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Direct and indirect effects of retail promotions on sales and profits in the do-it-yourself market

Dirk Van den Poel[a,*], Jan De Schamphelaere[b], Geert Wets[c]

[a]*Department of Marketing, Ghent University, Hoveniersberg 24, 9000 Gent, Belgium*
[b]*Ghent University, Hoveniersberg 24, B-9000 Gent, Belgium*
[c]*Limburg University Centre, Universitaire Campus, B-3590 Diepenbeek, Belgium*

Abstract

In this study, we measure complementary effects of retail promotions for a large number of product pairs. For this, we make use of market basket analysis. We argue that failing to take these cross-effects into consideration, may lead retail managers to severely underestimate the impact of promotional efforts. Moreover, we provide guidelines for optimizing promotional strategies. To this end, we introduce *lift*, a measure for the strength of a complementary relationship, as a moderator in explaining the variation in complementary effects of retail promotions across product pairs. We show that the stronger the complementary relationship (higher *lift*), the stronger is the cross-impact of retail promotions. However, in case of simultaneously promoting two complementary products, larger promotional impact is seen when weaker product pairs (lower *lift*) are considered.

Keywords: Association rules; Lift; Complementary products; Marketing

1. Introduction

A matter of continuing interest to retailers, and marketers in general, is how and to what extent marketing-mix instruments affect consumers' purchase behavior. Assortment decisions, lay out, price and promotion planning, all offer opportunities to influence consumers' shopping and purchase behavior and hence retailer sales and profits.

Researchers and retailers have quickly acknowledged that the impact of marketing actions goes beyond the individual product as a result of product interdependencies in the retail assortment (substitutes and complements). How marketing-mix decisions affect substitutes' sales has been well described in the marketing literature (e.g. Kumar & Leone, 1988; Moriarty, 1985; Walters, 1991). In this paper, we will focus on complementary product relationships.

Several alternatives are available for incorporating complementary product relationships when devising or evaluating marketing-mix tactics. Firstly, Brijs, Swinnen, Vanhoof, and Wets (1999) argue that the profitability impact of *assortment* decisions can be better assessed when complementary relationships are taken into consideration. Secondly, insights into product interdependencies can also be of use for designing *store lay out*. If transaction data reveal that two products or product categories often occur together in a shopping basket, the retailer may decide to place them as close as possible to each other so as to facilitate the shopping task for the customer or to place them as far apart as possible to expose consumers to as many products as possible. Thirdly, a better planning and more reliable evaluation of *promotions* can be achieved when product complementarities are kept in mind. Indeed, Mulhern and Padgett (1995) show that 75% of the customers, whose main reason for the store visit is a particular retail price promotion, also purchase regular priced products. Failing to consider these indirect effects of price promotions may lead managers to underestimate promotional effects and draw misleading conclusions.

In this paper, our focus is on promotional activities in the presence of complementary product relationships. We put forward that an understanding of how products in the retail assortment interrelate and of how these interrelationships can be exploited by price and promotion strategies, can help

* Corresponding author. Tel.: +32-9-264-89-80; fax: +32-9-264-42-79.
E-mail addresses: dirk.vandenpoel@ugent.be (D. Van den Poel); geert.wets@luc.ac.be (G. Wets).

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retailers drive purchase behavior and make optimal use of promotional resources. Chintagunta and Haldar (1998), Hruschka et al. (1999), Manchanda, Ansari, and Gupta (1999), Mulhern and Leone (1991), Russell and Petersen (2000), and Walters (1988, 1991) have documented that price promotions of a certain product boost both sales of the promoted product itself and sales of (non-promoted, full-margin) complementary products. Still little is known about the effect of jointly promoting complementary products. If two products tend to be purchased together, does simultaneously promoting those two products deliver additional profits compared to the case in which only one of the two products is promoted? Even less is known about why promotional cross-impact differs across product or product category pairs. Are effects of (joint) promotions different for strong (high statistical dependence of the two products) versus weak (low statistical dependence of the two products) complementary product pairs? Given the limited space available in retailers' promotional folders, a retail manager might be interested in the answer to those questions in order to optimize the composition of promotion folders. Moreover, manufacturers may be encouraged to coordinate their promotional activities if synergies can be achieved by joint-promotion actions.

With our study, we contribute to the literature, dealing with promotional effects on complementary products, in three ways.

Firstly, drawing upon market basket analysis and association rules, we measure cross-effects of retail price promotions for a large number of complementary product pairs at different levels in the product hierarchy. We first do this at the SKU level. Then, we look how pairs of products/brands (grouping of SKU's of the same brand in the same product category under one and the same denominator) are affected by promotions.

Secondly, we take a first step in explaining the variation in promotional impact across product pairs. To this end, we introduce *lift*, a measure for the strength of complementary relationships, as a moderating variable. In this context, we discuss the effects of promoting the main product only, promoting the complement only and simultaneously promoting both products.

Thirdly, apart from measuring promotional impact on frequency of co-occurrence of a product pair in a shopping basket, we also measure how purchase quantity of the complement is affected.

The remainder of this paper is structured as follows. In Section 2, we review the previous work dealing with promotions and complementary relationships in product assortments. Section 3 offers a more technical approach to association rules and market basket analysis. In Section 4, we describe the data and variables used in our study. This is followed by a discussion of the empirical results in Section 5. We conclude our paper with a listing of some limitations of our study and directions for future research in Section 6.

2. Previous research and hypothesis development

The (direct) influence of the marketing-mix elements on sales and profitability of products has taken an important place in the marketing literature. For an overview, we refer to Hanssens, Parsons, and Schultz (1989). Researchers and retailers have quickly acknowledged that the impact of promotions goes beyond the individual product and affects substitutes, complementary products and even products in competing stores. Numerous studies have dealt with promotional effects on substitutes' sales (e.g. Kumar & Leone, 1988; Moriarty, 1985; Walters, 1991).

The list of studies about complementary effects of promotions is, however, less extensive. Several authors (e.g. Chintagunta & Haldar, 1998; Russell & Petersen, 2000) distinguish two types of complementary products. On one hand, products are use (true) complements if they are typically consumed together and on the other hand, products are purchase (spurious) complements if they are purchased together rather as a result of one-stop shopping or concurrent purchase cycles. With respect to the latter type, Mulhern and Leone (1991) suggest that all items in a retail store can be complements since they can be purchased at the same time in the same place.

Complementary purchases can be influenced through the effect that retail promotions have on store switching and store traffic. Retailers use promotion folders to induce store switching behavior, to generate store traffic and to make customers buy their additional purchases within the same store. Keng and Ehrenberg (1984) suggest that consumers switch stores as a result of retail promotions. For disposable diapers, Kumar and Leone (1988) attribute part of a sales bump of a promoted item to store substitution. Other researchers found little (Bodapati, Anand, & Srinivasan, 1996; Walters, 1991) or no evidence (Bucklin & Lattin, 1992) of store substitution in the presence of price promotions in the fast moving consumer goods (FMCGs) environment. Bodapati et al. (1996) suggests that a rather small proportion (20%) of consumers is influenced by feature advertising in their store choice. Walters (1988) finds, for some cases, a direct effect of price promotions on store traffic. This traffic building effect of retail promotions is particularly desirable since consumers may engage in one-stop shopping and purchase an assortment of additional items once they are in the store. Indeed, Mulhern and Padgett (1995) show that 75% of the customers, whose main reason for the store visit is a particular retail price promotion, also purchase other (regular priced) products.

Other authors investigate promotional effects for true consumption complements. Mulhern and Leone (1991) and Walters (1988, 1991) reported weak cross-elasticities for spaghetti and spaghetti sauce and cake mix and cake frostings. The latter studies made use of sales response models. An alternative to this approach is market basket analysis. It offers the opportunity to measure complementary effects more precisely. Only in recent research,

shopping baskets composed the unit of analysis for identifying promotional influences on complementary products. Chintagunta and Haldar (1998), Manchanda et al. (1999), and Russell and Petersen (2000) show for a limited number of product categories that a price decrease resulted in a higher purchase probability of a product and its complements. Hruschka, Lukanowicz, and Buchta (1999) conducted a large-scale study and came, for some categories, to the same conclusions.

The above studies give insights into how promotions may influence sales of complementary products. They also mention the importance of optimizing promotional strategies or discuss potential implications of their research with regard to joint promotions (e.g. Russell & Kamakura, 1997). Yet, to our knowledge, only Chintagunta and Haldar (1998) explicitly investigate, at the sales level, how simultaneous promotions may reinforce one another. Having developed a bivariate hazard model, they compared different scenarios and concluded that the increase in purchase probability, as a result of simultaneous promotions, was of a magnitude of 0.8% for pasta and 0.3% for pasta sauce. The authors note that the small sales gain must be traded off against loss in profit margins. In our study, we compare sales (and profits) generated in different promotional scenarios: only the main product is promoted, only the complement is promoted and both are promoted at the same time.

Manchanda et al. (1999), Mulhern and Leone (1991), Russell and Petersen (2000), and Walters (1991) show that complementary effects vary across pairs of products (brands) and across pairs of product categories. To date, no attempt has been made to explain those variations. In addition, the literature provides some implicit indications that cross-effects may differ for strong (high statistical dependence between two products) versus weak (low statistical dependence between two products) complements. The reasoning is as follows. From Russell and Kamakura (1997), who show that preferences for brand names exhibit strong consistency across product categories, we infer that brand A (in product category X) has a stronger complementary relationship with the same brand in product category Y than with brand B in product category Y. As Mulhern and Leone (1991) and Walters (1991) observe higher cross-effects for items that have the same brand name, it is appropriate to state that cross-effects of retail promotions are larger for product pairs with a stronger complementary relationship. Therefore,

H_1: Cross-effects of retail promotions (individual promotions and joint promotions) depend on the strength of the complementary relationship.

Hruschka et al. (1999) and Russell and Petersen (2000) point out that one of the limitations of their research, and previous research, is that they only consider how often products or product categories are purchased together, but neglect how much of these items is purchased. In the promotion literature, some effort has been made to split the direct impact of price promotions in its different components and to isolate the stockpiling effect. Gupta (1988) shows that only 2% of a sales increase due to a promotion is accounted for by stockpiling. When considering complements, one may expect that the purchase quantity increase of the main product will be followed by an increase of the purchase quantity of the complement, especially in the case of strong consumption complements. The indirect effect (complement) is expected to be smaller than the direct effect. Therefore, we propose the following hypothesis:

H_2: Retail promotions of a product have a positive effect on the purchase quantity of the complementary product.

3. Methodology

Faced with massive amounts of transaction data, extracting useful knowledge is a challenging task. Association-rule discovery is one of the many techniques to mine higher-level information from an abundance of data. It is claimed to be a key tool for discovering regularities in customer purchase behavior. In marketing, association rules have proved successful for developing cross-selling strategies (Anand, Patrick, Hughes, & Bell, 1998), for product recommendations in on-line shopping environment (Changchien & Lu, 2001) and for product assortment decisions in a retail setting (Bell, Chiang, & Padmanabhan, 1999). When applied to marketing association-rule discovery is often referred to as *market basket analysis*. When analyzing cross-effects of retail promotions, this approach yields some major advantages compared to previous studies. Firstly, whereas Mulhern and Leone (1991) and Walters (1988, 1991) estimate cross-elasticities based on aggregated sales data, we take the shopping basket as the unit of analysis meaning that we precisely measure which products are purchased together during a shopping trip. Secondly, association-rule techniques produce an extensive list of associations or frequently purchased product pairs and enable us to extend our study beyond a small number of predefined complementary product pairs typically investigated in studies like Chintagunta and Haldar (1998), Manchanda et al. (1999), and Russell and Petersen (2000).

Although Böcker (1975) came up with pairwise association measures to identify relationships between pairs of items in an assortment, an efficient algorithm to discover association rules from large databases was first introduced by Agrawal, Imielinski, and Swami (1993). They provide the following formal description of this technique.

Let $I = \{i_1, i_2, \ldots, i_k\}$ be a set of items. Let D be a set of transactions, where each transaction T is a set of items such

that $T \subseteq I$. Associated with each transaction is a unique identifier. We say that a transaction T contains X, a set of some items in I, if $X \subseteq T$. An association rule is an implication of the form $X \Rightarrow Y$, where $X \subset I$, $Y \subset I$ and $X \cap Y = \varnothing$. The rule $X \Rightarrow Y$ has *confidence* c if $c\%$ of the transactions in D containing X also contains Y. The rule $X \Rightarrow Y$ holds in the transaction set D with *support* s if $s\%$ of the transactions in D contains $X \cup Y$. We define *absolute support* as the absolute number of transactions in D, containing both X and Y.

A major challenge in the field of association-rule discovery from large databases is to identify the 'useful' patterns or association rules. Brin, Siverstein, and Motwani (1998) argue that confidence is a poor measure to detect the dependence of the consequent with respect to the antecedent. Confidence can be high simply because $P(Y)$ is high while X and Y might be highly independent. Moreover, one can argue what the meaning is of a high confidence level when the a priori probability of Y is higher. They introduced an alternative interestingness measure lift. The lift of a rule $X \Rightarrow Y$ is a measure for the statistical dependence between X and Y and is formulated as the conditional probability of Y given X, divided by the unconditional probability of Y.

$$\text{Lift} = P(Y|X)/P(Y) = P(X \wedge Y)/P(X) \cdot P(Y). \quad (1)$$

Hence, if lift exceeds one, X and Y co-occur more frequently compared to the case of independence. Concretely, if lift equals five, Y is five times more likely to occur in a basket if X occurs in the basket, compared to the situation in which X does not occur in the basket.

A concrete example, suppose that scanner data reveal that in a period of 2 weeks 10 000 transactions (tickets or baskets) were handled. Paint occurred in 250 baskets and paint brushes in 200 baskets. Paint and paint brush were purchased together 100 times.

The association rule *Paint* $\Rightarrow$ *Paint brush* then has support 1%, an absolute support of 100 and a lift of 20.[1]

Both Agrawal et al. (1993) and Brin et al. (1998) proposed some measures, respectively (absolute) support and lift, to evaluate the interestingness of an association rule. We discuss how we use these measures in our research.

We use absolute support as a substitute measure for 'sales of the complementary product'. We do this for one major reason. Mulhern and Leone (1991) and Walters (1988, 1991) estimate cross-elasticities based on sales response models. They use sales of the complementary product as the dependent variable. Absolute support is a more exact measure as it indicates 'the number of times the complement is purchased given that the main product is purchased' or 'the number of shopping baskets that contain both products'.

[1] As mentioned by one of the reviewers, absolute support should be interpreted with caution when purchase data include both filler and regular shopping trips.

The absolute support measure has, however, not frequently been used in the marketing literature. Böcker (1975) applies pairwise association coefficients and Hruschka et al. (1999) uses joint purchase probabilities. In addition, this market basket approach has also been adopted in the models developed by Chintagunta and Haldar (1998), Manchanda et al. (1999), and Russell and Petersen (2000).

In analogy with Betancourt and Gautschi (1990) and Hruschka et al. (1999), we say that two products are complements if they are purchased together more frequently compared to the case of stochastic independence. This means that two products are complements if lift has a value exceeding 1. As we only consider those product pairs in our analysis (see Section 5), we ensure that we are dealing with complementary products regardless of the absolute support measure.

4. Data

Scanner data were drawn from the database of a major do-it-yourself retailer over a 1-year period. Besides the scanner data, we obtained information on purchasing and selling prices, profit margins and on the composition of the promotional leaflets. As promotional folders are distributed every 2 weeks, the transaction data are split into periods that exactly match these 2-week periods.

The transaction data set contains on average 141.383 tickets. The retail assortment is composed of more than 45.000 SKU's (and more than 12.000 products). Hruschka et al. (1999) state that if a retailer is interested in cross-selling, he or she should consider high-volume products with high contribution that have a strong complementary relation with other frequently bought high contribution categories. Therefore, we select 100 SKU's/products that are among the highest sales and profit generators and that have been in promotion at least twice during the period covered in the study. On average, those products were sold 256 times within a period of 2 weeks or about 20 times a day. We regard those as main products (left hand side) of an association or complementary product pair. Association rules are then generated between those main products and all other products in the store assortment, with their corresponding support, absolute support and lift values. In this, we differ from previous studies that worked with a limited number of predefined pairs of products or product categories. For further analysis, we selected only those product pairs that are statistically dependent (lift >1), in analogy with the definition of complements in Betancourt and Gautschi (1990) and Hruschka et al. (1999), and have sufficient sales and profit potential considered over a whole year to be of interest to retailers (absolute support >250). Eventually, there are 191 product pairs that meet all requirements.

Due to the limitations of an observational as opposed to an experimental study, we are not able to analyze all interesting promotional effects. Firstly, given that price changes do not form a continuum and that low and high discounts may affect profits in a different way or direction, we opt for creating a dummy variable *Hidi1*, indicating whether a product gets a large discount or not (Table 1). Secondly, a quick view on the data reveals that a price discount of a product is always accompanied by retail advertising and vice versa, meaning that the data do not allow separating the discount effect from the promotion (folder) effect. Thirdly, simultaneous large discounts on both main and complementary products occur rarely so that this effect cannot be reliably measured. Finally, we were not able to test the asymmetry in complementary effects (Manchanda et al., 1999; Mulhern & Leone, 1991; Walters, 1991) as the situation in which a complementary product is in promotion when the main product is not in promotion does not occur frequently. However, as mentioned before, the latter is not within the focus of our study since we want to provide insights starting from promotions on main products with a high sales and profit level. Moreover, it reflects the policy of the do-it-yourself retailer to mainly promote the best selling products from the assortment.

The dependent and independent variables accounted for in our study are listed in Table 1.

As the sales of do-it-yourself products are highly dependent on weather conditions, we also included data on weather conditions in our model to capture seasonal disturbances. Association code was included to absorb initial structural differences between product pairs.

Table 1
Dependent and independent variables

Dependent variables	
Absolute support	Frequency of two products co-occurring in the same shopping basket
Purchase quantity complement	Average purchase quantity of a complementary product over all joint purchases with the main product
Profit complement	Absolute support × purchase quantity complement × profit margin complement
Independent variables	
Promo1 (Promo1 and 2)	Value 1 if the main product (both main and complementary product) is in a promotion leaflet. Value 0 if not
Hidi1 (Hidi1 and Promo2)	Value 1 if the main product gets a large discount (and complementary product is promoted). Value 0 if not. A discount is called a large discount if the relative price change is higher than the median value (−20%)
Lift	Lift of association $X \Rightarrow Y$ is $P(Y\|X)/P(Y)$ measured over a 1-year period
Co-variates	Weather conditions and association code

5. Findings

In the following, we discuss the results obtained at the SKU and product level.

5.1. SKU level

Our results, revealing a significant ($p < 0.001$) and positive impact of price promotions on sales and profits of the promoted item (left panel, Table 2), confirm the findings of previous studies (e g. Blattberg & Wisniewski, 1989; Kumar & Leone, 1988). We also find that high discounts of a product in a promotion leaflet trigger extra sales of the promoted product ($p < 0.001$). This finding is in line with studies (e.g. Blattberg & Wisniewski, 1989) reporting negative price elasticities. The latter sales increase resulting from high discounts, however, is in our case not sufficient to compensate for the loss in profit margin (right panel, Table 2).

Having found significant direct effects of price promotions, we can now further analyze whether the promotional impact goes beyond the individual product. Featuring a product in a promotion leaflet does significantly affect the frequency of co-occurrence with and consequently the profits of its complements (see *Promo1* in Table 3). This confirms the findings of Chintagunta and Haldar (1998), Manchanda et al. (1999), Mulhern and Leone (1991), Russell and Petersen (2000), and Walters (1988, 1991). However, high discounts, on average, do not prompt an additional increase in absolute support (Hidi1 in Table 3). On the other hand, we observe a significant interaction effect between Hidi1 and lift, which will be discussed later in this section.

Our results (*Promo1 and 2* and *Hidi1 and Promo2* in Table 3) support the finding of Chintagunta and Haldar (1998) that simultaneous promotions positively influence the frequency of co-occurrence in a shopping basket. Note that a high discount of a main product does have an effect on its complements when it is also discounted, indicating that cherry pickers attracted to the store by a largely discounted item, may be also more willing to buy its complements in the same store if they are on promotion.

From Table 3, we learn that the interactions between the promotion variables and lift are significant, meaning that complementary effects of price promotions differ according

Table 2
ANOVA results: own effects of retail promotions (SKU level)

	Sales main product				Profits main product			
	F	*P*	Eta^2	Sign	*F*	*P*	Eta^2	Sign
Promo1	80.45	<0.001	0.038	+	110.61	<0.001	0.052	+
Hidi1	10.99	0.001	0.005	+	25.63	<0.001	0.013	−

Table 3
ANOVA results: cross-effects of retail promotions (SKU level)

	Absolute support				Profit associated product			
	F	*P*	Eta^2	Sign	*F*	*P*	Eta^2	Sign
Promo1	43.56	<0.0001	0.020	+	12.14	0.0005	0.003	+
Promo1 and 2	82.11	<0.0001	0.011	+	2.90	0.0885	0.001	+
Hidi1	1.22	0.269	0.000	NS	0.83	0.3624	0.000	NS
Hidi1 and Promo2	14.08	0.0002	0.003	+	3.90	0.0485	0.001	+
Promo1 × lift	40.49	<0.0001	0.010	+	26.47	<0.0001	0.006	+
Promo1 and 2 × lift	44.10	<0.0001	0.011	−	3.34	0.0677	0.001	−
Hidi1 × lift	18.18	<0.0001	0.004	+	17.20	<0.0001	0.004	+
Hidi1 and Promo2 × lift	22.80	<0.0001	0.006	+	4.95	0.0261	0.001	+

NS, not significant at 10% level.

to the strength of a product association. Hypothesis 1 is hereby confirmed. To specify the relationship between retail promotions and absolute support (and profit of the complement) at different levels of lift, we use the 'spotlight' procedure described in Irwin and McClelland (2001). In their approach, they propose to select three (meaningful) values for lift, being a high level of lift (Q3 = 75% percentile), a medium level of lift (median) and a low level of lift (Q1 = 25% percentile). To test whether the effect of a retail promotion at a particular lift level is significantly different from zero, it is sufficient to test the coefficient of the promotional variable in three new models, in which lift is replaced by, respectively, 'lift-Q3', 'lift-median' and 'lift-Q1'. The results for absolute support are displayed in Fig. 1.

Fig. 1a shows that the stronger the complementary relationship, the higher the effect of retail promotions on complementary products. High discounts significantly affect complementary products only through the moderating variable lift (Table 3). Fig. 1c gives more details about this interaction. High discounts only raise the absolute support level of strong complementary product pairs. Our findings contradict Walters and MacKenzie (1988) and Walters and Rinne (1986), who report that highly discounted loss leaders fail to influence sales or profits of any complementary non-promoted items. This difference in results may be explained by the way the variables are defined. Note that Walters and MacKenzie (1988) and Walters and Rinne (1986) worked at an aggregated sales level and not at the level of individual products as we do.

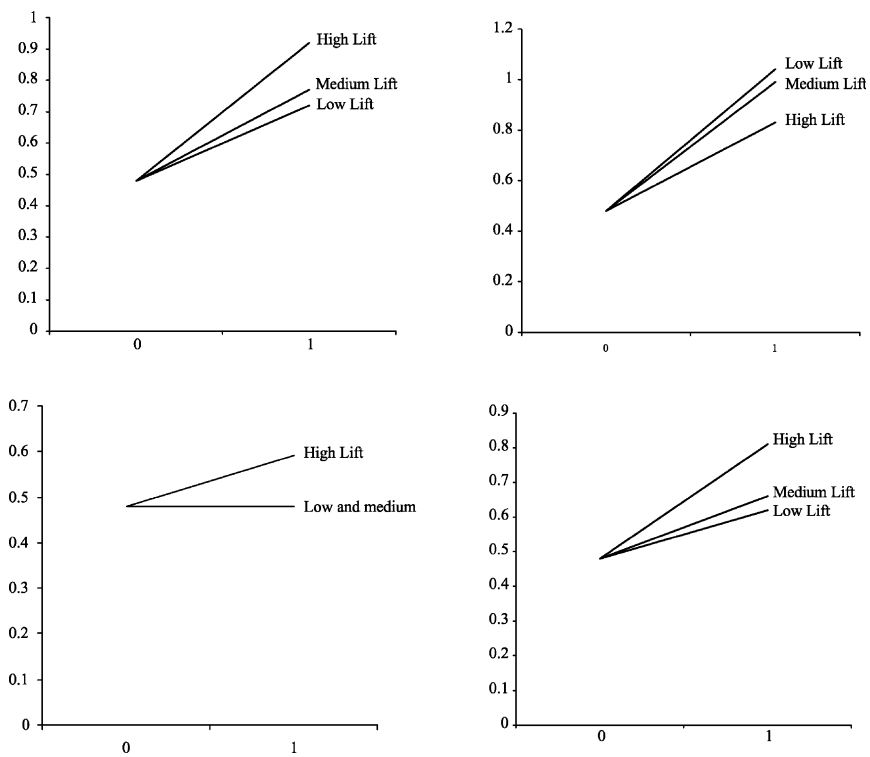

Fig. 1. Cross-effects in different promotional scenarios for weak versus strong complements. (a) Cross-effect Promo1, (b) cross-effects Promo1 and 2, (c) cross-effects of Hidi1, and (d) cross-effects of Hidi1 and Promo2.

For example, aggregated sales of non-promoted items represent, in their studies, the difference between store sales and sales of promoted items. Russell and Petersen (2000) refer to 'cherry picking' behavior, which may explain the absence of an effect of promotions on complementary products. We add that, in our case, cherry pickers, attracted to the store by high discounts, do buy complements but only the strongest product complements, those that are necessary for the main product to be of use (e.g. paint and paint brush).

Moreover, we find evidence that simultaneous promotions of main and complementary products work different for weak versus strong complementary product pairs. Fig. 1b indicates that, given the limited space in promotional leaflets, it is recommended for retailers to feature a main product rather together with its weaker complements in a promotion folder, than with its stronger complements.

At the profit level, similar results were obtained. However, there is one remarkable result that might warn retail managers for thoughtless joint-promotion tactics. The effect of simultaneous promotions (Promo1 and 2) on profits in case of strong complementarity is only just significant at the 10% level. When selecting the maximum lift value (strong complements) as input for the spotlight procedure in Irwin and McClelland (2001), we find that, for the strongest product pairs, joint promotions (Promo1 and 2) significantly ($p < 0.001$) and negatively affect profits of the complement.

The existence of an effect on the purchase quantity of the main product is a prerequisite for finding this effect on the complement. For all main products, we run a general linear model to estimate whether promotions have an effect on the purchase quantity of the main products. We find that this is the case for only nine products. An explanation may be found in Bell et al. (1999), who suggest lower stockpiling intensity in categories with low storability and lower purchase frequency, typically encountered in do-it-yourself stores, and that category specific factors have greater influence on variability in promotional response than do brand-specific factors.

For those main products and their complements, we measure whether this effect on purchase quantity also emerges at the level of the complement. We define the purchase quantity of the complement as the average purchase quantity over all the baskets containing a certain product pair. We conduct the analysis (ANOVA) allowing for different effects for weak and strong complementary product pairs.

The results in Table 4 show that none of the promotion variables have a significant impact on the purchase quantity of the complement. In other words, promotions fail to affect the number of items of a complementary product sold per shopping trip. This means that, for instance, if paint is promoted this will lead a consumer to buy two volumes of paint instead of one (direct effect) but does not make him buy more paint brushes than in the case of no promotions.

Table 4
ANOVA results: effects of promotions on purchase quantity of complement

	Absolute support			
	F	*P*	Eta^2	Sign
Promo1	0.27	0.606	0.000	NS
Promo1 and 2	0.34	0.560	0.000	NS
Hidi1	0.37	0.543	0.000	NS
Hidi1 and Promo2	0.00	0.982	0.000	NS
Promo1 × lift	0.00	0.968	0.000	NS
Promo1 and 2 × lift	0.21	0.645	0.000	NS
Hidi1 × lift	0.00	0.954	0.000	NS
Hidi1 and Promo2 × lift	0.13	0.721	0.000	NS

NS, not significant at 10% level.

H_2 is not confirmed, indicating that the sales and profit increase of complements attributable to retail promotions are, in our case, strictly due to their effect on the number of customers buying the products together. However, care should be taken as even for the cases of joint promotions we do not find an effect, which indicates that the purchase quantity of the complements is even insensitive for own promotions.

5.2. Product level

Whereas the results obtained at the SKU level already give some interesting insights into the complementary effects of price promotions, we decided on performing the same analysis at a somewhat higher level in the product hierarchy. Similar SKU's of the same brand in the same product category are grouped. For instance, SKU codes standing for different colors and different sizes of paint of brand A are considered as belonging to the product 'paint of brand A'. In the remainder, we will call this the 'product level'. The marketing-mix variables at the product level are made operational in the same manner as at the SKU level. For example, if one SKU of paint of brand A is on promotion (or gets a large discount), we say paint of brand A is on promotion (or gets a large discount).

In this part, we take the product level as the basis for analysis to get an additional view on the results reported in Section 5.1 and to show that these results are not an artifact as a result of handling the SKU level.

Almost all of the variables of interest, that are significant at the SKU level (Table 3), appear to be significant at the product level as well (Table 5). The fact that the sign of promotional effects are the same at the SKU (Table 5) compared to the product level (Table 5) yields more support for our findings.

An interesting finding here is that joint promotions (Promo1 and 2) still have an effect on absolute support and profits of the complement, meaning that there is no reason to

Table 5
ANOVA results: cross-effects of retail promotions (product level)

	Absolute support				Profit associated product			
	F	*P*	Eta^2	Sign	*F*	*P*	Eta^2	Sign
Promo1	360.41	<0.0001	0.057	+	28.22	<0.0001	0.007	+
Promo1 and 2	140.50	<0.0001	0.019	+	11.04	0.0009	0.003	+
Hidi1	12.63	0.004	0.002	+	10.11	0.0015	0.002	+
Hidi1 and Promo2	5.60	0.018	0.001	+	0.44	0.5071	0.000	NS
Promo1 × lift	45.96	<0.0001	0.007	+	26.55	<0.0001	0.006	+
Promo1 and 2 × lift	49.99	<0.0001	0.008	−	4.67	0.0307	0.001	−
Hidi1 × lift	21.50	<0.0001	0.004	+	2.67	0.1022	0.001	NS
Hidi1 and Promo2 × lift	26.39	<0.0001	0.005	+	0.73	0.3933	0.000	NS

NS, not significant at 10% level.

believe that consumers all switch to the promoted complementary SKU among all other non-promoted alternatives. But we notice that profits of the complement are no longer significantly affected by Hidi1 and Promo2. This may point to a substitution effect at the level of the complement: cherry pickers attracted by the high discount on the main product, will switch to a promoted SKU in the complementary product group.

5.3. Conclusions

Both at the SKU and product level, we found significant effects of price promotions on sales and profits of complementary products Our study provides clear indications that complementary products better be taken into account when evaluating promotional efforts. Analyzing promotional effects on complementary products at two different levels in the product hierarchy yielded similar results. Additionally, we offer guidelines for devising promotional strategies that take advantage of complementary product relationships within the assortment (Table 6).

Featuring a discounted product in a retail folder does, apart from stimulating its own sales, increase the sales volume of complementary products. This increase gets larger as the strength of the complementary relation rises. We warn for thoughtless execution of joint-promotion strategies as empirical evidence shows that the impact of joint promotions is larger for weaker, though statistically dependent, complementary product pairs. Retailers, wishing to set up an efficient promotion scheme, should therefore take into account the strength of complementary product pairs and work together with the brand manufacturers in order to compose the most profitable promotion folders.

We also show that retail promotions do not influence the purchase quantity of complements. Consequently, their effect on sales and profits of complements is fully attributable to the number of customers buying the products together. However, this should be interpreted carefully as we were working with complements that seem to be insensitive to own promotions.

Finally, we provide evidence that joint promotions do not necessarily stimulate people to buy the promoted complementary SKU among all other alternatives in the complementary product group.

6. Limitations and further research

The focus of our study is to analyze complementary effects of different promotional scenarios for a large number of product pairs. We take the shopping basket as the unit of analysis and make use of association-rule techniques to efficiently discover complementary product pairs from a huge amount of transaction data. We provide clear evidence, at two different levels in the product hierarchy that promotional impact goes well beyond the individual product. Additionally, we propose lift, a measure for

Table 6
Summary: cross-promotional effects on complementary products in different promotional scenarios

		Complement	
		No discount	Discount in leaflet
Main product	Discount in leaflet	The *stronger* the complementary relationship, the *more* impact on sales and profits of the complement	The *weaker* the complementary relationship, the *more* impact on sales and profits of the complement
	High discount in leaflet	*Only* impact on sales and profits of the complement in case of *strong* complements	The *stronger* the complementary relationship, the *more* impact on sales and profits of the complement

the strength of a product association, as a moderating variable in explaining complementary effects of price promotions. We find that price promotions have a higher impact for stronger product pairs. Our results regarding joint-promotion strategies suggest, given the limited space in promotion folders, that featuring a product in a promotion folder with its weaker, though statistically dependent, complements, is a more profitable strategy to pursue than jointly promoting stronger complements.

To place the findings and conclusions in proper perspective, we pinpoint several limitations to our study that may serve as potential directions for further research.

Confronted with the limitations of an observational study, we were obliged to exclude some interesting promotional variables from the analysis. Whereas we acknowledge that, e.g. in-store promotions may work in a different way than do advertised promotions, in-store promotions did not occur during the period of investigation. In addition, store layout, proximity of complementary products, competitors' promotional efforts and other factors affecting shopping behavior were not considered in our study.

In a DIY setting, a strong complementary relationship might reflect the necessity of buying (and consuming) two products together, whereas this might not be the case or to a lesser extent when dealing with FMCG. Joint promotions for a necessary product pair may not be interesting as the products are very likely to be purchased together anyhow. Therefore, the finding that joint promotions have a larger impact for weaker complementary product pairs might be sector specific. Future studies should investigate whether the findings concerning joint promotions and the moderating role of lift still hold in other types of stores, e.g. in a FMCG retail chain.

Whereas we focused on lift as a moderator in explaining the variation in promotional effects across product pairs, the role of other factors, such as storability of a product and impulse buying, can be examined and linked to cross-price elasticities.

We did not consider the potential impact of individual differences in consumer profiles on complementary product purchases. In current retail environments, loyalty cards are widely available (Ziliani, 2000). The additional demographic data could be incorporated in analyzing purchasing patters (Buckinx, Moons, Van den Poel, & Wets, 2004; Buckinx & Van den Poel, 2004). We leave this as an issue for further research.

Price promotions are designed to generate an immediate market response. Dekimpe et al. (1999) showed that, in the long run, sales of a product are not affected by price promotions. However, no research has been done yet on long-run effects of price promotions on co-purchasing complementary products. Consumers, who once bought two products together when simultaneously promoted, may indeed develop this habit and reveal the same purchase behavior during future shopping trips.

Finally, it is not unlikely that, in case of joint promotions, product substitution takes place at the level of the complement. This situation might lead us to overestimate promotional effects on complements. To what extend this holds, might be researched in future studies.

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