over time but fail to recognize the possible occurence of multiple purchases. The latter situation holds for the stochastic choice models mentioned so far: virtually all of these models ignore the presence of (and therefore automatically the particular dependence between) simultaneous choices. Already in 1979, Mc Alister recognized the limitations of such a simplification: " For choice situations in which choices are highly dependent on one another, models incorporating that dependence should be much better predictors than independent choice models. As the level of dependence declines, the discrepancy between predictions should decline... The independent choices model is the degenerate case of models incorporating dependence. Hence, one has nothing to lose, but perhaps much to gain by employing a dependence incorporating model of choice."

As indicated above, the model introduced by Harlam and Lodish(1995) represents a notable exception in the literature, being the first to account for the dependency among sequential and simultaneous choice decisions. While recognizing the model's merits, though, one also observes some limitations. First, the model relies on strict assumptions on the nature of the multiple purchase decision process, which is characterized as sequential in nature, the sequence in which items are considered being determined by long term preferences. Second, as will be argued below, the model is fairly restrictive in the type of purchase event feedback that is allowed between and within purchase occasions.

The model presented in the next section builds on the tradition of dynamic logit choice models, and can be seen as an extension of Harlam and Lodish's approach to modeling multiple purchases.

3. Multiple purchases and choice dynamics

Multiple purchases have been shown to constitute a high percentage of purchases in various product categories. Several authors (Simonson, 1990, Walsh, 1995, Harlam and Lodish, 1995) have pointed out that simultaneous purchase decisions are likely to be interrelated. Ignoring multiple purchases (e.g. by omitting these observations from the estimation sample), or the dependency among simultaneous purchase decisions (an approach followed by Papatla and Krishnamurthi, 1992) can result in incorrect or incomplete conclusions with respect to variety seeking behavior. Omitting multiple purchase data may lead to an underestimation of the overall degree of variety seeking behavior in a product category, because within set variation is not taken into account and because high variety seekers seem to be more inclined to buy heterogeneous purchase sets than low variety seekers (see, e.g., Gijsbrechts et al, 1996). The alternative approach, which treats multiple purchases as separate, independent purchase decisions avoids this bias in the estimation sample, but still fails to fully capture within purchase set variation, thereby underestimating the variation in behavior for consumers who buy large, heterogeneous purchase sets, and overestimating it for those who buy multiple units of the same item simultaneously.

< Insert Figure 1 here>

To obtain an accurate and complete picture of dynamic choice behavior, both preference reinforcement and variety seeking behavior have to be allowed for, over time as well as within the same purchase occasion. Figure 1 displays possible combinations of temporal and contemporaneous dependency relationships among purchase decisions.

The diagonal cells (II and IV) represent 'pure behavior', where consumers either seek variation within purchase sets and over time, or stick to the same item all the time and for their complete purchase sets. These behavioral tendencies are to be expected when *true* loyalty (strong intrinsic preferences for a given item, cell II) or *direct* variety seeking (cell IV) prevail, and dominate the purchase decision (Mc Alister and Pessemier, 1982, Walsh, 1995). 'Mixed' behavior, a combination of variety seeking in sequential purchases and variety avoidance in simultaneous purchases or vice versa, usually arises under the influence of 'additional' product-, household- and situation-specific factors. To illustrate: handling costs, search costs or promotions may induce variety seeking consumers to buy several units of the same item rather than engaging in the more complex process of selecting and handling a heterogeneous set of items on a given purchase occasion (a shift from type IV to type I behavior). Similarly, the presence of multiple uses or users, or a desire for flexibility in future consumption situations (Simonson, 1990, Walsh, 1995), may result in multi-item loyalty (stimulate type III instead of type II behavior). Harlam and Lodish's model focuses on this type of behavior, assuming that consumers tend to *repurchase items with the same characteristics across shopping trips*, while they may engage in multiple item purchases to *balance the preferences of a single person and/or several household members*. While Harlam and Lodish's model does not exclude the possibility that a consumer will prefer homogeneity within a shopping trip on some of the attributes (while seeking variety in others), it is restrictive in that it does not allow for variety seeking behavior over time[5].

Harlam and Lodish further assume that *the mental selection process for an assortment of multiple purchases made simultaneously on the shopping trip ... is consistent with one that occurs successively. This suggests that the consumer makes a series of decisions when purchasing a collection of items rather than one decision for the set of items*. The order in which the simultaneously purchased items are processed, is assumed to be the (long term) preference order. These assumptions may be irrealistic for a number of reasons. First, even if the selection process occurs successively, the multiple purchase decision may still have to

[5] Harlam and Lodish use a loyalty variable, similar to the one specified by Guadagni and Little(1983), to capture the dependency among sequential purchases.

be regarded as one decision for the set of items, given the possibility of feedback and adjustment within the shopping trip. In reality, consumers are indeed found to 'change their mind' before leaving the store, and exchange one selected item for another one. Such a mechanism of successive choices with feedback and readjustment may constitute an efficient way to arrive at 'utility maximizing' purchase sets. Second, even if the items are evaluated successively without feedback or adjustment, the assumption that the order of evaluations corresponds to the long term, stable preference order may not always prove to be correct. For one, preferences may change over time for reasons of variety seeking and other factors (e.g. situation, choice context). Also, people may be indifferent towards some items, in which case no strict preference order can be imposed. Finally, consumers may adopt evaluation orders based on factors other than preference, the more since they can adjust decisions in later stages of the process. Possible orders are shelf layout (consumers often use shelves as a 'shopping list', preferred items may be 'scattered' over a wide shelf range), in-store promotions (when items in promotion are processed first and later on compared with favorite items), last purchases... Consequently, different consumers may use different evaluation orders, depending on the choice tactics used (see, e.g. Hoyer 1984 for a discussion on choice tactics). To the extent that the actual decision order does not correspond to the long term preference order, Harlam and Lodish's model may provide an inaccurate or incomplete picture of the multiple purchase decision process.

4. A new approach to modeling multiple purchases

The major purpose of the model presented in this paper, is to contribute to a better understanding and prediction of dynamic choice behavior, by modeling both the dependency among sequential and simultaneous choice decisions in a flexible manner, and without imposing assumptions on the nature of the simultaneous choice process. In particular, given the two-way feedback that may exist within a shopping trip and lacking information on the eventual order in which items were considered, our model treats the choice of a purchase set as 'one decision'. Consequently, the choice alternatives considered by our model are purchase sets[6], rather than individual items in the product category. The flexibility of the model further stems from the fact that no a priori restrictions are imposed on the direction (positive or negative) of the purchase feedback within and between purchase occasions. In other words, in line with the arguments developed above, temporal and contemporaneous

[6] If the household purchases only one unit on a given occasion, the set of choice alternatives (purchase sets) again becomes a set of individual choice items.

feedback may in principle be positive as well as negative, the direction of the feedback being at least partly conditioned by the household's variety seeking or reinforcement tendency.

The model developed below concentrates on purchase set choice, *given* a decision on the number of units acquired by the household on that particular occasion. Also, in the choice stage, consumers are assumed to consider only a subset of all available items, this subset having been determined in a screening stage preceding the ultimate choice. Evidence on the use of consideration sets for single item purchases is given in Shocker et.al. (1991), and in a special issue of IJRM on consideration sets (1995, 12(1)). Allenby and Ginter demonstrated, for example, that *consideration sets exist and are important, in even the simplest of choice settings* (Allenby and Ginter, 1995, p.78). If consumers use consideration sets to simplify the selection of a single item, they will certainly do so for more complex choice problems such as the selection of a set of items. In accordance with theoretical and empirical evidence, we further assume that consideration sets remain relatively stable over time, except for changes triggered by (in store) marketing actions. (Roberts and Nedungadi, 1995, Allenby and Ginter, 1995, Mitra, 1995).

In developing our multiple purchase model, we denote by J the set of items available in the product category, j:1--> J. A purchase set s is then completely characterized by the number of units n^s_j that it contains of each item j. S is the index set of all such possible purchase sets. Several relevant subsets of S can be identified, such as S_N - comprising all purchase sets containing exactly N units - and S^h_N - in which only purchase sets of size N and containing items belonging to the consideration set of household h, are listed. The choice made by a household on a given purchase occasion is indicated by the variable y^h_t, $y^h_t=s$ meaning that household h selected purchase set s at time t. Whether purchase set s will be chosen depends on its utility, $u^h(s,t)$, compared to the utility in this same period of all other purchase sets considered by the household. More specifically, the probability that household h will select purchase set s (of a given size N) out of all considered sets of size N, is given by the following MNL expression:

$$P(y^h_t = s \mid N^h_t = N,\ J^h) = 0 \qquad \text{if } s \notin S_N^h \qquad (1)$$

$$= \frac{e^{u^h(s,t)}}{\sum_{r \in S_N^h} e^{u^h(r,t)}} \qquad \text{if } s \in S_N^h$$

j = item indicator ; $j \in J$
h = household indicator
t = period / purchase occasion
s = purchase set ; $s \in S$
$S = \{s \mid n_j^s \in \mathbb{N},\ \forall\, j \in J\}$
$S_N = \{s \mid n_j^s \in \mathbb{N},\ \sum_j n_j^s = N\}$
J^h = subset of items considered by h
$S_N^h = \{s \mid n_j^s \in \mathbb{N},\ \sum_j n_j^s = N,\ n_j^s = 0 \text{ if } j \notin J^h\}$
$P(y^h_t = s \mid N^h_t = N,\ J^h)$ = probability that h buys s in t, given N
$u^h(s,t)$ = utility of purchase set s for household h in t
N^h_t = number of units bought by h in t

For any household h, the utility of a purchase set s can thus be defined as follows :

$$u^h(s,t) = \sum_{j \in s} n^s_j * u^h_{j,t} + u^h[varw^h(s,t)] + u^h[varb^h(s,t)] + \theta^h_{s,t} \qquad (2)$$

where
n^s_j = number of units of item j in set s
$u^h_{j,t}$ = utility of item j for household h in t
$u^h_{j,t} = \alpha_j + \beta_j * X^h_{k,j,t}$
$X^h_{k,j,t}$ = marketing (and other) explanatory variables
$u^h[varw^h(s,t)]$ = utility of variation within set s
$u^h[varb^h(s,t)]$ = utility of variation between set s and previous purchases
$\theta^h_{s,t}$ = stochastic component of utility

The systematic component of purchase set utility thus consists of the sum of: (i) the utilities of the individual items belonging to the set, $u^h_{j,t}$, (ii) the utility (or disutility) of variation within the purchase set, $u^h(varw^h(s,t))$, and (iii) the utility (or disutility) of variation compared to previous purchases, $u^h(varb^h(s,t))$.

The utility of within purchase set variation can be modeled in a variety of ways, but will always contain $varw^h(s,t)$, the *average difference between items in the purchase set*, as a core variable. A specific form of $u^h(varw^h(s,t))$ considered later in this paper is the following:

$$u^h(varw^h(s,t)) = (\,\delta^w_v + \gamma^w_v .\ VST^h)\ .\ varw^h(s,t)$$

where VST^h is a household specific variable reflecting the household's 'intrinsic' variety seeking tendency, and δ^w_v and γ^w_v are parameters. More details on the calculation and interpretation of $varw^h(s,t)$ and VST^h are provided in section 5. At this stage, it suffices to note that, while we expect γ^w_v to be positive (households with a high variety seeking tendency 'value' within purchase set variation more highly), there is no sign constraint on 6^{w}_{v} , and hence on $6^{w}_{v} + \gamma^{w}_{v}.\ VST^{h}$. This implies that (i) within purchase set variation may be considered as an asset (positive $6^{w}_{v} + \gamma^{w}_{v}.\ VST^{h}$) or as a source of 'disutility' (negative $6^{w}_{v} + \gamma^{w}_{v}.\ VST^{h}$), and (ii) that this evaluation may differ among households.

A completely similar reasoning holds for the utility of between purchase set variation, $u^{h}(varb^{h}(s,t))$. This utility of temporal variation will depend on the *average difference* $varb^{h}(s,t)$ *between items contained in purchase set s, and items previously bought by the household.* Letting

$$u^{h}(varb^{h}(s,t)) = (6^{b}_{v} + \gamma^{b}_{v}.\ VST^{h})\ .\ varb^{h}(s,t)$$

and allowing 6^{b}_{v} to be positive as well as negative, we obtain the same flexibility as for within purchase set variation.

From equations (1) and (2), it is clear that the multiple purchase model (hereafter: MPM) does nor require assumptions on the order of choices within a purchase set, and accounts for intertemporal and contemporaneous choice dependencies without any restrictions on the direction of the feedback. If both simultaneous and successive purchase decisions are independent, the utility of a set is exclusively determined by the individual items' utilities. Dependency among simultaneous purchase decisions, may increase (variety seeking) or decrease (variety avoidance) the utility of heterogeneous purchase sets. Similarly, purchase sets that strongly differ from previous choices may be considered as relatively more (variety seeking) or less (variety avoiding) attractive. The equations also show that, if only one unit is purchased at a time, the model naturally reduces to the traditional multinomial logit model.

The multiple purchase model can be estimated by ML-estimation, maximizing the following Loglikelihood function :

$$LL = \sum_{h}\sum_{t}\sum_{s} d^{h}_{s,t} * \log[P(y^{h}_{t} = s | N^{h}_{t} = N\ ,\ J^{h})]$$

$$d^{h}_{s,t} = 1 \textit{ if household h purchased set s in period t}$$
$$= 0, \textit{ otherwise}$$

To assess the contribution of the MPM to the explanation and prediction of dynamic choice decisions, the MPM will be compared to a traditional multinomial logit model that treats multiple purchases as separate observations. This benchmark model is further referred to as the 'Single Purchase Model' (SPM). Empirical results are discussed in the next section.

5. Empirical results.

5.1. Data.

The data used to validate the MPM were collected in the context of a realistic computer experiment. In total, 1200 respondents participated in the experiment. The interviews were conducted in 5 stores of a large Belgian supermarket chain, in order to obtain a large and heterogenous sample of respondents with sufficient shopping experience[7]. Respondents were (randomly) assigned to two out of four possible categories (cereals, jam, margarine and paper towel), provided they exceeded a minimal consumption rate in the assigned categories. The purchase task involved selecting items from a 'simulated' shelf layout on the screen, that reproduced the actual in store shelves based on scanned pictures of real products. Respondents could pick one or more items for purchase (or decide not to make any purchases in the product category), and made purchase decisions in the two product categories for 12 (fictitious) successive weeks. Inventory levels were updated 'weekly' on the basis of purchases and the average consumption rate, and displayed on the bottom of the screen to enable respondents to make realistic purchase quantity decisions. During the twelve week period, promotions were simulated for two test items[8] according to 20 scenario's presented to different groups of consumers. Treatments consisted of 4 promotion types indicated on the package by means of promotion labels : a direct price promotion, a coupon redeemable on the next purchase occasion, an extra product amount, and a small gift. Shelf space manipulations represented an additional treatment. The experimental design allowed for the evaluation of all main effects, and of selective second order interaction effects between treatments.

Table 2 provides summary data on the purchases realized in the experimental setting.

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[7]This was a crucial factor in the experiment's validity, because dynamic choice behavior had to be reproduced in a realistic manner.

[8]To make sure that promotional effects would not be confounded with the impact of product characteristics, while keeping the required number of observations manageable, only two items in each product class were subject to promotions.

Multiple purchases revealed to be important in two of the four product categories, jam and cereals. Table 2 also indicates the average degree of purchase variation in each category, measured by the entropy index. The figures clearly demonstrate that multiple purchases are more predominant in categories with stronger variation in behavior: for jam and cereals, they account for 37% and 50% of the purchase histories, resp. In brief, multiple purchases cannot be ignored, and have to be taken into account when analyzing the impact of variety seeking behavior in a product category.

< Insert Table 2 here>

5.2. Explanatory Variables

Table 3 summarizes the explanatory variables considered for inclusion in the MPM model. 4 types of variables can be distinguished: (i) dummy variables indicating the items' characteristics (brand, product variety), (ii) marketing mix variables reflecting whether or not an item is on promotion in a given period, as well as the nature (and eventually the value) of this promotion, (iii) variation variables, quantifying the variation present within a purchase set on a given occasion (contemporaneous variation), or the variation brought about by this purchase set compared to the previous purchase (temporal variation), (iv) variety seeking tendency variables, characterizing the household's intrinsic desire for variation. Two variety seeking tendency scales were incorporated in the computer questionnaire to quantify the households' desire for variation: the EAP scale of Baumgartner and Steenkamp (1995), and the Varseek scale developed by Van Trijp and Steenkamp(1992). Scores on the two scales were significantly and positively correlated with one another, and with various measures of variety seeking behavior computed over the household's purchase history excluding promotion items. Since scale data will seldom be available in conjunction with scanner panel information, we subsequently concentrated on the behavior based entropy measure[9] to characterize the household's overall need for variation.

It is important to emphasize the different meaning and role of the variation variables $varw^h(s,t)$ and $varb^h(s,t)$ on the one hand, and the household variety seeking tendency variables VST^h on the other. The variety seeking tendency variables VST^h should be

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[9] In particular, we used *relative* entropy to characterize the household's variety seeking tendency: this is the absolute entropy divided by the maximum entropy given the assortment's characteristics (see, e.g., Van Trijp and Steenkamp, 1990). Relative entropy will be a figure between zero and one, one pointing to maximum variety seeking.

considered as 'intrinsic household characteristics', reflecting the households' need for variation irrespective of particular purchase sets or occasions over time. Naturally, one would assume that households with a higher level of VST^h are more inclined to buy purchase sets that bring about variation. Incorporating VST^h can thus be seen as a way of allowing for household heterogeneity in the 'valuation' of variation and eventually other variables[10]. The variables $varw^h(s,t)$ and $varb^h(s,t)$ are essentially related to purchase sets and quantify the variation that an eventual purchase of a particular set of items would offer in itself (within set variation), and in view of the previous purchase (temporal variation)[11]. Such purchase set variation may be quantified in a number of ways. In the present application, we calculate variation, based on the characteristics of items on a number of discrete attributes relevant in the product class.

If we let K be the number of attributes along which items are evaluated, and k the attribute index, k:1 --> K (e.g. k=1 would correspond to the attribute 'brand', k=2 to 'taste', etc.), then within set variation is calculated as the average difference between units belonging to purchase set s as follows:

$$varw^h(s,t) = \sum_k \sum_j \sum_r \frac{n^s_j * n^s_r * A^k_{j,r}}{K * N_t * (N_t - 1)}$$

where

$A^k_{j,r}=0$ *if items j and r are similar on attribute k, and* 1 *otherwise*

N_t= *the total number of units bought in t*

Similarly, temporal variation brought about by a purchase set on a particular occasion is 'constructed' from the average difference on relevant attributes between items bought now and those bought on the previous occasion:

10 A similar approach has been adopted by Ansari et al (1995), who include a household's 'long term propensity to switch' as a household characteristic.
An alternative way of including household heterogeneity would be to use a latent class estimation approach, like the one suggested by Kamakura and Russell (1989). Latent class estimation of the MPM model was carried out for two latent classes, in three product categories. The approach yielded interesting results, consumers belonging to different latent classes were found to systematically differ in variety seeking tendency. Unfortunately, computational difficulties hampered this type of heterogeneous estimation, for both the single purchase and the multiple purchase model, in some product categories. Also, the relatively limited number of observations made introduction of more than two latent classes less feasible.

11 In fact, the temporal variation variable is somewhat comparable in meaning and nature to 'classical' purchase event feedback variables often included in logit models.

$$varb^h(s,t)=\sum_{ss\in S}\sum_k\sum_j\sum_r y^h_{ss,t-1}\frac{n^s_j*n^{ss}_r*A^k_{j,r}}{K*N_t*N_{t-1}}$$

where
$A^k_{j,r}=0$ *if items j and r are similar on attribute k, and* 1 *otherwise*
N_t= *the total number of units bought in t*

Note that our calculation of $varb^h(s,t)$ involves a comparison with the previous purchase set only. Our reason for using a first order measure is purely practical, inspired by the short purchase histories available. Extension of $varb^h(s,t)$ to a higher order measure that includes a comparison with a longer sequence of past purchase occasions is straightforward(see, e.g. Gijsbrechts et al, 1996).

< Insert Table 3 here>

As indicated earlier, the model assumes that households select items from their consideration set. A self-reported measure of the consideration set was obtained during the experiment: respondents were asked to indicate all items they would consider to buy in the future. Comparison of this information with actual purchases (made in the subsequent purchase simulation) revealed that a number of purchases had been made outside the (self-reported) consideration set[12]. Similar problems with self-reported consideration sets have been encountered by other researchers (see e.g. Shocker et.al. 1991, Andrews and Srinivasan 1995). Andrews and Srinivasan therefore suggest that '*other than directly asking consumers for their set of considered brands..., we can define the consideration set of options which has been chosen at least once during a time interval*'. Other researchers have followed the same approach (see e.g. Hensher and Johnson, 1981, Siddarth, Bucklin and Morrison, 1993, Trivedi, Bass and Rao 1995). In our application, both approaches (i.e. self reported versus revealed consideration sets based on actual purchases) were used and compared: they appeared to give similar results in terms of goodness-of-fit (slightly better for the revealed set) and parameter estimates. For this reason, only the results obtained with the revealed

[12] From an analysis of the deviations between indicated and revealed consideration set, two important explanations seemed to emerge. First, some respondents interpreted the consideration set too narrowly. Although they indicated only 1 item, several different items were purchased during the simulations, presumably because they misunderstood the question and merely indicated the item they would purchase on the next purchase occasion. Second, respondents seemed to have specified the consideration set disregarding (the effect of) marketing mix variables. A high percentage of deviations was observed for the two test items in all product categories.

consideration sets are reported here.

5.3. Results

In each product category, 6 versions of the MPM model were estimated ranging from a simple 'base case' with only brand and product type dummy variables (MPM0), to more complex specifications including promotional effects and contemporaneous and temporal purchase set variation. Models MPM4 and MPM5 also include interaction effects with the households' variety seeking tendency[13]: these interaction variables allow households with a lower or higher intrinsic desire for variety to react differently to various promotions and attach different utilities to the contemporaneous or temporal variation brought about by specific purchase set choices. To avoid collinearity, the variety seeking tendency VST^h and variation variables $varw^h(s,t)$ and $varb^h(s,t)$ were standardized (see Jaccard et.al., 1990, Cooper and Nakanishi, 1988). No transformation was applied to the promotion variables, because of their 'discrete' nature (the extra amount, gift and shelf variables are dichotomous, and price and coupon promotions take on only three possible values: 0, reduction for test item 1, reduction for test item 2).

< Insert Tables 4 to 7 here>

Results for various specifications of the MPM are reported in tables 4 to 7. The base model was used to calculate goodness-of-fit measures (see Ben-Akiva and Lerman, 1985). The last 3 rows of the tables provide information on the goodness-of-fit of each model specification (Loglikelihood, rho squared), and the improvement in goodness of fit over the more restricted model (model indicated between brackets) as measured by the Likelihood-ratio

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[13] As indicated earlier, a behavioral measure of variety seeking tendency was used to estimate the interaction effects. More specifically, for each household an entropy measure was computed from its purchase history over all non-promotion items (i.e. all items except the two test items) to quantify VST^h. This measure allows for multiple purchases and reflects the household's switching tendency independent of promotions. Use of the variety seeking tendency scales to measure VST^h lead to similar estimation results, in that all interaction effects were positive and significant. Yet, the utility of between and within purchase set variation remained negative over the whole range of the scales, despite the high degree of variety seeking behavior observed for cereals and jam. A similar observation was made for the single purchase model. The relationship between the general variety seeking tendency and buying behavior in specific product categories seems not to be strong enough - although significant - to be fully reflected in the measured differences in the utility of variation (parameter estimates).

statistic.

For all products, acceptable levels of goodness of fit (the rho squared statistic ranges from .58 to .72) are obtained for all model specifications that incorporate one or more variation variables (MPM2 to MPM5). Considering the changes in fit from the base model (MPM0) to the complete model (MPM5), we see that each extension of the model entails a significant improvement. Only for jam this is not completely true: incorporation of within set variation only leads to an improved fit for this product category if interaction effects are also included. Overall, the largest increases in fit are realized by introduction of temporal variation (MPM2) and of interaction effects between variety seeking tendency and promotions and variation (MPM4, MPM5 in comparison with MPM3). Smaller, but significant improvements are obtained when within set variation is incorporated into the MPM (MPM3 and MPM5 in comparison with MPM2 and MPM4). The complete model (MPM5) that incorporates variation between and within sets as well as interaction effects between household variety seeking tendency on the one hand, and promotions and purchase set variation on the other, provides the best fit for all products. Rho squared values for this model specification are highest for the two functional products margarine and paper towel. This is probably due to the strong tendency in these categories to avoid variation in simultaneous purchases: incorporating within set variation as an explanatory variable (the coefficient of which will be negative and large in absolute value) substantially improves the model's explanatory power.

All main effects are significant and have the expected sign, except for some brand- and product type variables, where insignificant parameters point to similarity with the reference brand and type.

Interaction effects between variety seeking tendency and price cuts, premiums and coupons are positive and significant in all cases, except for jam where coupon interactions are not significant, and for paper towel where no reliable interaction between premiums and variety seeking is found. Changes in shelf space or offering extra product amounts, on the contrary, tend to entail similar reactions from variety seeking and non-variety seeking consumers[14]. This absense of significant interactions is not completely unexpected. Shelf space effects are limited overall, so that the chances of finding 'outspoken differences' between subgroups of households are minimal. For the extra amont variable, we note that while variety seekers may be more deal prone in general, they probably tend to be less attracted by the idea of

[14] Only for jam a significant and positive interaction for the extra amount variable is observed, while for margarine, we observe a negative interaction between variety seeking and shelf space increases.

buying larger quantities (extra amounts) of the same product.

Given that VST^h has been standardized, the main effects of promotion and variation variables reflect the utility of promotions and variation for households with an average variety seeking tendency (see Jaccard et.al.1990). The interaction parameters measure the increase (decrease) in utility of promotions and purchase set variation with higher (lower) levels of variety seeking tendency. The overall impact of a promotion[15] on the utility of the purchase set is then equal to :

$$ME^h[promo_{k,j,t}] = (\beta_k + \gamma_k * VST^h)$$

$promo_{k,j,t}$ = *promotion of type k for item j in period t*
β_k = *main effect of promotion of type k*
γ_k = *interaction parameter for promotion k and variety seeking tendency*
VST^h = *variety seeking tendency of household h*
$ME^h[promo_{k,j,t}]$ = *overall marginal effect of promotion k*

Table 8 reflects these promotion effects in different product categories for varying levels of VST^h: the minimum variety seeking tendency score, the average score minus one standard deviation, the average score, the average score plus one standard deviation, and the maximum score. Additional t-tests (see Jaccard et.al. 1990) on the overall promotion effects reveal that these effects remain significant at various levels of variety seeking tendency, except in a few 'extreme' cases. The table further confirms that households with a high intrinsic need for variety respond more strongly to price cuts, coupon actions and especially to premium promotions than variety avoiding households. For extra amount or shelf space, such a pattern is absent or much less outspoken.

< Insert Table 8 here >

The impact of variation within and between purchase sets, and its interaction with households' variety seeking tendencies, can be analyzed in a similar vein. The overall marginal effect of a change in (within or between) purchase set variation on utility is given by:

[15] For extra amount, gift or shelf space, this expression quantifies the effect of the *presence* of such a promotion, while for price or coupon promotions, it measures the impact of a *marginal change* in price cut or coupon face value on purchase set utility.

$$ME^{h}[varx^{h}_{s,t}] = (\beta^{x}_{v} + \gamma^{x}_{v} * VST^{h})$$

where
$ME^{h}[varx^{h}_{s,t}]$ = *overall marginal effect of variation x (x= w or b)*
$varx_{s,t}$ = *variation measure for set s in period t*
β^{x}_{v} = *main effect of variation*
γ^{x}_{v} = *interaction parameter for variation and variety seeking tendency*
VST^{h} = *variety seeking tendency of household h*

Table 9 reports this overall effect of purchase set variation for households with different variety seeking tendencies. The main effect is significant and negative for all product categories, indicating that the average household tends to buy similar items over time and simultaneously. Yet, there is a clear difference in the overall utility of variation (taking interaction effects into account) between the 4 product categories. High variety seekers have a positive utility[16] of temporal and of within set variation for the two hedonic[17] products cereals and jam. In contrast, almost all households avoid variation for the two functional products, margarine and paper towel. Only households with the highest (observed) variety seeking tendency exhibit a positive utility of temporal variation for margarine and paper towel, while within set variation in these categories is always perceived as negative. These results are in line with theoretical expectations (see Campo 1993, Van Trijp 1995), and results obtained in other empirical studies (see Van Trijp 1995, Gijsbrechts et al, 1996).

< Insert Table 9 here>

The results point to the presence of different types of dynamic choice behavior (preference reinforcement, variety seeking), and different combinations of temporal and contemporaneous dependency relationships. For cereals, the model suggests that high variety seekers tend to seek variety in purchasing behavior over time as well as within the same shopping trip (type IV behavior), which is in line with the high degree of variety seeking behavior and the high percentage of multiple purchases observed for this product category. For jam, all consumers except for the ones with the highest variety seeking tendencies, are 'expected' to buy homogeneous purchase sets, while all strongly and moderately variety seeking households in

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[16] *Positive* in the sense that the purchase set's utility is positively related to the variation level.

The a priori classification of cereals and jam as 'hedonic products', and margarine and paper towel as 'functional products' was tested and 'confirmed', using perceptional data of a subsample of respondents.

this category will buy different items over time (type I behavior). For the two functional products margarine and paper towel, the MPM predicts that the majority of consumers will buy similar items over time and within the same purchase set (type II behavior), which adequately reflects the low degree of variety seeking behavior and the low percentage of multiple purchases found for these product categories. Low variety seekers display similar behavior (preference reinforcement, homogeneous purchase sets) for the two hedonic products, jam and cereals. The combination of preference reinforcement over time with variety seeking within the same shopping trip (type III behavior) was predicted for none of the product categories, and did not appear either in the overall variation measures (for none of the products, a high percentage of multiple purchases and a low degree of temporal variation in behavior was observed). In other words, we find that in the product categories at hand, variety avoiders may switch to another alternative under some circumstances (for example, in response to a promotion), but rarely buy different items at the same time.

The empirical results show that the MPM has both face and statistical validity, that it can capture various types of dynamic choice behavior, and that it can provide a better understanding of both positive and negative feedback relationships between sequential ánd simultaneous purchase decisions. To fully assess the contribution of the MPM to the explanation and prediction of dynamic buying behavior, the model should be confronted with simpler, 'classical' MNL specifications that explain the choice of single items instead of purchase sets, we refer to these models as 'single purchase models'(SPM).

< Insert Tables 10 to 13 here>

Like for the MPM, different versions of the SPM were estimated, the results are presented in tables 10 to 13. As before, the starting point is a base model (SPM0) incorporating brand and product type dummies only. Model SPM1 corresponds to a classical zero order model in which all individual item choices are considered as 'independent' decisions, influenced only by product attributes and promotional conditions at the time of purchase. Models SPM2 and SPM3 do account for temporal variation. By its nature, the SPM model does not allow for interdependencies between simultaneously bought items[18]. Like for the MPM, there is a significant improvement in fit with each model extension from the base (SPM0) to the complete model (SPM3), for all product categories.

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[17]Unless an a priori order is imposed on items bought on a given purchase occasion (cfr. supra).

All parameters are significant and have the expected sign, except for some brand and product type dummy variables, and for the interaction between variety seeking tendency and shelf space (for cereals, margarine and paper towel), extra amount (margarine, paper towel) and a gift (paper towel). Overall, the pattern of the estimates obtained with the SPM models is similar to that of MPMs, but the reliability of the MPM parameters is higher in general than for those of the SPM.

Goodness of fit as measured by the rho squared statistic is substantially lower than for the MPM. A closer look at the LL of the base model and the changes in brand and product type dummies shows, however, that this is at least partly a result of a better performance of the base model. Brand and product type dummy variables only, give a better prediction of single items' choice shares than of the share of purchase sets in the MPM. The rho-squared statistic is therefore not the appropriate measure to compare the fit of the MPM and SPM. The loglikelihood value cannot be compared either, because of the large differences in the number of observations and choice units. To compare the descriptive properties of MPM and SPM, we therefore take a different approach and 'recalculate' the likelihood for the observed purchases of sets of items, using the estimated single item probabilities from the SPM[19]. This is done as follows. For every purchase set bought by a household, we identify the different 'ordered' vectors of purchases that could give rise to this purchase set. For instance, if a purchase set comprises three units, two of which are of item 1 and one of item 2, then three different purchase vectors could be associated with this purchase set: [item 1, item 1, item 2], [item 1, item 2, item 1], [item 2, item 1, item 1]. The probability of every ordered purchase vectors equals, under the SPM models's assumption of within purchase set independence, the product of the SPM choice probabilities of the items in the vector. This probability is obviously the same for every ordered purchase vector associated with a given purchase set. In our example, every vector would have a probability of $(P_1)^2*P_2$, where P_1 and P_2 are the SPM probabilities for items 1 and 2, resp. The probability of the observed purchase set is then set equal to the probability of the ordered purchase vector, times the number of different ordered vectors underlying the purchase set, in our case :$3*(P_1)^2*P_2$. This procedure is used for all purchase sets, and forms the basis for computing the overall LL. The resulting LL value can be compared with the LL of the MPM, since the number of observations and choice units are the same. Table 14 provides information on the 'recalculated' LL obtained for SPM1 (the zero order model) and for SPM3 (which includes

[18]Descriptive model validation based on the comparison of 'hit rates' between the MPM and SPM revealed less appropriate because of the non-negligeable number of 'ties' and 'near equal probabilities'.

temporal dynamics and consumer heterogeneity), and compares it with the LL of the complete MPM: MPM5. For all product categories, the MPM not only provides a substantially better fit to the data than the zero order model, its explanatory power is also considerably higher than that of SPM3. This confirms the superiority of the multiple purchase model in describing real dynamic choice behavior.

< Insert Table 14 here>

6. Conclusions and directions for future research.

In this paper, we proposed a new model of dynamic choice behavior. The model offers an improvement over existing dynamic MNL models, in that it considers interdependencies between item choices in a particular product category over time as well as simultaneously, in a flexible manner (i.e. allowing for positive as well as negative purchase feedback within and between purchase sets) and without recourse to assumptions on the unobserved order of choices within a shopping trip. By incorporating interdependencies between as well as within purchase sets while allowing for household heterogeneity, the model seeks to provide a better understanding of dynamic choice patterns.

Our empirical results reveal that accounting for simultaneous interdependencies between choices in a product category significantly improves the explanatory power of the choice model, thereby confirming a previous finding of Harlam and Lodish (1995). More importantly, however, our model provides evidence that different dynamic buying patterns, combining positive and negative feedback mechanisms within and between purchase sets, may prevail in different product categories, and in different consumer segments. A number of households exhibit 'pure behavior' in that their temporal and simultaneous feedback are either both positive (meaning that they tend to buy the same 'homogeneous' purchase sets over time: a phenomenon that prevails in our functional product classes paper towel and margarine), or negative (they seek variety over time as well as within purchase sets, this is true for about 'half' of the households in the cereals category). In other cases, there is evidence of 'mixed' behavior. This is for instance true for jam, where households with an intrinsic need for variety buy different items over time (negative temporal feedback), but in homogeneous purchase sets (positive simultaneous feedback). The situation hypothesized by Harlam and Lodish (negative temporal and positive simultaneous feedback) was not encountered in our analysis. Understanding these dynamic patterns may yield important insights to the manufacturer and the retailer. For one, the timing and coordination of in store promotion actions for different items in a category may be aligned with the dynamic purchase tendencies of the majority of households and/or of specific target groups. Also, our analysis suggests that, apart from their intrinsic preference for purchase sets that offer more variation, consumers with higher variety seeking tendencies respond differently to promotions of various types: this type of information may prove extremely relevant for the selection of promotion types depending on the objectives of the campaign and on the segments to be addressed.

Surely, the present analysis is characterized by a number of limitations. While the MPM has superior explanatory power, this comes at the cost of increased model complexity. Especially in cases where consumers' consideration sets are large and purchase quantities bought on a single occasion substantial, the number of possible purchase sets to be considered may become prohibitive. In such situations, one may have to carry out the analysis at a more aggregate level than that of product items (e.g. consider the brand level or the brandsize level instead), and/or concentrate on a subset of available items only, a practice already adopted to date in a number of studies. Other limitations stem from the characteristics of the data set. While collecting data from a controlled computer experiment clearly offers advantages (among others: the possibility to confront variety seeking tendencies based on scales with behavioral indicators), it automatically entails some drawbacks. In particular, the relatively short purchase histories forced us to adopt simple measures of purchase set variation, aggregated at the item level and including first order temporal feedback only. Also, in the absence of long time series, consideration sets in our model were assumed to be stable, and based on revealed sets. Though our results seem to be insensitive to changes in the consideration set specification, the use of a less restrictive approach might be worthwhile in other applications and less controlled settings.

Future research could thus envisage further model refinements in the measurement of purchase set variation, and (dynamic) consideration sets. Extending the analysis to other product categories might further substantiate our findings on the complexity of dynamic purchasing patterns, and help reveal not only the nature of these patterns, but also the reason for their existence.

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Table 1 : variety seeking models

	dependency among purchases*					explanatory variables		aggregation level	contribution
	t-	s-	0.00	t+	s+	marketing mix	other		
Markov brand switching models									
Givon (1984)	x		(x)	x				individual	extension to multiple brands, both neg. and pos. purchase feedback
Lattin and McAlister (1985)			(x)	x				individual	market structure identification that accounts for VSB
Kahn et.al. (1986)	x		x	x				product	zero to 2nd order models measuring various forms of behavior
Kahn and Raju (1991)	x		(x)	x		price discount		product	incorporates marketing mix variable
Trivedi et.al. (1994)	x		x				dissimilarity, ideal point	individual	stochastic level of variety sought by the individual
Logit/probit choice probability models									
Lattin (1987)	x		(x)	x			attribute perceptions	individual	VSB may differ across attributes
Bawa (1990)	x		x	x				individual	allows for hybrid behavior (mixture of inertia and VSB)
Papatla and Krishnamurthi (1992)	x		x	x		price	dissimilarity	segment	incorporates 4 characteristics of dynamic choice behavior (loyalty, VS, inertia, mobility)
Ansari et.al. (1995)	x			x		in-store marketing variables	VST characteristics	product	two-level hierarchical model that distinguishes between switching and brand choice decision
Harlam and Lodish (1995)		x	(x)	x		in-store marketing variables	attribute level variation variables		accounts for dependency among simultaneously purchased items, and positive purchase feedback over time

* t- : negative purchase feedback over time, s- : negative dependency among simultaneously chosen items, 0: zero-order behavior, t+ : positive purchase feedback over time, s+ : positive dependency among simultaneously chosen items.

Figure 1: Dependency among simultaneous and sequential purchase decisions.

	Sequential purchase decisions +	 -
simultaneous Purchase Decisions +	II tendency to buy the same homogeneous purchase sets on subsequent occasions	I tendency to buy different but homogeneous purchase sets over time
-	III tendency to buy the same heterogeneous purchase sets on subsequent occasions	IV tendency to buy different and heterogeneous purchase sets over time

Table 2: number of purchase observations and multiple item purchases

	paper towel	margarine	jam	cereals
number of purchase occasions where at least 1 item was bought	3001	4324	3207	2613
percentage of multiple purchases (occasions)	2	7	15	29
percentage of respondents who made at least 1 multiple purchase	7	15	37	50
entropy (average over households)	.463	.515	1.124	1.109

Table 3: explanatory variables

variable	description
Brand and variety dummy variables $DB_{k,j}$ $DV_{l,j}$	Brand and variety-specific effects were captured by means of brand dummy variables, $DB_{k,j}$, and variety dummy variables, $DV_{l,j}$, equal to 1 if item j belongs to brand k (or variety l), and equal to zero otherwise.
Marketing mix variables * $Price_{j,t}$ * $Coup_{j,t}$ * $Extra_{j,t}$ * $Gift_{j,t}$ * $Shelf_{j,t}$	* value of direct price reduction for item j in period t (=0, in absence of a price promo) * face value of the coupon for item j in period t (=0, if no coupon was offered) * dummy variable, equal to 1 if an extra amount was offered for item j in period t * dummy variable, equal to 1 if a small gift was attached to item j in period t * dummy type variable, equal to 1 if item j received extra shelf facings in period t, equal to -1 if item j's shelf space was reduced in period t, and equal to zero otherwise
Variation variables * $varw^h(s,t)$ * $varb^h(s,t)$	* variation within purchase set s * (average) difference between items in set s and the item(s) purchased on the previous purchase occasion t-1
Household Variety Seeking Tendency * VST^h	* E.A.P. -scale * varseek scale * entropy computed over all non-promotion/test items

Table 4 : Estimation Results : Multiple Purchase Model , Cereals

(1) parameters	(2) Base model	(3) MPM1	(4) MPM2	(5) MPM3	(6) MPM4	(7) MPM5
Kellogg's	.514945[a]	.753200[a]	.182352[d]	.171964[d]	.223141[c]	.215535[c]
GB	.416594[a]	.296144[a]	-.908353[a]	-.856107[a]	-.883480[a]	-.831286[a]
sugar	.557212[a]	.280730[a]	-.407137[a]	-.397704[a]	-.347549[a]	-.343753[a]
chocolate	.934287[a]	1.09540[a]	-.015185	-.019413	.053419	.049274
honey	.625539[a]	.733605[a]	-.245025[a]	-.236482[b]	-.184497[c]	-.173941[c]
variety	1.47285[a]	1.67591[a]	.342304[a]	.333300[a]	.335016[a]	.322945[a]
price		.056233[a]	.020885[a]	.020447[a]	.027835[a]	.028128[a]
coupon		.062308[a]	.021704[a]	.020912[a]	.026651[a]	.026415[a]
extra amount		2.34635[a]	.821321[a]	.795428[a]	.909908[a]	.889249[a]
gift		.815584[a]	.350477[a]	.339410[a]	.485090[a]	.494182[a]
shelf space		.529816[a]	.258026[a]	.250929[a]	.276637[a]	.272673[a]
price * VST					.026600[a]	.026885[a]
coupon * VST					.011442[c]	.012849[b]
extra am.* VST					.204988[d]	.211979[d]
gift * VST					.662269[a]	.648429[a]
shelf * VST					.060879	.059675
var. across			-1.07440[a]	-1.03900[a]	-.059714[a]	-.059290[a]
var. within				-.517381[a]		-.055712[a]
var.acr.* VST					.162386[a]	.147402[a]
var.with.* VST						.119224[a]
LL (observations)	-8596 (1981)	-8398 (1981)	-3375 (1981)	-3366 (1981)	-3314 (1981)	-3294 (1981)
L.R.-test : χ^2		396[a] (MPM0)	10046[a] (MPM1)	18[a] (MPM2)	122[a] (MPM2)	40[a] (MPM4) 144[a] (MPM3)
ρ^2		.02175	.6060	.6069	.6124	.6145

[a] significant at the 1% level
[b] significant at the 2.5% level
[c] significant at the 5% level
[a] significant at the 10% level

Table 5 : Estimation Results : Multiple Purchase Model , Jam

(1) parameters	(2) Base model	(3) MPM1	(4) MPM2	(5) MPM3	(6) MPM4	(7) MPM5
Qualité Ard.	-1.09084[a]	1.19987[a]	-.183808	-.176224	-.190482	-.172670
Bonne Maman	-2.51627[a]	-3.49363[a]	-.703884[a]	-.705800[a]	-.733309[a]	-.674029[a]
GB	-1.13748[a]	-1.63166[a]	-.687988[a]	-.688509[a]	-.702789[a]	-.633163[a]
Wit produkt	-.816698[a]	-.928388[a]	-.106206[d]	-.075615	-.094438	-.088300
abrikozen	-1.50593[a]	-2.29828[a]	-.705557[a]	-.738867[a]	-.668710[a]	-.599518[a]
ananas	-1.07765[a]	-1.38827[a]	-.659904[a]	-.717719[a]	-.730136[a]	-.652172[a]
krieken	-.161309[a]	-.086536[d]	-.116485[c]	-.124826[c]	-.069775	-.073065
bananen	-5.47418[a]	-5.14249[a]	.448652[a]	.429535[a]	.470246[a]	.396061[a]
viervruchten	-1.53734[a]	-2.30915[a]	-.442401[a]	-.450771[a]	-.414634[a]	-.368908[a]
frambozen	-.157518	-.342483[c]	-.447746[b]	-.484049[b]	-.498260[a]	-.389541[c]
price		.210910[a]	.094107[a]	.089259[a]	.101487[a]	.090014[a]
coupon		.213523[a]	.084148[a]	.081297[a]	.085721[a]	.077963[a]
extra amount		3.29990[a]	1.33368[a]	1.29173[a]	1.37627[a]	1.22849[a]
gift		.761776[a]	.564885[a]	.537526[a]	.681676[a]	.556451[a]
shelf space		.184682[a]	.194780[a]	.174202[a]	.192905[a]	.161816[b]
price * VST					.018450[a]	.014934[b]
coupon * VST					.002341	.002601
extra am.* VST					.184443[c]	.153263[c]
gift * VST					.478403[a]	.343296[a]
shelf * VST					.062509	.048799
var. across			-.719461[a]	-.418912[a]	-.059441[a]	-.093750[a]
var. within				-.286592[a]		-.265255[a]
var.acr.* VST					.118730[a]	.099843[a]
var.with.* VST						.124877[a]
LL (observations)	-10712 (2745)	-10206 (2745)	-4441 (2745)	-4481 (2745)	-4385 (2745)	-4274 (2745)
L.R.-test : χ^2		1012[a] (MPM0)	11530[a] (MPM1)	(-80) (MPM2)	112[a] (MPM2)	222[a] (MPM4) 414[a] (MPM3)
ρ^2		.0458	.5839	.5801	.5885	.5987

[a] significant at the 1% level
[b] significant at the 2.5% level
[c] significant at the 5% level
[a] significant at the 10% level

Table 6 : Estimation Results : Multiple Purchase Model , Margarine

(1) parameters	(2) **Base model**	(3) **MPM1**	(4) **MPM2**	(5) **MPM3**	(6) **MPM4**	(7) **MPM5**
Wit produkt	-.123060[a]	-.441264[a]	-.170014[a]	-.145725[b]	-.167050[a]	-.158117[b]
Planta	-6.16513[a]	-6.48501[a]	-1.39899[a]	-1.07513[a]	-1.37564[a]	-1.04468[a]
Effi	-4.03888[a]	-4.49116[a]	-1.43124[a]	-1.09547[a]	-1.45003[a]	-1.10860[a]
Alpro	-3.85997[a]	-3.36147[a]	.217452[b]	.173710[c]	.083158	.071508
Minelma	-4.67528[a]	-4.55304[a]	-.280694[a]	-.201919[a]	-.280905[a]	-.209042[a]
Yogood	-7.71225[a]	-7.90733[a]	-1.06168[a]	-.767752[a]	-1.18795[a]	-.882772[a]
Roda	-3.14600[a]	-3.35796[a]	-1.11574[a]	-.836745[a]	-1.18732[a]	-.913482[a]
Margarine	-.401348[a]	-.552527[a]	-.090737[d]	-.061571	-.094125[d]	-.065790
Package size	3.62826[a]	4.13094[a]	.733528[a]	.593530[a]	.763639[a]	.630920[a]
price		.511164[a]	.182750[a]	.147640[a]	.203912[a]	.164535[a]
coupon		.352364[a]	.117691[a]	.096233[a]	.127944[a]	.104939[a]
extra amount		2.10824[a]	.860054[a]	.715416[a]	.953353[a]	.790978[a]
gift		2.40326[a]	.792553[a]	.653321[a]	.865179[a]	.710987[a]
shelf space		.261174[a]	.325750[a]	.264850[a]	.299934[a]	.237404[a]
price * VST					.124921[a]	.098101[a]
coupon * VST					.020487[a]	.014951[b]
extra am.* VST					.048291	.004978
gift * VST					.448613[a]	.340041[a]
shelf * VST					-.127579[a]	-.105185[c]
var. across			-1.76468[a]	-1.48741[a]	-.211604[a]	-.174238[a]
var. within				-2.48543[a]		-.303908[a]
var.acr.* VST					.146332[a]	.121096[a]
var.with.* VST						.066991[a]
LL (observations)	-9890 (2879)	-9578 (2879)	-3230 (2879)	-2950 (2879)	-3077 (2879)	-2800 (2879)
L.R.-test : χ^2		624[a] (MPM0)	12696[a] (MPM1)	560[a] (MPM2)	306[a] (MPM2)	554[a] (MPM4) 300[a] (MPM3)
ρ^2		.0301	.6719	.7001	.6868	.7146

[a] significant at the 1% level
[b] significant at the 2.5% level
[c] significant at the 5% level
[a] significant at the 10% level

Table 7 : Estimation Results : Multiple Purchase Model , Paper Towel

(1) parameters	(2) **Base model**	(3) **MPM1**	(4) **MPM2**	(5) **MPM3**	(6) **MPM4**	(7) **MPM5**
GB	-1.72581[a]	-1.97932[a]	-1.59322[a]	-1.27596[a]	-1.57769[a]	-1.26007[a]
Scottex	-2.07870[a]	-1.63939[a]	-.557591[a]	-.460661[a]	-.498065[a]	-.410423[a]
Domex	-7.56399[a]	-8.57801[a]	-2.26520[a]	-1.83507[a]	-2.20953[a]	-1.77949[a]
Decor	-2.44509[a]	-3.45470[a]	-.023138	-.008308	.002928	.017725
price		.275735[a]	.115208[a]	.095518[a]	.117794[a]	.097732[a]
coupon		.146422[a]	.067953[a]	.056290[a]	.067322[a]	.055633[a]
extra amount		4.12039[a]	1.97093[a]	1.61023[a]	1.99297[a]	1.62681[a]
gift		.608676[a]	.487469[a]	.403008[a]	.526230[a]	.428571[a]
shelf space		1.91692[a]	.479717[a]	.392385[a]	.439838[a]	.363711[a]
price * VST					.023559[a]	.018196[a]
coupon * VST					.019657[a]	.015301[a]
extra am.* VST					.011078	-.015620
gift * VST					.014832	.022182
shelf * VST					.108727[a]	.076014[d]
var. across			-1.66535[a]	-1.55468[a]	-.124597[a]	-.116451[a]
var. within				-4.24236[a]		-.309709[a]
var.acr.* VST					.038171[a]	.036802[a]
var.with.* VST						.045662[a]
LL (observations)	-7598 (2839)	-6843 (2839)	-2399 (2839)	-2142 (2839)	-2347 (2839)	-2086 (2839)
L.R.-test : χ^2		1510[a] (MPM0)	8888[a] (MPM1)	514[a] (MPM2)	104[a] (MPM2)	522[a] (MPM4) 112[a] (MPM3)
ρ^2		.0982	.6829	.7166	.6890	.7223

[a] significant at the 1% level
[b] significant at the 2.5% level
[c] significant at the 5% level
[a] significant at the 10% level

Table 8 : marginal utility promotions

VST	minimum	low	average	high	maximum
(1) price promotion					
cereals	-0,004	0,001243	0,028128[a]	0,055013[a]	0,11628[a]
jam	0,071227[a]	0,07508[a]	0,090014[a]	0,104948[a]	0,159685[a]
margarine	0,104554[a]	0,066434[a]	0,164535[a]	0,262636[a]	0,533201[a]
paper	0,088349[a]	0,079536[a]	0,097732[a]	0,115928[a]	0,175663[a]
(2) coupon					
cereals	0,011058[d]	0,013566[b]	0,026415[a]	0,039264[a]	0,068545[a]
jam	0,074691[a]	0,075362[a]	0,077963[a]	0,080564[a]	0,090096[a]
margarine	0,095798[a]	0,089988[a]	0,104939[a]	0,11989[a]	0,161125[a]
paper	0,047743[a]	0,040332[a]	0,055633[a]	0,070934[a]	0,121165[a]
(3) extra amount					
cereals	0,635894[a]	0,67727[a]	0,889249[a]	1,101228[a]	1,584296[a]
jam	1,03569[a]	1,075227[a]	1,22849[a]	1,381753[a]	1,943506[a]
margarine	0,787934[a]	0,786[a]	0,790978[a]	0,795956[a]	0,809687[c]
paper	1,634865[a]	1,64243[a]	1,62681[a]	1,61119[a]	1,559912[a]
(4) premium					
cereals	-0,28081	-0,15425	0,494182[a]	1,142611[a]	2,620283[a]
jam	0,124595	0,213155[d]	0,556451[a]	0,899747[a]	2,158026[a]
margarine	0,503079[a]	0,370946[a]	0,710987[a]	1,051028[a]	1,988868[a]
paper	0,417132[a]	0,406389[a]	0,428571[a]	0,450753[a]	0,523573
(5) shelf space					
cereals	0,20135[c]	0,212998[b]	0,272673[a]	0,332348[b]	0,468338
jam	0,100428	0,113017	0,161816[b]	0,210615[a]	0,389477
margarine	0,301716[a]	0,342589[a]	0,237404[a]	0,132219[c]	-0,15788
paper	0,324513[a]	0,287697[a]	0,363711[a]	0,439725[a]	0,689268[a]

[a] significant at the 1% level
[b] significant at the2.5% level
[c] significant at the5% level
[d] significant at the10% level

Table 9 : marginal utility variation

VST	minimum	low	average	high	maxium
(1) between set variation					
cereals	-0,23546[a]	-0,20669[a]	-0,05929[a]	0,088112[a]	0,424019[a]
jam	-0,21935[a]	-0,19359[a]	-0,09375[a]	0,006093	0,372047[a]
margarine	-0,24828[a]	-0,29533[a]	-0,17424[a]	-0,05314[a]	0,280843[a]
paper	-0,13543[a]	-0,15325[a]	-0,11645[a]	-0,07965[a]	0,041166
(2) within set variation					
cereals	-0,19821[a]	-0,17494[a]	-0,05571[a]	0,063512[b]	0,335206[a]
jam	-0,42235[a]	-0,39013[a]	-0,26526[a]	-0,14038[a]	0,317332[a]
margarine	-0,34487[a]	-0,3709[a]	-0,30391[a]	-0,23692[a]	-0,05215[c]
paper	-0,33326[a]	-0,35537[a]	-0,30971[a]	-0,26405[a]	-0,11415[a]

[a] significant at the 1% level
[b] significant at the2.5% level
[c] significant at the5% level
[d] significant at the10% level

Table 10: Estimation Results : Single Purchase Model , Cereals

(1) parameters	(2) Base model	(3) SPM1	(4) SPM2	(5) SPM3
Kellogg's	.221645[c]	.271194[b]	.226445[c]	.265943[b]
GB	-.970774[a]	-1.04554[a]	-.893389[a]	-.870983[a]
sugar	-.414988[a]	-.523404[a]	-.443460[a]	-.373004[a]
chocolate	.010702	.014678	.039687	.108477[d]
honey	-.222322[b]	-.226990[b]	-.168869[d]	-.110600
variety	.370606[a]	.387628[a]	.415596[a]	.421165[a]
price		.022326[b]	.030834[a]	.048952[a]
coupon		.019865[a]	.024238[a]	.031443[a]
extra amount		.631587[a]		.803415[a]
gift		.280140[c]	.371918[a]	.663452[a]
shelf space		.190404[b]	.228816[a]	.248457[b]
price * VST				.037542[a]
coupon * VST				.010524
extra am.* VST				.143833
gift * VST				.672651[a]
shelf * VST				.044575
var. across			-.990252[a]	-.103222[a]
var.acr.* VST				.191002[a]
LL (Observations)	-3369 (2386)	-3348 (2386)	-3258 (2386)	-3216 (2386)
L.R.-test : χ^2		42[a] (MPM0)	180[a] (MPM1)	84[a] (MPM2)
ρ^2		.0030	.0294	.0395

[a] significant at the 1% level
[b] significant at the 2.5% level
[c] significant at the 5% level
[a] significant at the 10% level

Table 11 : Estimation Results : Single Purchase Model , Jam

(1) parameters	(2) Base model	(3) SPM1	(4) SPM2	(5) SPM3
Qualité Ard.	-.267966[d]	-.263753[d]	-.201011	-.235922[d]
Bonne Maman	-.504126[a]	-.790214[a]	-.707606[a]	-.737099[a]
GB	-.623154[a]	-.822249[a]	-.724082[a]	-.741354[a]
Wit produkt	-.040646	-.065300	.011610	.009006
abrikozen	-.567409[a]	-.792943[a]	-.692594[a]	-.650939[a]
ananas	-.701560[a]	-.802375[a]	-.628407[b]	-.659485[a]
krieken	-.114172[d]	-.066707	-.069773	-.042766
bananen	.430825[a]	.516136[a]	.567509[a]	.563677[a]
viervruchten	-.288007[a]	-.524563[a]	-.474006[a]	-.449709[a]
frambozen	-.352515[d]	-.478483[c]	-.383646[d]	-.366577[d]
price		.087027[a]	.097004[a]	.108043[a]
coupon		.084096[a]	.089020[a]	.091991[a]
extra amount		1.34768[a]	1.41014[a]	1.48627[a]
gift		.560078[a]	.613201[a]	.788238[a]
shelf space		.204993[a]	.226985[a]	.232762[a]
price * VST				.017925[d]
coupon * VST				.002680
extra am.* VST				.146837
gift * VST				.473552[a]
shelf * VST				.068079
var. across			-.708592[a]	-.073704[a]
var.acr.* VST				.108454[a]
LL (observations)	-4490 (3088)	-4293 (3088)	-4205 (3088)	-4153 (3088)
L.R.-test : χ^2		394[a] (MPM0)	176[a] (MPM1)	104[a] (MPM2)
ρ^2		.0405	.0599	.0697

[a] significant at the 1% level
[b] significant at the 2.5% level
[c] significant at the 5% level
[a] significant at the 10% level

Table 12 : Estimation Results : Single Purchase Model , Margarine

(1) parameters	(2) Base model	(3) SPM1	(4) SPM2	(5) SPM3
Wit produkt	-.226518[b]	-.236392[b]	-.264390[a]	-.264106[b]
Planta	-1.50960[a]	-1.77449[a]	-1.44564[a]	-1.42059[a]
Effi	-1.62767[a]	-1.92825[a]	-1.54147[a]	-1.54128[a]
Alpro	.221161[d]	.295188[c]	.226914[d]	.063776
Minelma	-.318802[a]	-.291480[a]	-.272950[b]	-.271314[b]
Yogood	-1.33095[a]	-1.46867[a]	-1.05440[a]	-1.25108[a]
Roda	-1.51537[a]	-1.59870[a]	-1.23275[a]	-1.27852[a]
Margarine	-.045296	-.085811	-.076815	-.061071
Package size	1.00426[a]	1.20937[a]	1.00574[a]	1.03785[a]
price		.183971[a]	.211616[a]	.249492[a]
coupon		.108233[a]	.131214[a]	.145669[a]
extra amount		.815372[a]	1.01544[a]	1.12714[a]
gift		.720344[a]	.850415[a]	.935228[a]
shelf space		.305821[a]	.397618[a]	.379012[a]
price * VST				.123257[a]
coupon * VST				.010091
extra am.* VST				.053524
gift * VST				.415439[a]
shelf * VST				-.123125
var. across			-1.39918[a]	-.166165[a]
var.acr.* VST				.116022[a]
LL (observations)	-2873 (3032)	-2787 (3032)	-2492 (3032)	-2385 (3032)
L.R.-test : χ^2		172[a] (MPM0)	590[a] (MPM1)	214[a] (MPM2)
ρ^2		.0251	.1274	.1619

[a] significant at the 1% level
[b] significant at the 2.5% level
[c] significant at the 5% level
[a] significant at the 10% level

Table 13 : Estimation Results : Single Purchase Model , Paper Towel

(1) parameters	(2) Base model	(3) SPM1	(4) SPM2	(5) SPM3
GB	-1.74730[a]	-2.23671[a]	-1.84680[a]	-1.81644[a]
Scottex	-.696085[a]	-.672977[a]	-.622377[a]	-.556169[a]
Domex	-2.29536[a]	-3.04083[a]	-2.51488[a]	-2.42844[a]
Decor	-.075416	-.138167[c]	-.044319	-.020751
price		.109819[a]	.123878[a]	.125946[a]
coupon		.084096[a]	.095225[a]	.095903[a]
extra amount		2.08515[a]	2.39573[a]	2.42831[a]
gift		.628391[a]	.741885[a]	.781967[a]
shelf space		.280997[a]	.372923	.356233[a]
price * VST				.026367[a]
coupon * VST				.021980[a]
extra am. * VST				.128390
gift * VST				.004327
shelf * VST				.029357
var. across			-1.45391[a]	-.111380[a]
var.across * VST				.035481[a]
LL (observations)	-2422 (2873)	-2189 (2873)	-1959 (2873)	-1914 (2873)
L.R.-test : χ^2		466[a] (MPM0)	460[a] (MPM1)	90[a] (MPM2)
ρ^2		.0925	.1870	.2023

[a] significant at the 1% level
[b] significant at the 2.5% level
[c] significant at the 5% level
[a] significant at the 10% level