J. of the Acad. Mark. Sci. (2012) 40:86–101
DOI 10.1007/s11747-011-0288-8

A cross-category and cross-country analysis of umbrella branding for national and store brands

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Received: 27 June 2011 / Accepted: 2 September 2011 / Published online: 18 September 2011

Abstract The large penetration of store brands has been accelerated by a substantial increase of their availability across various categories. Although store brands have generated tremendous interest in the literature, little work has been done on umbrella branding strategies for store brands. We extend the previous work of Erdem (1998) and Erdem et al. (2004) by studying the learning spillover effects of umbrella brands across categories for both national and store brands. We apply the Multivariate Multinomial Probit Model of cross-category learning across five product categories to study differences across store versus national umbrella brands in three countries (i.e., the United States, the United Kingdom, and Spain). Our results indicate that cross-category learning effects exist between different product categories in consumer packaged goods for both store brands and national umbrella brands, although some of the categories in which correlated learning happens differ between the two. The degree of cross-category learning also varies across categories.

Keywords Brand choice · Store brands · Umbrella branding

A substantial increase in the availability of store brands across various categories and the expectation that recessionary trends often involve a shift toward store brands have renewed scholarly interest in understanding consumer behavior related to store brands. Despite the breadth of the literature on store brands (e.g., Batra and Sinha 2000; Dhar and Hoch 1997; Sethuraman 1992), little research has been done on umbrella branding in the context of store brands. Most previous research has concentrated on the umbrella branding of national brands rather than store brands. For example, Erdem (1998) demonstrated how consumers may learn about national umbrella brands through their user experiences across categories. Erdem et al. (2004) further estimated a learning model to explain differential market shares for store brands in the United States versus those in Europe; however, they did not explore any cross-category learning effects.

The purpose of this work is to extend previous work by Erdem (1998) and Erdem et al. (2004) to study the learning spillover effects of umbrella brands across multiple categories for both national and store brands. For this purpose, we apply the Multivariate Multinomial Probit Model of cross-category learning, which allows for simultaneous and interdependent choice of different brands across categories. To the best of our knowledge, our model is the first Multivariate Multinomial Probit Model (MVMNP) with learning (previous learning models assumed the multinomial logit (MNL)). In addition, we repeat the analysis in three countries: the United States, the United Kingdom, and Spain. Our results indicate that cross-category learning effects exist between several pairs of categories for both store and national umbrella brands, although some of the categories in which correlated learning happens differ between store and national umbrella brands. The degree of cross-category learning also varies across product categories. This paper provides valuable insights into cross-learning effects of umbrella brands and differences in learning between store and national umbrella brands. It has managerial implications such that umbrella brands—whether national or store brands—need to provide consistent experiences within and across categories and firms

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need to understand the factors underlying the transfer of quality associations thoroughly.

We briefly outline the relevant literature in the next section. We subsequently introduce our model and discuss our data and empirical findings. We conclude with a discussion of implications and future research.

Literature review

Literature on umbrella brands

Theoretical work has established that umbrella branding might reduce consumer uncertainty and perceived risk associated with extension (Wernerfelt 1988). Early empirical work also demonstrated that consumers—faced with uncertainty about product quality—might develop prior expectations about the quality of an extension based on the perceived quality of its parent brand (Montgomery and Wernerfelt 1992). According to Erdem (1998), in the context of a dynamic structural model with myopic consumers, consumers' quality perceptions for a brand in a particular category (toothpaste) are affected by their experience with the same brand in another category (toothbrush). She estimates a multinomial logit model, thereby not allowing for coincidence in purchases across the two categories studied. Also, she focuses on consumers' learning of national umbrella brands and did not take into account that of store brands, which are also umbrella brands in general.

Although prior literature has provided evidence for spillover effects in umbrella branding (e.g., Balachander and Ghose 2003; Chen and Liu 2004; Erdem 1998),[1] Moorthy (2010) has shown that such branding serves as a signal of quality only if the correlation between the parent and new brands is large enough. Indeed, the success of brand extensions has been shown to largely depend on the fit between the original product and the extension (Rotemberg 2010; Volckner and Sattler 2006; Volckner et al. 2008).

Finally, theory papers have shown conditions when umbrella branding may or may not be the optimal strategy for firms (e.g., Amrouche and Zaccour 2009; Cabral 2008; Miklos-Thal 2008). For example, Amrouche and Zaccour's (2009) analysis takes into account the strategic interactions between manufacturers and retailers as well as the positive spillover among private label sales in different categories. Surprisingly, their results indicate that umbrella branding may lead to lower profits for the retailer. These results ultimately depend on the market potential of the different brands in the various categories and the degree of competition between the national brand and the private label. Ultimately, the literature demonstrates that umbrella branding does not always imply high quality (Hakenes and Peitz 2008). Despite the breadth of the literature on national umbrella brands, store brands have not been investigated in depth as "umbrella brands."

Recent literature on store brands

A number of studies in the recent literature on store brands have focused on the impact of store brands either on retailers' margin and profit (Ailawadi and Harlam 2004) or on store loyalty (Ailawadi et al. 2008; Corstjens and Lal 2000; Sudhir and Talukdar 2004). Previous literature has also examined the determinants of retailers' store and national brand pricing behaviors (Cotterill and Putsis 2000; Cotterill et al. 2000). On the other hand, some researchers have investigated the competitive interaction between national and store brands. For example, Chintagunta et al. (2002) investigate changes in preferences for national brands and price elasticities due to the introduction of a store brand. The introduction of a store brand has been shown to influence not only brand choice but also retailers' bargaining power (Geyskens et al. 2010; Meza and Sudhir 2010; Narasimhan and Wilcox 1998; Pauwels and Srinivasan 2004). Furthermore, Gielens (2011) find that new products offering substantially new, intrinsic benefits are relatively more effective than other new product introductions and even more so when fighting private labels rather than national brands. In contrast, private labels are hardly hurt by new products that offer new, extrinsic benefits.

In addition, existing literature has examined differential market shares of store brands across product categories. It has been shown that private label shares are higher in categories with low perceived consumer risk (Batra and Sinha 2000), higher relative quality, and lower quality variability (Sethuraman 1992). Furthermore, Sethuraman (2003) measures the overall brand equity of national brands based on customers' reservation price and perceived quality differentials between national and store brands. He concentrates on the decomposition of brand equity into quality and non-quality equity, yet neglects to consider the role of consumer learning in the formation of quality perceptions.

Lastly, Erdem et al. (2004) have shown that differences between national and store brands' perceived quality and experience variability, as well as differences in consumer sensitivities to price, risk, and quality across countries, may explain the differential success of store brands across countries. Szymanowski and Gijsbrechts (2012) take into account cross-brand learning among private labels based on the assumption that spillovers may also occur between different private labels perceived as similar. However, none of these papers—including Erdem et al. (2004)—allow for

[1] Following Erdem (1998), a number of papers have modeled correlated learning across alternatives or attributes. We refer the reader to Ching et al. (2011) for a detailed review of such papers.

any cross-category effects, including cross-category learning effects.

Model

Consider a set of consumers (households) I={i|i=1, 2, …, I} that make purchases chosen from at least one of M different product categories, where M={m|m=1, 2, …, M} and I is the number of consumers. Let $J_n=\{j_n|\ j_n=1, 2, \ldots, J_n\}$ be the set of national brands that is available in at least one of m categories, and $J_s=\{j_s|\ j_s=1, 2, \ldots, J_s\}$ is the set of store brands that is available in at least one of m categories. The consumers' purchases are observed over the period T={t|t=1, 2, …, T}, where T is the time span.

Consumers may be imperfectly informed and thus uncertain about product quality. As mentioned in Erdem (1998), this uncertainty can persist even after the consumers experience the product, because use experience might provide only noisy information. Thus, consumer perceptions of quality levels may deviate from true levels. Therefore, we define the overall quality of store brands and national brands as follows:

$$X_{ij_ntm} = A_{j_nm} + x_{ij_ntm} \quad (1)$$

$$X_{ij_stm} = A_{j_sm} + x_{ij_stm} \quad (2)$$

where X_{ij_ntm} is the overall quality level of national-brand j_n in category m that consumer i would have perceived at time t if consumer i purchased the brand in category m at time t. A_{j_nm} is the (true) mean quality level for national-brand j_n in category m, and x_{ij_ntm} is an i.i.d. random error term. We denote the overall quality level, mean quality level, and random error term for the store brands as X_{ij_stm}, A_{ij_sm}, and x_{ij_stm}, respectively. Equations 1 and 2 show that experience with a brand provides unbiased but imperfect information about the brand's true product quality.

As in Erdem (1998), we assume that consumers learn about the mean brand quality levels (A_{j_n}, A_{j_s}) through Bayesian updating. Previous literature suggests that the Bayesian updating mechanism often provides a reasonable fit to observed choice behavior (Erdem 1998; Erdem and Keane 1996; Erdem et al. 2004; Roberts and Urban 1988). We also assume that consumers' priors on the quality levels A_{j_n} and A_{j_s} are normally distributed at time t=0 for m=1, 2,…, M, and consumer prior qualities are correlated across categories for national and store umbrella brands.[2]

[2] If a brand j_n is not available in category m, all the terms related to category m would be zero.

$$\begin{bmatrix} A_{j_n1} \\ A_{j_n2} \\ \vdots \\ A_{j_nM} \end{bmatrix} \sim N\left(\begin{bmatrix} \overline{A}_{j_n1} \\ \overline{A}_{j_n2} \\ \vdots \\ \overline{A}_{j_nM} \end{bmatrix}, \begin{bmatrix} \sigma^2_{A_n1} & \pi_{A_n1,2} & \cdots & \pi_{A_n1,M} \\ \pi_{A_n1,2} & \sigma^2_{A_n2} & \cdots & \pi_{A_n2,M} \\ \vdots & \vdots & \ddots & \vdots \\ \pi_{A_n1,M} & \pi_{A_n2,M} & \cdots & \sigma^2_{A_nM} \end{bmatrix} \right) \quad (3)$$

$$\begin{bmatrix} A_{j_s1} \\ A_{j_s2} \\ \vdots \\ A_{j_sM} \end{bmatrix} \sim N\left(\begin{bmatrix} \overline{A}_{j_s1} \\ \overline{A}_{j_s2} \\ \vdots \\ \overline{A}_{j_sM} \end{bmatrix}, \begin{bmatrix} \sigma^2_{A_s1} & \pi_{A_s1,2} & \cdots & \pi_{A_s1,M} \\ \pi_{A_s1,2} & \sigma^2_{A_s2} & \cdots & \pi_{A_s2,M} \\ \vdots & \vdots & \ddots & \vdots \\ \pi_{A_s1,M} & \pi_{A_s2,M} & \cdots & \sigma^2_{A_sM} \end{bmatrix} \right) \quad (4)$$

In Eqs. 3 and 4, $\left(\overline{A}_{j_n1}, \ldots, \overline{A}_{j_nM}\right)^T$ is the vector of prior mean perceived quality levels for national brand j_n, such that $E_{0i}\left[A_{j_nm}\right] = \overline{A}_{j_nm}$ for each consumer. $\sigma^2_{A_nm}$ and $\pi_{A_nk,m}$ are the prior variance of consumer quality beliefs in regard to the national brand's quality level in category m and the initial covariance between the quality levels of the umbrella brands in categories k and m, where k≠m, as perceived by consumer i at t=0. We denote the prior mean perceived quality levels, the prior variance, and the initial covariance between the quality levels (the covariance between the prior beliefs for the umbrella brand) in categories k and m of store brand as $\left(\overline{A}_{j_s1}, \ldots, \overline{A}_{j_sM}\right)^T$, $\sigma^2_{A_sm}$, and $\pi_{A_sk,m}$, respectively. Thus, the diagonal elements of the covariance matrix in Eqs. 3 and 4 capture consumers' initial uncertainty with the national and store brands, respectively, while the off-diagonal elements capture the covariance of initial priors. Hence, these covariance terms can be conceptualized reflections of the degree of perceived fit between categories, since if consumers do not see the two product categories' fit at all, they may also feel that the information embedded in the use experience of an umbrella brand in one category is irrelevant for that brand in the other category.

The random error terms associated with consumer latent attribute (quality) perceptions are distributed as

$$x_{ij_ntm} \sim N\left(0, \sigma^2_{x_nm}\right) \quad (5)$$

$$x_{ij_stm} \sim N\left(0, \sigma^2_{x_sm}\right) \quad (6)$$

where $\sigma^2_{x_nm}$ and $\sigma^2_{x_sm}$ refer to the experience variability for national brands and store brands, respectively, in category m. The experience variabilities are allowed to be different across categories. We assume that x_{ij_ntm} is i.i.d. across consumers, national brands, and time periods and that $x_{ij_s tm}$ is i.i.d. across consumers, store brands, and time periods in each category. The experience variabilities capture the noisiness of information contained in use experience. Since national brands may achieve higher quality standardization, it might be expected that $\sigma^2_{x_n m} < \sigma^2_{x_s m}$. Because consumers perform Bayesian updating, their expectations of the quality can be described as follows where the operator $E_{ti}(\cdot)$ denotes the expectation operator, given the information consumer i has at time t:

$$E_{ti}\begin{bmatrix} A_{j_n1} \\ A_{j_n2} \\ \vdots \\ A_{j_nM} \end{bmatrix} = \begin{bmatrix} \overline{A}_{j_n1} \\ \overline{A}_{j_n2} \\ \vdots \\ \overline{A}_{j_nM} \end{bmatrix} + \begin{bmatrix} z_{ij_nt1} \\ z_{ij_nt2} \\ \vdots \\ z_{ij_ntM} \end{bmatrix}, \quad \begin{bmatrix} z_{ij_nt1} \\ z_{ij_nt2} \\ \vdots \\ z_{ij_ntM} \end{bmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \\ \vdots \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma^2_{A_nij_nt1} & \pi_{A_nij_nt1,2} & \cdots & \pi_{A_nij_nt1,M} \\ \pi_{A_nij_nt1,2} & \sigma^2_{A_nij_nt2} & \cdots & \pi_{A_nij_nt2,M} \\ \vdots & \vdots & \ddots & \vdots \\ \pi_{A_nij_nt1,M} & \pi_{A_nij_nt2,M} & \cdots & \sigma^2_{A_nij_ntM} \end{bmatrix} \right) \tag{7}$$

$$E_{ti}\begin{bmatrix} A_{j_s1} \\ A_{j_s2} \\ \vdots \\ A_{j_sM} \end{bmatrix} = \begin{bmatrix} \overline{A}_{j_s1} \\ \overline{A}_{j_s2} \\ \vdots \\ \overline{A}_{j_sM} \end{bmatrix} + \begin{bmatrix} z_{ij_st1} \\ z_{ij_st2} \\ \vdots \\ z_{ij_stM} \end{bmatrix}, \quad \begin{bmatrix} z_{ij_st1} \\ z_{ij_st2} \\ \vdots \\ z_{ij_stM} \end{bmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \\ \vdots \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma^2_{A_sij_st1} & \pi_{A_sij_st1,2} & \cdots & \pi_{A_sij_st1,M} \\ \pi_{A_sij_st1,2} & \sigma^2_{A_sij_st2} & \cdots & \pi_{A_sij_st2,M} \\ \vdots & \vdots & \ddots & \vdots \\ \pi_{A_sij_st1,M} & \pi_{A_sij_st2,M} & \cdots & \sigma^2_{A_sij_stM} \end{bmatrix} \right) \tag{8}$$

Here, z_{ij_ntm} and z_{ij_stm} denote consumer i's expectation errors at time t in category m for national brand j_n and store brand j_s, respectively.

The variances and the covariance of consumer quality beliefs (or, expectation errors) for national brand j_n at any time t are as follows:

$$\sigma^2_{Aij_ntm} = E\left[\left(A_{j_nm} - E_{ti}\left[A_{j_nm}\right]\right)^2\right], \text{ m} = 1, 2, \ldots, \text{M} \tag{9}$$

$$\pi_{Aij_ntm,k} = E\left[\left(A_{j_nm} - E_{ti}\left[A_{j_nm}\right]\right)\left(A_{j_nk} - E_{ti}\left[A_{j_nk}\right]\right)\right], \quad \text{k} \neq \text{m}, \text{k} = 1, 2, \ldots, \text{M} \tag{10}$$

Similarly, those for store brand j_s at any time t are

$$\sigma^2_{Aij_stm} = E\left[\left(A_{j_sm} - E_{ti}\left[A_{j_sm}\right]\right)^2\right], \quad \text{m} = 1, 2, \ldots, \text{M} \tag{11}$$

$$\pi_{Aij_stm,k} = E\left[\left(A_{j_sm} - E_{ti}\left[A_{j_sm}\right]\right)\left(A_{j_sk} - E_{ti}\left[A_{j_sk}\right]\right)\right], \quad \text{k} \neq \text{m}, \text{k} = 1, 2, \ldots, \text{M} \tag{12}$$

$\sigma^2_{Aij_ntm}$ and $\sigma^2_{Aij_stm}$ are the variance of consumer i's quality beliefs associated with national and store brands, whereas $\pi_{Aij_ntm,k}$ and $\pi_{Aij_stm,k}$ depict the covariance between the quality levels in categories m and k as perceived by consumer i given this consumer's information at time t.

According to the Bayesian updating rule as in Erdem (1998) and Erdem et al. (2004),

$$\begin{aligned} E_{ti}\left[A_{j_nm}\right] &= E_{t-1,i}\left[A_{j_nm}\right] \\ &\quad + \beta_{mij_ntm}\left(X_{ij_ntm} - E_{t-1,i}\left[X_{ij_ntm}\right]\right) \\ &\quad + \sum_{\substack{k=1 \\ k\neq m}}^{M} \beta_{k,ij_nt,m}\left(X_{ij_nt,k} - E_{t-1,i}\left[X_{ij_nt,k}\right]\right) \end{aligned} \tag{13}$$

$$\begin{aligned} E_{ti}\left[A_{j_sm}\right] &= E_{t-1,i}\left[A_{j_sm}\right] \\ &\quad + \beta_{mij_stm}\left(X_{ij_stm} - E_{t-1,i}\left[X_{ij_stm}\right]\right) \\ &\quad + \sum_{\substack{k=1 \\ k\neq m}}^{M} \beta_{k,ij_st,m}\left(X_{ij_st,k} - E_{t-1,i}\left[X_{ij_st,k}\right]\right) \end{aligned} \tag{14}$$

where the β_{cij_ntm} and β_{cij_stm}, c=1, 2,…, M, i=1, 2,…,I, j=1, 2,…, J, t=1, 2,…, T, m=1, 2,…,M, are the Kalman gain coefficients obtained from the Kalman filtering algorithm.

It is clear from Eqs. 13 to 14 that β_{cij_ntm} and β_{cij_stm} represent the weight attached to the cth piece of information with respect to brand j_n and j_s, respectively. When the precision of the cth piece of information for national brands is higher, β_{cij_ntm} is larger. Equations 13 and 14 allow consumers to update their expectations about quality after gaining use experience with the same umbrella national or store brand in another category.

Consumer i also updates the variances $\left(\sigma^2_{Aij_ntm}, \sigma^2_{Aij_stm}\right)$ and the covariances $\left(\pi_{Aij_ntm,k}, \pi_{Aij_stm,k}\right)$ of the quality levels for national brand j_n and store brand j_s in category m at time t. As in the Technical Appendix in Erdem (1998),

$$\sigma^2_{Aij_ntm} = \left(1-\beta_{mij_ntm}\right)\sigma^2_{Aij_nt-1,m} - \sum_{\substack{k=1\\k\neq m}}^{M} \beta_{k,ij_nt,m}\pi_{Aij_nt-1,m,k}, \tag{15}$$

$$m = 1, 2, \ldots, M, k = 1, 2, \ldots, M$$

$$\sigma^2_{Aij_stm} = \left(1-\beta_{mij_stm}\right)\sigma^2_{Aij_st-1,m} - \sum_{\substack{k=1\\k\neq m}}^{M} \beta_{k,ij_st,m}\pi_{Aij_st-1,m,k} \tag{16}$$

and

$$\pi_{Aij_nt,m,k} = \left(1-\beta_{mij_ntm}\right)\pi_{Aij_nt-1,m,k} - \sum_{\substack{k=1\\k\neq m}}^{M} \beta_{k,ij_nt,m}\sigma_{Aij_nt-1,m,k}{}^2 \tag{17}$$

$$\pi_{Aij_st,m,k} = \left(1-\beta_{mij_stm}\right)\pi_{Aij_st-1,m,k} - \sum_{\substack{k=1\\k\neq m}}^{M} \beta_{k,ij_st,m}\sigma_{Aij_st-1,m,k}{}^2 \tag{18}$$

In our model, we denote the mean (perceived) quality levels as A and perceived risk (variance of quality beliefs) as σ^2_A (Erdem 1998; Erdem and Keane 1996; Erdem et al. 2004).

Recall from Eqs. 7 to 8 that z_{ij_ntm} and z_{ij_stm} denote the consumer perception errors at time t for brand j_n and brand j_s in category m. Thus, $z_{ij_ntm} = E_{ti}\left[A_{j_nm}\right] - A_{j_nm}$ and $z_{ij_stm} = E_{ti}\left[A_{j_sm}\right] - A_{j_sm}$. In addition, because x_{ij_stm} has a mean of zero, $E_{t-1,i}\left[X_{ij_ntm}\right] = E_{t-1,i}\left[A_{j_nm}\right]$ and $E_{t-1,i}\left[X_{ij_stm}\right] = E_{t-1,i}\left[A_{j_sm}\right]$. Given these expressions, Eqs. 13 and 14 can be written as follows:

$$z_{ij_ntm} = z_{ij_nt-1,m} + \beta_{mij_ntm}\left(x_{ij_ntm} - z_{ij_nt-1,m}\right) + \sum_{\substack{k=1\\k\neq m}}^{M} \beta_{k,ij_nt,m}\left(x_{ij_nt,k} - z_{ij_nt-1,k}\right) \tag{19}$$

$$z_{ij_stm} = z_{ij_st-1,m} + \beta_{mij_stm}\left(x_{ij_stm} - z_{ij_st-1,m}\right) + \sum_{\substack{k=1\\k\neq m}}^{M} \beta_{k,ij_st,m}\left(x_{ij_st,k} - z_{ij_st-1,k}\right) \tag{20}$$

Equations 13 through 20 capture consumer learning about true product quality and the interdependence of quality expectations across products that share the same national or store umbrella brand names. The model implies that consumers who have some experience with brand j in one category have a lower perceived variance associated with brand j in other categories given a nonzero perceived covariance. Our model extends the research of Erdem (1998) and Erdem et al. (2004) by incorporating learning about both umbrella national and store brands across categories.

Expected utilities

We assume that U_{ijtm}, the utility of consumer i from the purchase of brand j∊J at time t, where J is the set of brands that includes both national brands and store brands and is available in at least one of M categories, depends on the perceived quality level X_{ijtm} and price P_{ijtm} of brand j in category m that consumer i experiences at time t. Also, to allow for risk aversion, we allow U_{ijtm} to depend on X_{ijtm} nonlinearly. One such nonlinear utility function that captures risk aversion and risk taking is the quadratic form that follows:

$$U_{ijtm} = \alpha_{im}P_{ijtm} + w_{im}X_{ijtm} + w_{0m}\gamma_{im}X_{ijtm}{}^2 + \varepsilon_{ijtm} \tag{21}$$

Where α_{im} and w_{im} are the price sensitivity and utility weight of the perceived quality levels for consumer i in category m, respectively, and are heterogeneous across consumers. w_{0m} is the mean utility quality weight, and γ_{im} is the heterogeneous risk-aversion coefficient. If $w_{0m}>0$, then $\gamma_{0m}<0$ suggests risk aversion at the mean, where γ_{0m} is the mean of γ_{im}. If $w_{0m}>0$ and $\gamma_{0m}=0$, this suggests risk neutrality at the mean, while $w_{0m}>0$ and $\gamma_{0m}>0$ imply risk-taking behavior at the mean. Finally, ε_{ijtm} is a time varying stochastic component of utility, which is assumed to be i.i.d. normally distributed with mean zero and covariance Σ, and it captures random unobservable preference shocks that are known by the consumer but are unobservable by the analyst. We allow consumer heterogeneity in price sensitivities(α_{im}) to be correlated across categories.

$$\begin{bmatrix}\alpha_{i1}\\ \vdots \\ \alpha_{iM}\end{bmatrix} \sim N\left(\begin{bmatrix}\alpha_{01}\\ \vdots \\ \alpha_{0M}\end{bmatrix}, \begin{bmatrix}\sigma^2_{\alpha 1} & \pi_{\alpha,1,2} & \cdots & \pi_{\alpha,1,M}\\ \pi_{\alpha,1,2} & \sigma^2_{\alpha 2} & & \pi_{\alpha,2,M}\\ \vdots & & \ddots & \\ \pi_{\alpha,1,M} & & \cdots & \sigma^2_{\alpha M}\end{bmatrix}\right), \tag{22}$$

Also,

$$w_{im} \sim N(w_{0m}, \sigma_w), \text{ and } \gamma_{im} \sim N\left(\gamma_{0m}, \sigma^2_\gamma\right), \tag{23}$$

m = 1, 2,..., M

Thus, utility weights(w_{im}) and risk sensitivities(γ_{im}) are allowed to be heterogeneous across consumers.

In addition, we specify i's utility for no purchase (not purchasing any brand) in category m at time t as

$$U_{ijtm} = TREND_m t + \varepsilon_{0tm} \tag{24}$$

where $TREND_m$ is the time trend coefficient.[3] The utility function can be expressed as

$$U_{ijtm} = V_{ijtm} + \varepsilon_{ijtm} \tag{25}$$

where

$$V_{ijtm} = \alpha_{im}P_{ijtm} + w_{im}X_{ijtm} + w_{0m}\gamma_{im}{X_{ijtm}}^2 \tag{26}$$

Consumers form expectations about product quality and thus about the utility they derive from consuming a brand. Thus, the expected utility of consuming brand j in category m at time t for consumer i, given the information consumer i has at time t, is

$$E_{ti}\left[V_{ijtm}\right] = \alpha_{im}P_{ijtm} + w_{im}E_{ti}\left[X_{ijtm}\right] + w_{0m}\gamma_{im}E_{ti}\left[{X_{ijtm}}^2\right] \tag{27}$$

Rearranging Eq. 27, we present the following:

$$E_{ti}\left[V_{ijtm}\right] = \alpha_{im}P_{ijtm} + w_{im}E_{ti}\left[X_{ijtm}\right] + w_{0m}\gamma_{im}E_{ti}\left[X_{ijtm}\right]^2 + w_{0m}\gamma_{im}E_{ti}\left[\left(X_{ijtm} - E_{ti}\left[X_{ijtm}\right]\right)^2\right] \tag{28}$$

Equation 28 can be written as follows:

$$E_{ti}\left[V_{ijtm}\right] = \alpha_{im}P_{ijtm} + w_{im}\left(A_{jm} + z_{ijtm}\right) + w_{0m}\gamma_{im}\left(A_{jm} + z_{ijtm}\right)^2 + w_{0m}\gamma_{im}\left({\sigma_{Aijtm}}^2 + \sigma^2_{xm}\right)^2 \tag{29}$$

Note that the experience variabilities, σ^2_{xm}, are different for store brands and national brands as in Eqs. 5 and 6. The fourth term in Eq. 29 suggests that, in the case of risk aversion, uncertainty and perceived variance associated with the mean quality level of brand j $\left(\sigma^2_{Aijtm}\right)$will lower consumer expected utility. In this context, $\sigma^2_{Aijtm} + \sigma^2_{xm}$ can be conceptualized as the perceived risk associated with a brand. As long as π_A is positive, perceived variance will be lower and expected utility under risk aversion will be higher since the more experience a consumer has with brand j in any categories in which brand j is available, the more precise the information gained through experience is.

Choice probabilities

Let Y_{it}=[j_{it1}, j_{it2}, ..., j_{itM}] denote the index vector of the alternatives chosen by consumer i for the m categories at time t. The probability of observing a choice profile y_{it}=[j_1, j_2, ..., j_M] at time t conditional on β_i and Σ is given by

$$\Pr\left(Y_{it} = y_{it}|\beta_i, \sum\right) = \Pr\left(U_{ij_1t1} \geq \max_{p\in C_1} U_{ipt1}, U_{ij_1t2} \geq \max_{p\in C_2} U_{ipt2}, \ldots, U_{ij_1tM} \geq \max_{p\in C_M} U_{iptM}\right) \tag{30}$$

where C_m is a choice set for category m with J_m elements. Given the multivariate normal distribution assumption for ε, we can rewrite Eq. 30 as follows:

$$\Pr_{it}\left(Y_{it} = y_{it}|\beta_i, \sum\right) = \int_{\varepsilon_{it}\in B_{it}} \phi(\varepsilon_{it})d\varepsilon_{it} \tag{31}$$

where B_{it}={ε_{it} s.t. $U_{ij_1t1} \geq \max_{p\in C_1} U_{ipt1}, U_{ij_1t2} \geq, \max_{p\in C_2} U_{ipt2}, \ldots, U_{ij_1tM} \geq \max_{p\in C_M} U_{iptM}$} and $\varphi(\varepsilon_{it})$ is the joint normal density with mean zero and covariance Σ. Thus, we estimate a multivariate multinomial probit model, which allows random components to be correlated across the m categories.[4] The

[3] When we estimated a version of this specification with a constant, the constant was small in magnitude and statistically insignificant in several cases, so we used this specification for no purchase.

[4] In the covariance matrix for multivariate multinomial probit errors, we allow the utility error terms for the no-purchase options and umbrella brands to be correlated across categories and restrict other correlations (covariances) to be zero for tractability. We do not report these estimates in the results section, but these are available upon request from the authors.

dimension of this integral is the total number of brands available across all m categories ($=\sum_{k=1}^{M} J_k$).

The likelihood for the household i is given by

$$\prod_{t=1}^{T} \Pr_{it}\left(y_{it}|\beta_i, \sum\right) \tag{32}$$

and the unconditional likelihood for an arbitrary consumer is obtained as

$$\int\int\cdots\int\prod_{t=1}^{T} \Pr_{it}\left(y_{it}|\beta_i, \sum\right) f(\beta_i)d\beta_i \tag{33}$$

Since this equation requires multidimensional integral, we use the GHK simulator, which is the most widely used probit simulator (Train 2003). As our estimation method, we adopt the method of simulated maximum likelihood (SML).

Identification

Similar to Erdem (1998) and Erdem et al. (2004), three identification restrictions are made. First, since only relative quality levels matter, we set

$$\sum_{j=1}^{J} A_{jm} = 0 \tag{34}$$

where the set of J includes both the store and national brands.

The second identification problem is the scale invariance in Eq. 26. To remove this indeterminacy, we normalize the distribution of w_{im} by imposing the following requirement:

$$\sigma_w = 1 \tag{35}$$

The last indeterminacy in the model is rotational invariance (Erdem 1998). To solve this problem, we fix the direction of the utility weights vector and the risk-aversion parameters matrix as follows:

$$w_{im} \sim N(w_{0m}, 1), \text{and } \gamma_{im} \sim N\left(\gamma_{0m}, \sigma_\gamma^2\right) \tag{36}$$

Finally, we should note that empirical identification of learning models has been discussed in other papers in depth (e.g., Erdem et al. 2008). Here it may suffice to say that price parameters are empirically identified by variation in prices. The learning parameters (experience variabilities, prior uncertainty, etc.) are identified by patterns in switching behavior, conditional on past choices. Furthermore, the quadratic functional form of the utility function helps to separately identify the quality levels, weights, and risk coefficients.

Data

We used A.C. Nielsen's household-level scanner panel data on detergent, ketchup, toilet paper, margarine, and canned tuna in three countries (Spain, the United Kingdom, and the United States). The Spain dataset includes household purchases at 89 stores across the country in 1999–2000. The U.K. dataset includes household purchases at 212 stores across the country in 1998–1999. Finally, the U.S. dataset includes household purchases at 119 stores in Atlanta and Chicago in 1998–1999.

The market share of store brands varies by product category and across countries. In general, store brands in consumer product categories are relatively stronger in European countries than in the United States. For example, the store brand market share for toilet paper in Spain and the United Kingdom exceeds 40%, while in the United States it is only 11% (Table 1). In addition, the store brand share for detergent is almost 10 times larger in Spain and the United Kingdom (23.8% and 27.4%) than in the United States (2.8%). Table 1 reports the market share and unit price for the top national and store brands in each category and country.

Four to six national brands in each category across countries, in combination with store brands, constitute 75–95% of the market in each country. The United Kingdom has three national umbrella brands: Family Choice and Nisa are available in four categories, and Heinz is available in two categories. The United States has no national umbrella brands available in at least two of the five categories in our dataset. In Spain, a couple of national umbrella brands exist, but the number of purchases for them is extremely small. Neither Spain nor the United States has "national" umbrella brands that account for a relatively high market share; however, store brands are available in all five categories in all three countries. Since multiple store brands are available, we lumped those that are available across the categories studied into one "store brand" for each market and treated it as an umbrella store brand in our analysis for each country. We included all the brands in Table 1 for the model estimation. Since the United Kingdom has national umbrella brands across different categories, we utilized the three national umbrella brands available in the United Kingdom to compare the difference in umbrella branding strategies between national and store umbrella brands in the United Kingdom only.

For the analysis, all data were aggregated to the week level. Since our model captures cross-category learning across the five product categories, the households with fewer than three purchases in any of the five categories were excluded from the analysis. We also excluded households that purchased brands not included in this study. This resulted in a sample of 922 households in Spain, 3,333 in

Table 1 Descriptive statistics of marketing variables

	Spain			United Kingdom			United States		
	Brands	Market share	Mean price	Brands	Market share	Mean price	Brands	Market share	Mean price
Detergent	Ariel	13.0	354.62	Persil	19.1	0.2005	Tide	28.7	0.0063
	Wipp	8.8	290.08	Ariel	15.4	0.2191	All	11.1	0.0041
	Skip	6.3	339.95	Bold	12.3	0.1689	Purex	10.5	0.0031
	Colon	8.1	281.67	Daz	8.9	0.1643	A&H	10.2	0.0033
	Elena	6.1	211.11	Surf	7.0	0.1561	Wisk	9.2	0.0056
	Dixan	5.1	269.57	NISA	0.1	0.0933	Surf	7.6	0.0053
	Store label	23.8	163.96	Store label	27.4	0.1258	Store label	2.8	0.0038
Ketchup	Orlando	18.0	246.03	Heinz	45.7	0.1549	Heinz	53.2	0.0057
	Prima	16.4	311.87	Daddies	5.7	0.1308	Hunts	21.6	0.0047
	Calve	7.4	427.29	Family Choice	0.2	0.0769	Delmonte	7.2	0.0041
	Heinz	6.4	529.61	NISA	0.1	0.1346	Store label	18.0	0.0036
	Store label	34.6	233.54	Store label	46.9	0.1077			
Toilet paper	Scottex	12.4	34.84	Andrex	22.0	42.6679	Charmin	31.6	0.0396
	Colhogar	16	31.76	Kleenex	14.2	37.1981	Angelsoft	19.2	0.0258
	PP	7.8	21.88	Family Choice	0.1	11.3125	Northern	17.8	0.0399
	Store label	44.5	26.95	NISA	0.1	27.0420	Kleenex	13.0	0.0456
				Store label	51.7	32.6729	Scott	7.4	0.0597
							Store label	11.0	0.0278
Margarine	Tulipan	25.2	414.67	Flora	21.8	0.1699	Shedd	22.7	0.0771
	Artua	19.2	445.78	Stork	9.5	0.0902	Bluebonnet	18.1	0.0569
	Flora	12.4	487.75	St Ivel	8.9	0.1694	Imperial	17.1	0.0645
	Ligeresa	4.5	522.80	Vitalite	6.8	0.1661	I Can't Believe	15.0	0.1352
	Store label	21.4	215.55	Family Choice	0.1	0.0875	Parkay	9.5	0.1124
				NISA	0.1	0.0960	Land O'Lakes	9.2	0.1234
				Store label	41.4	0.0851	Store label	8.4	0.0615
Tuna	Isabel	18.9	70.30	John West	19.3	0.3190	Starkist	46.5	0.0146
	Calvo	13.5	66.27	Princes	14.6	0.2924	Bumblebee	20.4	0.0153
	Rianxeira	13.3	75.38	Family Choice	0.1	0.2196	Chicken of Sea	18.4	0.0139
	Miau	6.3	67.15	Heinz	0.1	0.3510	Store label	14.8	0.0104
	Albo	3.5	152.67	Store label	48.7	0.2482			
	Store label	26.8	64.36						

"Mean price" is a price per unit in dollars, pesetas, and pounds for the United States, Spain, and the United Kingdom, respectively

the United Kingdom, and 324 in the United States. We kept all the 324 households in the United States for the model estimation. For Spain and the United Kingdom, we randomly selected 300 households to make the sample sizes computationally manageable and have similar sample sizes across countries.

Empirical results

Table 2 reports the goodness-of-fit statistics for the three models estimated: the MVMNP with correlated random normal errors but no learning, the model with learning but no cross-category learning, and our full model with cross-category learning. Our full model fits the data best in all three countries.

Tables 3, 4, 5, 6 and 7 list the parameter estimates, except for mean quality level estimates (listed in Tables 8, 9, 10, 11 and 12) and the covariance-variance matrices (listed in Tables 13, 14 and 15).

The parameter estimates in Tables 3, 4, 5, 6 and 7 all have the expected signs in all three countries and across all product categories. The price sensitivities are negative, the quality weights are positive, and consumers are risk averse. Initial uncertainty exists, and in most cases initial uncertainty about store brands is higher than that of national brands. Use experience provides (noisy) information about product quality (please see the estimates of experience

Table 2 Goodness-of-fit statistics by country

	Model without learning	Model without cross-category learning	Full model
Spain			
-LL	28530.30	27847.21	27625.92
BIC	29046.88	28412.53	28337.44
United Kingdom			
-LL	26453.99	25901.06	25665.74
BIC	26980.32	26476.12	26387.01
United States			
-LL	25083.14	24776.91	24605.27
BIC	25604.60	25347.10	25321.66

Table 3 Parameter estimates for the detergent category

Parameter estimates	Spain	United Kingdom	United States
Mean price sensitivity α_0	−0.052 (0.09)	−0.06 (0.008)	−0.041 (0.006)
Standard deviation of price sensitivity σ_α	0.456 (0.008)	0.382 (0.012)	0.282 (0.004)
Mean utility (quality) weight ω_0	0.102 (0.003)	0.04 (0.003)	0.031 (0.007)
Mean risk aversion γ_0	−2.4 (0.771)	−3.75 (0.607)	−6.92 (1.758)
Standard deviation of risk aversion σ_γ	0.666 (0.907)	0.888 (0.295)	0.101 (1.37)
Prior std. dev of quality perceptions (national br.) σ_{An}	0.834 (0.042)	0.347 (0.020)	0.804 (0.038)
Prior std. dev. of quality perceptions (store br.) σ_{As}	0.891 (0.048)	0.665 (0.038)	2.806 (0.112)
Experience variability for national brands σ_{xn}	2.236 (0.898)	1.89 (0.112)	2.145 (0.761)
Experience variability for store brands σ_{xs}	2.294 (0.449)	2.078 (0.133)	4.987 (0.506)

Experience variability is reported as standard deviation

Table 4 Parameter estimates for the ketchup category

Parameter estimates	Spain	United Kingdom	United States
Mean price sensitivity α_0	−0.04 (0.007)	−0.02 (0.004)	−0.07 (0.005)
Standard deviation of price sensitivity σ_α	0.318 (0.007)	0.274 (0.010)	0.265 (0.009)
Mean utility (quality) weight ω_0	0.02 (0.004)	0.02 (0.003)	0.18 (0.010)
Mean risk aversion γ_0	−1.06 (0.695)	−2.5 (0.337)	−1.88 (0.895)
Standard deviation of risk aversion σ_γ	0.245 (0.844)	0.102 (0.021)	0.102 (0.995)
Prior std.dev. of quality perceptions (national br.) σ_{An}	0.392 (0.043)	0.099 (0.039)	0.475 (0.053)
Prior std. dev. of quality perceptions (store br.) σ_{As}	0.397 (0.037)	0.117 (0.032)	0.397 (0.245)
Experience variability for national brands σ_{xn}	0.894 (0.141)	1.057 (0.199)	1.087 (0.117)
Experience variability for store brands σ_{xs}	0.935 (0.336)	1.026 (0.241)	1.477 (0.104)

Experience variability is reported as standard deviation

Table 5 Parameter estimates for the toilet paper category

Parameter estimates	Spain	United Kingdom	United States
Mean price sensitivity α_0	−0.204 (0.004)	−0.103 (0.012)	−0.03 (0.002)
Standard deviation of price sensitivity σ_α	0.354 (0.011)	0.432 (0.012)	0.285 (0.011)
Mean utility (quality) weight ω_0	0.29 (0.010)	0.025 (0.010)	0.29 (0.021)
Mean risk aversion γ_0	−1.245 (0.541)	−5.12 (0.872)	−1.19 (0.108)
Standard deviation of risk aversion σ_γ	0.719 (0.571)	0.577 (0.299)	0.876 (0.302)
Prior std. dev. of quality perceptions (national br.) σ_{An}	3.029 (0.552)	0.475 (0.148)	3.751 (1.448)
Prior std. dev. of quality perceptions (store br.) σ_{As}	2.605 (0.302)	1.498 (0.597)	6.476 (1.024)
Experience variability for national brands σ_{xn}	1.347 (0.240)	0.69 (0.270)	0.775 (0.189)
Experience variability for store brands σ_{xs}	0.995 (0.266)	0.544 (0.231)	1.398 (0.275)

Experience variability is reported as standard deviation

Table 6 Parameter estimates for the margarine category

Parameter estimates	Spain	United Kingdom	United States
Mean price sensitivity α_0	−0.038 (0.004)	−0.034 (0.004)	−0.018 (0.002)
Standard deviation of price sensitivity σ_α	0.339 (0.008)	0.305 (0.010)	0.319 (0.009)
Mean utility (quality) weight ω_0	0.09 (0.095)	0.02 (0.003)	0.021 (0.010)
Mean risk aversion γ_0	−3.417 (0.986)	−3.06 (0.530)	−5.19 (1.882)
Standard deviation of risk aversion σ_γ	0.441 (1.09)	0.101 (1.000)	1.095 (2.970)
Prior std. dev. of quality perceptions (national br.) σ_{An}	1.088 (0.042)	0.925 (0.202)	1.507 (0.109)
Prior std. dev. of quality perceptions (store br.) σ_{As}	1.272 (0.120)	1.038 (0.058)	1.675 (0.344)
Experience variability for national brands σ_{xn}	0.884 (0.119)	0.252 (0.307)	0.354 (0.126)
Experience variability for store brands σ_{xs}	0.753 (0.231)	0.152 (0.307)	1.088 (0.488)

Experience variability is reported as standard deviation

Table 7 Parameter estimates for the tuna category

Parameter estimates	Spain	United Kingdom	United States
Mean price sensitivity α_0	−0.101 (0.004)	−0.088 (0.007)	−0.006 (0.003)
Standard deviation of price sensitivity σ_α	0.445 (0.013)	0.319 (0.008)	0.990 (0.012)
Mean utility (quality) weight ω_0	0.85 (0.162)	0.027 (0.010)	0.119 (0.032)
Mean risk aversion γ_0	−4.051 (0.932)	−4.03 (1.128)	−3.69 (2.485)
Standard deviation of risk aversion σ_γ	0.935 (0.860)	0.284 (0.987)	0.84 (1.302)
Prior std. dev. of quality perceptions (national br.) σ_{An}	1.000 (0.023)	0.785 (0.097)	1.275 (0.104)
Prior std. dev. of quality perceptions (store br.) σ_{As}	2.092 (0.820)	0.157 (0.102)	2.439 (1.010)
Experience variability for national brands σ_{xn}	0.47 (0.067)	0.285 (0.036)	1.116 (0.078)
Experience variability for store brands σ_{xs}	0.643 (0.102)	0.285 (0.050)	1.573 (0.109)

Experience variability is reported as standard deviation

Table 8 Estimates of the mean quality levels for detergent

	Estimates	Std.
Spain		
Ariel	1.035	(0.047)
Wipp	0.622	(0.108)
Skip	−0.112	(0.112)
Colon	−0.274	(0.069)
Elena	−0.607	(0.090)
Dixan	−1.039	-
Store Brand	0.375	(0.111)
United Kingdom		
Ariel	0.480	(0.058)
Bold	0.220	(0.050)
Daz	−0.475	(0.060)
Persil	0.505	(0.066)
Surf	−0.330	-
NISA	−0.172	(0.002)
Store Brand	−0.228	(0.066)
United States		
A&H	−0.262	(0.155)
All	−0.102	(0.112)
Purex	−0.346	(0.112)
Surf	−0.500	(0.069)
Tide	2.008	-
Wisk	−0.215	(0.129)
Store Brand	−0.583	(0.180)

Table 9 Estimates of the mean quality levels for ketchup

	Estimates	Std.
Spain		
Orlando	0.104	-
Prima	0.771	(0.086)
Heinz	0.341	(0.099)
Calve	−0.567	(0.01)
Store Brand	−0.649	(0.103)
United Kingdom		
Daddies	−0.103	-
Family	−0.578	(0.009)
NISA	−0.214	(0.019)
Heinz	1.399	(0.035)
Store Brand	−0.504	(0.073)
United States		
Delmonte	−1.022	-
Heinz	2.3248	(0.059)
Hunts	0.2052	(0.091)
Store Brand	−1.508	(0.165)

Table 10 Estimates of the mean quality levels for toilet paper

	Estimates	Std.
Spain		
Scottex	1.235	-
Colhogar	0.294	(0.077)
PP	−0.922	(0.056)
Store Brand	−0.607	(0.154)
United Kingdom		
Andrex	1.411	(0.169)
Kleenex	1.231	-
Family	−1.572	(0.074)
NISA	−0.951	(0.088)
Store Brand	−0.119	(0.006)
United States		
Angelsoft	−1.2707	(0.112)
Kleenex	1.487	-
Charmin	1.785	(0.081)
Scott	−0.357	(0.103)
Northern	−0.491	(0.152)
Store Brand	−1.1533	(0.207)

Table 11 Estimates of the mean quality levels for margarine

	Estimates	Std.
Spain		
Tulipan	1.339	(0.115)
Artua	0.675	-
Flora	−0.249	(0.172)
Ligeresa	−0.702	(0.132)
Store Brand	−1.063	(0.177)
United Kingdom		
Flora	1.022	(0.013)
Stivel	−0.195	-
Vitalite	−0.201	(0.154)
Stork	0.469	(0.105)
Family	−0.861	(0.005)
NISA	−0.475	(0.037)
Store Brand	0.241	(0.109)
United States		
Bluebonnet	−0.046	(0.169)
I Can't Believe	0.191	(0.189)
Land O'Lakes	−0.128	(0.116)
Parkay	−0.274	(0.144)
Shedd	0.005	-
Imperial	0.912	(0.177)
Store Brand	−0.66	(0.142)

Table 12 Estimates of the mean quality levels for tuna

	Estimates	Std.
Spain		
Isabel	0.675	(0.178)
Rianxeira	0.102	-
Calvo	0.209	(0.195)
Miau	−0.38	(0.108)
Albo	−0.33	(0.182)
Store Brand	−0.276	(0.230)
United Kingdom		
John West	0.304	-
Princes	0.167	(0.019)
Family	−0.320	(0.003)
Heinz	−0.049	(0.005)
Store Brand	−0.102	(0.008)
United States		
Bumblebee	0.371	(0.227)
Chicken of Sea	−0.237	-
Starkist	1.089	(0.200)
Store Brand	−1.223	(0.198)

variability). In most cases, heterogeneity in price sensitivities and degrees of risk aversion also exist. A few noteworthy exceptions should be mentioned—namely, the risk aversion parameter is statistically insignificant in margarine in Spain, experience variability of both national and store brands is statistically insignificant in margarine in the United Kingdom, and the standard deviation of risk aversion is insignificant (indicating a lack of heterogeneity) in the United States in detergent, ketchup, margarine, and tuna. It is also worth noting that, although experience variability is consistently higher in the United States for store brands than for national brands across all five categories, the reverse is true in the United Kingdom for ketchup, toilet paper, and margarine and in Spain for toilet paper and margarine. This result already hints at the relative success of store brands in the United Kingdom and Spain: store brands provide consumers with more consistent experiences than national brands in the United Kingdom and Spain (at least in a number of categories).

Table 13 reports the variance-covariance matrix of price sensitivities (recall that we allowed price sensitivity's heterogeneity distributions to be correlated in each country). Out of ten pairwise correlations, three in Spain, four in the United Kingdom, and five in the United States are significant.

Tables 14 and 15 report the variance and covariance matrices of prior quality perceptions for store and national umbrella brands, respectively. For store brands (Table 14), prior quality perceptions are correlated in three cases in Spain and the United Kingdom (i.e., tuna and margarine, ketchup and margarine, and ketchup and toilet paper) and four cases in the United States (i.e., tuna and margarine, tuna and ketchup, ketchup and toilet paper, toilet paper and detergent). In the case of national umbrella brands (Table 15), we have data from only the United Kingdom. For the Nisa brand, which is available in four product categories, three out of six pair-wise correlations are statistically significant (i.e., ketchup and detergent, deter-

Table 13 Covariance matrix of price sensitivity

	Detergent	Ketchup	Toilet paper	Margarine	Tuna
Spain					
Detergent	0.208*				
Ketchup	0.110*	0.101*			
Toilet paper	0.780*	0.231*	0.125*		
Margarine	0.132	0.392*	0.13*	0.115*	
Tuna	0.1	0.308	0.081	0.493	0.198*
United Kingdom					
Detergent	0.146*				
Ketchup	0.180*	0.075*			
Toilet paper	0.592*	0.250*	0.187*		
Margarine	0.193*	0.792*	0.201*	0.093*	
Tuna	0.151	0.54	0.182	0.43*	0.102*
United States					
Detergent	0.080*				
Ketchup	0.15*	0.07*			
Toilet paper	0.44*	0.18	0.081*		
Margarine	0.091	0.45*	0.203	0.102*	
Tuna	0.102*	0.334*	0.273	0.372	0.981*

Table 14 Covariance matrix of prior perceptions of quality for store brands

	Detergent	Ketchup	Toilet paper	Margarine	Tuna
Spain					
Detergent	0.891*				
Ketchup	0.010	0.397*			
Toilet paper	0.009	0.331*	2.605*		
Margarine	0.010	0.475*	0.102	1.272*	
Tuna	0.010	0.017	0.01	0.102*	2.092*
United Kingdom					
Detergent	0.665*				
Ketchup	0.235	0.117*			
Toilet paper	0.302	0.453*	1.498*		
Margarine	0.118	0.639*	0.379	1.038*	
Tuna	0.152	0.537	0.291	0.010*	0.157
United States					
Detergent	2.806*				
Ketchup	0.01	0.397*			
Toilet paper	0.058*	0.129*	6.476*		
Margarine	0.01	0.606	0.01	1.675*	
Tuna	0.01	0.024*	0.01	0.601*	2.439*

gent and toilet paper, and ketchup and toilet paper). For Heinz, prior quality perceptions are also correlated between the two categories in which Heinz is available: ketchup and tuna. Finally, Family Choice is available in four categories as well, but only one out of six possible correlations is statistically significant (i.e., between margarine and tuna).

A comparison of correlations among prior quality perceptions (covariances) between store and national brands in the United Kingdom (the only country in which we have national umbrella brands in multiple categories) reveals that the highest (and statistically significant) covariance occurs in the case of store brands between margarine and ketchup (0.639). The corresponding highest covariance for national brands is in the case of the umbrella brand Nisa and between ketchup and detergent (0.526). We do not observe large differences in the magnitudes of these covariances (correlated initial priors) for store versus national umbrella brands. These covariances indicate that, in the pairs of product categories, cross-category learning and association transfer occur from one category to the other. Interestingly, this transfer occurs even between food categories (ketchup) and non-food categories (toilet paper), although most correlations occur within the food categories. This is not surprising, given that perceived fit may be higher among such categories.

Table 16 reports several ratios of different parameter estimates to aid in our ability to make direct comparisons across countries (two parameter estimates are not directly comparable across countries due to the scale factor (Swait and Louviere 1993)). In ratio 1 (prior standard deviation of quality beliefs of store brands versus national brands), store brands are usually associated with higher initial uncertainty, especially in most categories in the United States. Ratio 2 is the ratio of experience variability of store brands to that of national brands; in this ratio, the United States generally has the highest numbers, indicating that its store brands relative to national brands provide consumers with less consistent experiences. Thus, noisiness of information of use experience is higher for store brands in the United States. In the United Kingdom, this ratio is either under 1 or close to 1, suggesting that store brands provide more consistent information or as consistent information (experiences) as national brands. The picture emerging from Spain is more similar to the results observed in the United Kingdom than in the United States. Ratio 3 compares risk coefficients to price sensitivity coefficients, indicating that in general U.S. consumers are more risk averse than price sensitive when compared to Spanish or U.K. consumers in four out of five categories.[5] Quality versus price sensitivity comparisons (ratio 4) show that U.K. consumers are more price sensitive than quality sensitive, while the opposite is true in Spain and especially the United States. Finally, ratio

[5] To ensure comparability across countries, we used prices in the utility in the same monetary units (US$) by converting the prices in the United Kingdom and Spain into dollar prices using the mean of monthly exchange rates during the period of analysis. The exchange rates we used were 1.638 (1£=US$1.638) for the United Kingdom and .006 (PTA1=US$.006) for Spain.

Table 15 Covariance matrix of prior perceptions of quality for national umbrella brands in the United Kingdom

	Detergent	Ketchup	Toilet paper	Margarine
Nisa—United Kingdom				
Detergent	0.748*			
Ketchup	0.526*	0.211*		
Toilet paper	0.251*	0.096*	0.887*	
Margarine	0.055	0.022	0.011	1.404*
Family Choice—United Kingdom				
Ketchup	0.302*			
Toilet paper	0.2	0.400*		
Margarine	0.109	0.016	1.404*	
Tuna	0.055	0.278	0.160*	0.140*
Heinz—United Kingdom				
	Ketchup	Tuna		
Ketchup	0.102*			
Tuna	0.400*	0.119*		

Table 16 Ratios of parameter estimates for cross-country comparisons

	United Kingdom	Spain	United States
Prior uncertainty (r1)			
Detergent	1.38435	1.03361	1.86817
Ketchup	1.08711	1.00636	0.91422
Toilet paper	1.77598	0.92737	1.31395
Margarine	1.05907	1.08126	1.05427
Tuna	0.44679	1.44637	1.38301
Precision of information contained in use experience (r2)			
Detergent	1.09958	1.02594	2.32494
Ketchup	0.97041	1.04586	1.35879
Toilet paper	0.78843	0.73868	1.80387
Margarine	0.60288	0.85181	3.07345
Tuna	1.0022	1.36809	1.4095
Risk versus price sensitivity (r3)			
Detergent	62.5	46.1538	168.78
Ketchup	125	26.5	26.8571
Toilet paper	49.7087	6.10294	39.6667
Margarine	90	89.9211	288.333
Tuna	45.7955	40.1089	615
Quality versus price sensitivity (r4)			
Detergent	−0.6667	−1.9615	−0.7561
Ketchup	−1	−0.5	−2.5714
Toilet paper	−0.2427	−1.4216	−9.6667
Margarine	−0.5882	−2.3684	−1.1667
Tuna	−0.3068	−8.4158	−19.833
Quality differentials between store and national brands (r5)			
Detergent	1.45122	0.63768	1.29056
Ketchup	1.36047	1.84176	1.64866
Toilet paper	1.08418	1.4915	1.64611
Margarine	0.76453	1.79388	1.72368
Tuna	1.33533	1.40889	2.12305

r1=the ratio of the std of the prior perception of store brands to the std of the prior perception of national brand

r2=the ratio of the experience variability of store brands to the experience variability of national brands

r3=the ratio of consumers' mean risk-aversion level to their mean price sensitivity

r4=the ratio of consumers' mean quality weight to their mean price sensitivity

r5=the ratio of the difference between the mean (perceived) quality level of the best national brand and the mean quality level of the store brand to the mean quality level of the best national brand

5 captures the perceived quality differences between national and store brands, demonstrating that national brands are perceived to be of higher quality in all countries, except for detergent in Spain and margarine in the United Kingdom. These results are overall in line with the findings in Erdem et al. (2004). Thus, we replicate their results with an extended model that incorporates cross-category learning and coincidence as well as extended analysis that involves more categories.

Discussion, conclusions, and future research

We estimated a model of quality learning that allows priors to be correlated for both store and national umbrella brands. Our results indicate that consumer learning occurs across categories for both brands. We did not find any significant differences in cross-learning effects between store and national umbrella brands. By using an extended model with cross-category effects (cross-category learning, correlated price sensitivities, and correlated probit errors—that is, coincidence), we also replicated the findings of Erdem et al. (2004) that store brands in the United States provide less consistent consumer experiences and are subject to higher perceived risk compared to national brands, which is often not the case in Europe. Furthermore, risk attitudes and price and quality sensitivities are different in the United States than in Europe. Higher risk aversion in the United States, coupled with higher perceived risk of store brands, leads to more aversion for store brands in the United States than in Europe.

One important managerial implication of this study is that umbrella brands—whether national or store brands—need to provide consistent experiences within and across categories as the existence of cross-learning effects means potential brand dilution effects when consumers are not satisfied with their brand experiences. Our results also suggest that cross-learning effects are not automatic for umbrella brands as the prior quality perceptions are not correlated in certain cases. In most extensions the assumption of the firm is that quality associations will be transferred; therefore, firms need to understand the factors underlying the transfer of quality associations thoroughly. In addition, we find variance in cross-category learning of umbrella brands across different countries. Hence, firms familiar with cross-category learning patterns in one country or category should not presume that similar patterns occur in other markets, nor should they be overconfident about their experience in similar product categories when extending their brands to dissimilar product categories.

Our study opens up some opportunities for future research. The current study does not analyze the factors underlying consumers' correlated priors about quality across different product categories for umbrella brands. Such correlations exist across some categories, but not between others; the strength of these associations varies by product category and country. Although perceived fit is deemed to be a critical factor in branding literature (Keller 2002), more research in the context of learning models is needed to study such factors underlying perceived fit and association transfer.

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