Modelling the Effect of Store Flyers on Supermarket Sales: an Application to Olive Oil Demand

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Abstract

In this paper we study the effect of store flyers on supermarket sales while controlling for other promotional strategies. We use a dataset of weekly sales of 16 olive oil products from a Spanish supermarket chain during the year 2017. We estimate a dynamic panel data model by GMM which allows us to examine both the short- and long-run effects of displaying products in store flyers. Our estimates show that products being featured in a store flyer exhibit 85 percent higher sales in the short-run, being the effect in the long-run of 109 percent. We also provide evidence that olive oil is a highly price-elastic product. Our estimates also indicate that placing the products on the end-of-aisle increases olive oil sales. Conversely, multibuy promotions are negatively related with sales.

Keywords: store flyers, promotions, dynamic model, supermarkets, panel data, olive oil

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1. Introduction

The effect of promotions on store performance has been widely studied in the marketing and retailing literature. Among the different promotional communication tools employed by supermarkets for featuring promotions, store flyers are among the most important ones (Luceri et al. 2014)[2]. According to Arnold et al. (2001), retailers spend on average between one third and one half of their marketing budgets on flyer promotions. For the case of Spain, firms spent more than 380 million euros on flyers in 2017 (Infoadex 2018).

Store flyers are mainly used to communicate price discounts. However, there is not much empirical evidence about their impact on sales. Exceptions are the works by Gijsbrechts et al. (2003) and Gázquez-Abad and Martínez-López (2016). While these empirical studies analyse the effect of flyers on store performance in the short-run (promotional bump), their effects in the long-run have not been studied (Prediger et al. 2019). We expect the appearance of a product on the store flyer to have not only a contemporary effect on sales but also a lagged effect on subsequent periods (carryover effect).

Therefore, the purpose of this paper is to analyse the effect of featuring products in store flyers on supermarket sales using a dynamic framework, which allow us to distinguish between short-run and long-run effects. The time dimension of promotions has been an issue of concern in the academic literature without having reached a clear consensus about its short and long run effects. Whereas some scholars have documented the existence of a negative post-promotion effect (e.g. Pauwels et al. 2002), others indicate that promotions increase sales in the long-run (e.g. Ailawadi et al. 2007). Indeed, Boulding et al. (1994) show that the long-run effect of promotions can be either positive or negative. We aim to provide new evidence on this issue.

Since store flyers are not the only promotional strategy used by supermarkets, our analysis also controls for four other promotional tools: price-discounts, coupons, multi-buy and end-of-aisle promotions. Our database comes from a large supermarket chain which provided us data about weekly aggregate sales for 16 products in the olive oil category during the year 2017. As current sales depend on past sales and promotions, we employ a partial adjustment model which is estimated using the Generalized Method of Moments.

Our results reveal that, on average, olive oil products that are featured in the store flyer increase their sales by 85 percent in the same week, being the cumulative effect in the long-run of 109 percent. As expected, we find that this positive effect decreases as the product is featured during several weeks and that flyers lead to brand-switching between

[2] We refer to free disposal printed catalogues in which products with temporary price discounts are featured. Store flyers are also referred to as catalogues, brochures, leaflets or free sheets (Gázquez-Abad and Martínez-López 2016).

products with the same characteristics. Our results also indicate that placing the products on the end-of-aisle increases olive oil sales. Conversely, multibuy promotions are negatively related with sales. We also provide evidence that olive oil products are highly price-elastic. A one percent increase in current price is associated with a 2.6 percent drop in sales.

The remainder of the paper is structured as follows. Section 2 reviews the related literature. Section 3 describes the database and provides some descriptive statistics. Section 4 presents the empirical model. Section 5 reports the estimation results and discusses its implications. Finally, Section 6 summarizes the findings and concludes.

2. Literature Review

The literature that studies the effects of promotions on store performance basically differ in the measure of performance used. While some scholars consider absolute incremental sales (Ailawadi et al. 2006), others focus on loyalty (Gedenk and Neslin 1999), store-traffic (Luceri et al. 2014) or store-choice (Volle 2001). Three stylized facts are found: i) the use of promotional advertising significantly increases sales (Kumar and Leone, 1988), ii) promotions of branded items and in categories with high frequency and penetration are more effective (Gauri et al. 2017), and iii) the existence of great heterogeneity in consumer response to promotional deals (Ailawadi et al. 2001)[3].

Among the different promotional strategies, coupons have been the most widely studied by academics (e.g. Venkatesan and Farris 2012; Osuna et al. 2016). Other scholars have examined the effectiveness of end-of-aisles (Garrido-Morgado and González-Benito 2015) as well as endcaps (Tan et al. 2018). However, the literature about the effects of store flyers is rather thin. The existing empirical studies can be decomposed into two different categories depending on whether the unit of analysis is the consumer or the store.

The effect of store flyers at the consumer level

One strand of literature has focused on the effect of store flyers on brand choice. Gázquez-Abad and Sánchez-Pérez (2009a, 2009b) analyse the effect of being featured in a store flyer on consumer's olive oil brand choice. Their results show that when a brand is advertised in a flyer the probability that consumers choose that brand is higher. Similarly, Ward et al. (2003) examine the effect of promotions in magazines, newspapers and periodicals on olive oil choice in Germany. Their findings point to the important role of promotions for enhancing Spanish olive oil sales.

[3] Traditionally, brand switching was considered to be the main effect of sales promotions (Gupta 1988). However, empirical research has documented that sales promotions also induce consumers to stockpile (Erdem et al. 2003), accelerate their purchases (Neslin et al. 1985) or store-switch (Kim and Kim 2017).

Other researchers have looked at how flyers affect purchased quantities. For example, Burton et al. (1999) show that both the number of products and total expenditure increased by more than 100% when they appeared in flyers. In their analysis, they measure the effect of flyers by means of consumers' self-report of having read the flyer or not.

Gázquez-Abad and Martínez-López (2016) go a step beyond and studied how consumers are influenced by store flyers in terms of purchase incidence, brand choice and purchase quantities. Using a sample of Spanish consumers and two product categories (olive oil and coffee), they show that store flyers mainly induce consumers to brand switch, but they do not significantly increase the quantities purchased.

Apart from its direct effect on featured products, store flyers can also affect consumer's purchasing decision of unadvertised products by influencing their intention to visit the store and buy (Burton et al. 1999). Chaabane et al. (2010) find that store flyers improve consumers' perceptions about the retailer's assortment and exert a positive effect on the intention to visit the store and buy. In the same way, Volle (2001) indicates that the number of promoted products in a flyer increases store choice probability. Van Lin and Gijsbrechts (2016) provide evidence that supermarkets take more advantage of flyers than other type of stores. As supermarkets are visited more often, price cuts and flyers exert a great impact and increase sales for both promoted and non-promoted products. Therefore, store flyers do not only act as a way of promoting products with a temporary price discount. They also allow retailers to inform consumers about their product assortment, which in turn can have important long-run effects on product sales even when they go back to their regular prices.

As indicated earlier, a stylized fact in the retailing literature is the existence of consumer heterogeneity. In this sense, it seems that whereas a large share of consumers can be influenced by promotions, others display a high brand loyalty and buy the same products independently of promotions (e.g. Laroche et al. 2001). Therefore, the effectiveness of store flyers for enhancing demand crucially depend on the so-called 'consumer's proneness' to promotions, defined as the degree to which consumers look for paying lower prices (Jensen et al. 2014). Apart from the utilitarian benefit of saving money, promotions also provide consumers hedonic benefits such as narrowing the pain of paying and having access to higher-quality brands that might not be bought at its normal price (DelVecchio 2005; Gázquez-Abad and Sánchez-Pérez 2009b)[4].

Gázquez-Abad et al. (2014) examine the differences between highly prone and less prone consumers to store flyers. They find that the flyer-prone consumer profile is quite different. Store flyer proneness is positively associated with deal involvement, which

[4] In this sense, Chandon et al. (2000) indicate that price-based promotions involve utilitarian benefits whereas non-price promotions are the ones which produce hedonic benefits.

implies that flyers are especially relevant for consumers who are willing to spend time searching for promotional information. In this sense, elderly people seem to be the ones who pay more attention to store flyers. Jensen et al. (2014) study consumers' attitudes toward flyers using a sample of both passive recipients and active decliners of flyers in Denmark. Their results show that apart from gathering information about price deals, a large share of consumers also read flyers for entertainment.

Gázquez-Abad and Sánchez-Pérez (2009c) explore consumers' deal-proneness to both monetary and non-monetary promotions. Their econometric framework allows them to classify consumers in different segments depending on their response to promotions. Three types of consumers are identified: loyal consumers, deal-seekers and preferred-brand seekers. Both loyal consumers and switching ones are strongly influenced by brand presence in store flyers. The first ones look for price deals in the preferred brands; the second ones search for special discounts in any brand. Schmidt and Bjerre (2003) study consumers' attitude towards flyers, finding three segments of consumers: flyer-prone, moderately flyer-prone and flyer-sceptic. Martínez and Montaner (2006) relate flyers-proneness to consumers' psychographic variables, finding that consumers who make use of store flyers are price conscious and plan their shopping trips ahead. Urbany et al. (2000) provide evidence that 77 per cent of single-store shoppers read flyers whereas this share rises to 89 percent for multi-store shoppers.

Pechlt (2004) argues that flyer-prone consumers are the ones who are willing to invest time and effort in checking whether the price for a product is lower than the previous week in order to take advantage of that. Walters and Jamil (2003) indicate that consumers who are sensitive to price are more willing to invest time and effort searching for promotions. Because of this, the synergistic effect of simultaneous price reductions and the use of flyers is an issue of great interest for retailers.

Lemon and Nowlis (2002) and Gázquez-Abad and Sánchez-Pérez (2009c) have shown that the joint use of promotional advertising and price cuts significantly increase store sales. Miranda and Konya (2007) study whether or not consumers purchase products due to the fact of being featured in flyers. Their findings show that highly price-sensitive consumers have the higher likelihood of reading flyers before visiting the store.

The effect of store flyers at the store level

Another way to analyse the effects of store flyers on store performance is at the store level. Luceri et al. (2014) examine the impact of flyers on store traffic and sales considering two different formats: hypermarket and supermarket. They find that flyer duration positively affects store sales from loyal customers in supermarkets and occasional buyers in hypermarkets. However, it does not affect store traffic, either in supermarkets or in hypermarkets. Gijsbrechts et al. (2003) study how changes in flyer composition affect store traffic and sales. They consider store-specific variables such as

the socio-demographic profile of the trading area and the level of competition with other stores. Their findings indicate that the discount size, the share of in-flyer space allocated to food items, the type of category featured on the cover page and the number of pages are positively associated with store traffic and sales.

While most of the existing literature about the effect of promotions on sales focuses on the short-run, Freo (2005) is one of the few papers that analyses the impact of sales promotions both in the short- and in the long-run. Her findings show that repeated promotions in perishable categories negatively affect sales in the long-run. Promotions thus mainly affect short-term sales, encouraging consumers to conduct non-planned shopping trips.

3. Database

Our database comes from a Spanish supermarket chain. We have information on weekly sales and the corresponding prices for 16 olive oil products during 2017 (52 weeks). Olive oil is obtained from the fruit of the olive tree. We have chosen the olive oil category because it constitutes an important product in Mediterranean societies in which consumers spend a large share of their budget. The olive oil category has been subject of analysis by Ward et al. (2003), Aprile et al. (2012) and Gázquez-Abad and Martínez-López (2016), among others. Among the different types of olive oil we only consider two types in our analysis: i) Extra Virgin, which constitutes the variety with the lowest acidity and the highest quality, and ii) olive oil that is composed of refined olive oils and virgin olive oils (hereafter labelled as Mixed Olive Oil)[5].

The weekly sales per product (aggregated over all stores) are 2,380 euros. As stores are located in different towns, differences in sales over time can be partially due to the different number of stores open in each period. Therefore, we divide the weekly sales per product by the number of store-days (i.e. the number of days that all the chain stores were open in each week). As a result, sales of product i at week t are expressed in euros per day and supermarket. Prices are weekly mean values. Given that products have different sizes, prices are expressed in euros/litre in order to make them comparable.

We also have information about all the promotional strategies that took place during the study period. The supermarket chain conducts five different promotions, which in some periods may take place simultaneously. They are:

- Price discount: it is a reduction of the normal price during a limited period of time. The supermarket chain conducts a high-low (HILO) price strategy so that after the temporary cuts, prices go back to their normal level.

[5] According to the Article 3 of the EU Regulation on marketing standards for olive oil (nº 29/2013 of 13 January 2012), what we label the Mixed Olive Oil category gathers products that are a mixture of refined olive oil and virgin olive oil (Art. 3 (c)) whereas the Extra Virgin Olive Oil group refers to "a superior category of olive oil obtained directly from olives and solely by mechanical means" (Art 3. (a)).

- Store flyer: flyers are normally handed out at the store (i.e. kept at specific points available for being taken) or sent to households (mass mailing).
- Coupons: it is a type of promotion that offers customer-specific discounts that range from 15% to 25% on specific items. It is only delivered to those clients who have a loyalty card and use it at the cash register upon checkout. Coupons can be redeemed in future purchases for a specific period of time (usually 2 weeks) after which they expire.
- End-of-aisle: this refers to products being displayed in the front part of the shelves with the purpose of drawing customers' attention.
- Multi-buy promotions: this promotion offers discounts for bulk purchase (a common example is the typical Buy-One-Get-One-Free deal). With this type of deal, the price per unit is lower.

We define five dummy variables that take value 1 if product i (i=1,…,16) was on a specific promotion on week t (t=1,…52) and 0 otherwise (denoted as *d_discount*, *d_flyer*, *d_coupon*, *d_endaisle* and *d_multibuy*). The data we analyse comes from a supermarket chain that only features in the store flyer those products that are on sale at a certain price discount. However, not all the products with a price discount appear in the flyer. Therefore, we define the variable *d_discount* as a dummy that takes value 1 when product i is on a price discount on on week t but it does not appear in the store flyer on that week t[6].

As we have information about prices, sales and promotional campaigns for 16 products during 52 weeks, our dataset has a panel structure and comprises 832 observations (52x16). We also have information on some time-invariant characteristics of the products, such as the specific type of olive oil (distinguishing between *mixed* olive oil and extra virgin olive oil), bottle size (small, normal or large) and brand (*Carbonell*, *Elosua*, *Giralda*, *Alteza* and *Hojiblanca*). Table 1 provides complete definitions and descriptive statistics for all the variables considered in the study.

[6] For a product to appear in a store flyer it is compulsory to have a temporary price cut, but not all the products with a price reduction appear in the store flyer. Therefore, we analyse the net effect of the store flyer once having controlled for the fact that the product is on discount.

Variable	Definition	Mean	SD	Min	Max
Sales	Sales per supermarket and day (euros)	7.758	8.546	0.308	50.16
Price	Price (euros/litre)	5.105	1.135	3.417	8.510
d_discount	Product has a price discount and it is not in the store flyer	0.161	0.367	0	1
d_flyer	Product has a price discount and appears in the store flyer.	0.126	0.332	0	1
d_coupon	Product is part of a coupon-based promotion	0.068	0.252	0	1
d_multibuy	Product is on a multi-buy promotion	0.039	0.195	0	1
d_endaisle	Product is placed at the end-of-aisle	0.144	0.351	0	1
d_mixed	Mixed olive oil product	0.5	0.5	0	1
d_extra_virgin	Extra Virgin olive oil product	0.5	0.5	0	1
d_size_small	Size: less than one litre	0.25	0.433	0	1
d_size_normal	Size: one litre	0.625	0.484	0	1
d_size_large	Size: two or three litres	0.125	0.330	0	1
d_Carbonell	Carbonell brand	0.562	0.496	0	1
d_Elosua	Elosua brand	0.125	0.330	0	1
d_Giralda	Giralda brand	0.062	0.242	0	1
d_Alteza	Alteza brand	0.187	0.390	0	1
d_Hojiblanca	Hojiblanca brand	0.062	0.242	0	1

Table 1.- Descriptive statistics (N=832).

Table 2 presents the 16 products considered in this study and some of their characteristics, such as bottle size, average price per litre and the number of weeks they appeared in the store flyer over our study period. We distinguish there between Extra Virgin Olive Oil products and Mixed Olive Oil products (those that combine olive oils that have undergone refining and oils obtained directly from olives). Information about average sales per product when the product appears in the store flyer and when it does not is also provided.

Several points can be highlighted from Table 2. First, it appears that the *Mixed* subcategory has been more promotion-intense in terms of appearance in store flyers than the *Extra Virgin* subcategory. Second, the appearance in the store flyer seems to be positively related with sales, since with the exception of *Extra Elosua*, the remaining 15 products show higher sales when featured in the store flyer in comparison to the periods when they were not. However, the 67% average increase in sales shown in Table 2 does not take into account the simultaneity with other type of promotions. To properly isolate the effect of store flyers on sales we rely on econometric analysis. The following section outlines our theoretical framework and the empirical model to be estimated.

Product type	Product	Size (litres)	Price (€/litre)	Weeks in store flyer	Sales per sup. and day (€)	Sales when d_flyer=1 (€)	Sales when d_flyer=0 (€)	Difference in sales (€)	Difference in sales (%)
Mixed Olive Oil	*Carbonell Suave*	1	4.69	14	19.65	24.14	18.00	6.13	31 %
	Elosua Suave	1	4.19	7	10.68	17.02	9.69	7.32	69 %
	Alteza Suave	1	3.88	5	33.38	38.76	32.80	5,96	18 %
	Alteza Intenso	1	3.89	3	6.02	8.26	5.88	2,37	39 %
	Giralda Suave	1	4.64	11	7.78	9.58	7.30	2,28	29 %
	Carbonell	3	4.82	2	5.18	9.30	5.02	4,27	82 %
	Carbonell Intenso	1	4.70	14	5.73	7.63	5.03	2,60	45 %
	Suave Carbonell	2	4.75	9	6.17	9.63	5.45	4,18	68 %
Extra Virgin Olive Oil	*Extra Carbonell*	0.75	6.47	10	4.52	5.02	4.40	0,62	14 %
	Extra Elosua	1	4.53	2	3.06	11.92	2.71	-1,52	-50 %
	Arbequina Carbonell	0.75	7.53	4	0.78	1.09	0.76	0,32	42 %
	Extra Carbonell	1	5.06	7	6.87	10.27	6.34	3,93	57 %
	Carbonell	1	4.74	7	3.76	11.59	2.55	9,04	240 %
	Extra Alteza	0.75	5.05	2	3.89	7.05	3.76	3,28	84 %
	Extra Hojiblanca	1	5.15	4	5.95	11.71	5.47	6,23	105 %
	Picual Carbonell	0.75	7.50	4	0.62	0.80	0.61	0,19	3 %
	Sample average			5.10	7.75	12.27	7.10	5,17	67 %

Table 2.- Descriptive statistics of the products

4. Empirical Model

Neoclassical consumer theory is static in nature, implying an instantaneous adjustment of consumers to new equilibrium values when prices or income change. However, in many situations, consumers can only adjust gradually to those changes due for example to the durability of the goods or to the existence of habits induced by past consumption (Pollak 1970). For this reason, our empirical strategy is based on a partial adjustment model.

a) The Partial Adjustment Model

This framework, originally developed by Nerlove (1958) assumes that each consumer has a desired level of quantity of product i. Aggregating over all consumers, this implies that at the supermarket level there is a long-run equilibrium aggregate sales of product i on week t (S_{it}*). Due to difficulties to adjust instantaneously, changes in actual sales are only a fraction of the difference between the desired level and the previous level. That is:

$$\frac{S_{it}}{S_{it-1}} = \left(\frac{S_{it}^{*}}{S_{it-1}}\right)^{\gamma} \tag{1}$$

where γ is a coefficient that reflects the speed of adjustment by consumers and must lie between 0 and 1. When $\gamma = 1$ the adjustment is complete since $S_{it}=S_{it}$*. When $\gamma = 0$ there is no adjustment ($S_{it}=S_{it-1}$). In this type of models, it is customary to assume that γ is constant across products and over time[7].

The desired level of sales of product i at week t by consumers is supposed to be a function of the logarithm of prices, promotional campaigns and some product-specific characteristics, so that:

$$S_{it}^{*} = \exp(\tilde{\alpha}_i + \tilde{\beta} \ln P_{it} + \tilde{\omega}\, d\_flyer_{it} + \sum_{k=1}^{K} \widetilde{\lambda_k} Z_{k\,it}) \tag{2}$$

where P_{it} is the price per litre, *d_flyer* is a dummy variable for whether product i is on the flyer at week t and Z is a vector of control variables.

Taking logs in (1) and (2), and after some arrangements, we get:

$$\ln S_{it} = \gamma\tilde{\alpha}_i + (1-\gamma)\ln S_{it-1} + \gamma\tilde{\beta} \ln P_{it} + \gamma\tilde{\omega}\, d\_flyer_{it} + \sum_{k=1}^{K} \gamma\widetilde{\lambda_k} Z_{k\,it} \tag{3}$$

[7] While the usual expression of the partial adjustment model is $S_{it} - S_{it-1} = \gamma\,(S_{it}^{*} - S_{it-1})$, it must be noted that it is equivalent to equation (1). We write the model in ratios since it is convenient for taking logs in the empirical implementation.

b) The empirical model

In the final model to be estimated, we augment equation (3) with three types of variables:

- The number of weeks product i is featured in the store flyer. In our sample, the same product can remain in the flyer up to four consecutive weeks. We expect the effect of the flyer on sales to decrease as the product is being featured during more weeks. To control for this, we define the variable *weeks_flyer* as a count for the number of consecutive weeks that a product has appeared in the store flyer.
- The number of competitors that are in the flyer. As argued in Section 2, promotions may lead to brand-switching, especially between products with similar characteristics. With the purpose of addressing this issue, we construct the variable *flyer_compet*, which indicates the number of products with the same characteristics that are featured in the flyer at each period[8]. Under brand-switching, we expect this variable to be negatively associated with sales.
- Time effects. We include weekly dummy variables in order to control for possible week-specific unobserved events.

Therefore, the final model to be estimated is the following:

$$\ln S_{it} = \alpha_i + \eta \ln S_{it-1} + \beta \ln P_{it} + \omega_0 d\_flyer_{it} + \omega_1 weeks\_flyer_{it} + \omega_2 flyer\_compet_{it} + \sum_{k=1}^{K} \delta_k Z_{1itk} + \sum_{m=1}^{M} \lambda_m Z_{2im} + \theta_t + \varepsilon_{it} \quad (4)$$

where Z_1 is a vector of dummy variables for the four other types of promotions (*d_discount*, *d_coupon*, *d_multibuy*, *d_endaisle)* and Z_2 is a vector of time-invariant product-specific dummy variables for type of oil, bottle size and brand (*d_mixed*, *d_size_small*, *s_size_large*, *d_carbonell*, *d_alteza*, *d_hojiblanca*, *d_giralda*)[9], θ_t are weekly time effects, and ε_{it} is a random error term.

In the short-run, the percent change in sales when price increases by one percent is given by the parameter β. In the long-run, the sales elasticity will be given by $\frac{\beta}{\gamma}$, where γ equals $1 - \eta$. The parameter η measures the existence of an inertia by which current sales depend on past sales. For the store flyer dummy variable, as our model is log-linear, its short-run marginal effect will be given by the following expression (see Halvorsen and Palmquist 1980):

[8] We grouped the 16 products into 4 categories based on the bottle size and the type of oil. The 4 groups were: i) 1 litre-container Mixed Olive Oil (6 products), ii) 1 litre-container Extra Virgin Olive Oil (4 products), less-than-a-litre Extra Virgin Olive Oil (4 products) and 2-3-litre Mixed Olive Oil (2 products).
[9] *d_extra_virgin*, *d_size_normal* and *d_elosua* act as the reference categories.

$$\frac{S_{it}(d\_flyer_{it}=1)-S_{it}(d\_flyer_{it}=0)}{S_{it}(\,d\_flyer_{it}=0)} = exp(\omega_0) - 1 \quad (5)$$

In the long-run, the long-run effect of being on the store flyer is equal to:

$$\frac{S^*_{it}(\,d\_flyer_{it}=1)-S^*_{it}(\,d\_flyer_{it}=0)}{S^*_{it}(\,d\_flyer_{it}=0)} = exp\left(\frac{w_0}{1-\eta}\right) - 1 \quad (6)$$

The marginal effects for the other promotional dummy variables in the short and long run are derived analogously to (5) and (6).

5. Estimation Results

Before estimating the dynamic model in equation (4), we first estimate a static version in which we do not consider the lag of the dependent variable, so that $\eta = 0$ (i.e., $\gamma=1$). This estimation will provide a benchmark with which we can compare the dynamic model.

5.1 *Static model*

We start estimating a static fixed effects model (henceforth FE) by Ordinary Least Squares (OLS). In doing so, we take into account the panel structure of our database and control for time-invariant unobserved heterogeneity. This FE model is estimated without any of the product-specific characteristics, as any time-invariant covariate is embodied in the individual effect. To explore the role of these observable product characteristics in explaining sales, we also estimate a pooled model (henceforth Pooled) by OLS. In this Pooled model we consider the size of the bottle as well as the type of oil and the oil brand. Table 3 shows the parameter estimates of both the Pooled and the FE models in the first and second column, respectively.

As expected, the price coefficient is negative and statistically significant in the two specifications. Given our double logarithmic specification, the price parameter represents the price elasticity of sales. In the FE model, a one percent increase in the current price leads to an almost 3.4 percent decrease in aggregate sales. This implies a price elasticity of demand of -4.4, indicating that olive oil is a product with a high demand elasticity[10].

The parameter estimate of the *d_flyer* variable is positive and statistically significant in the two models. This means that being in the store flyer on week t has a contemporaneous positive effect on sales. However, the effect of the number of weeks in the flyer on sales is negative in the FE model. Interestingly, the number of products

[10] $\frac{\partial \ln Sales}{\partial \ln Price} = \frac{\partial \ln Quantity}{\partial \ln Price} + \frac{\partial \ln Price}{\partial \ln Price}$; $\frac{\partial \ln Quantity}{\partial \ln Price} = \frac{\partial \ln Sales}{\partial \ln Price} - 1$

with the same characteristics that are on the flyer at each period is also negatively related with sales.

	FE	Pooled	Arellano-Bond
Ln S_{t-1}			0.169***
			(0.021)
Ln $price_t$	-3.381***	-4.866***	-2.604***
	(0.203)	(0.333)	(0.169)
d_flyer	0.539***	0.523***	0.616***
	(0.045)	(0.097)	(0.034)
weeks_flyer	-0.075***	-0.058	-0.135***
	(0.027)	(0.060)	(0.022)
flyer_compet	-0.026*	-0.023	-0.024**
	(0.015)	(0.033)	(0.011)
d_discount	0.354***	0.440***	0.403***
	(0.032)	(0.068)	(0.026)
d_coupon	-0.076	0.025	-0.014
	(0.048)	(0.104)	(0.036)
d_multibuy	-0.131**	-0.365***	-0.142***
	(0.057)	(0.124)	(0.043)
d_endaisle	0.232***	0.254***	0.130***
	(0.037)	(0.077)	(0.030)
d_mixed		0.631***	
		(0.064)	
d_size_small		0.706***	
		(0.129)	
d_size_large		-0.321***	
		(0.078)	
d_Carbonell		0.626***	
		(0.080)	
d_Alteza		0.215**	
		(0.090)	
d_Hojiblanca		1.062***	
		(0.117)	
d_Giralda		0.067	
		(0.105)	
Constant	6.521***	7.837***	
	(0.317)	(0.491)	
Week effects	YES	YES	YES
Observations	832	832	800
R-squared	0.682	0.752	0.789

Table 3: Estimation results
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Regarding the other promotional strategies, price discounts have a significant and positive effect on sales. Conversely, multi-buy promotions have a negative effect on sales, which at first glance can seem counterintuitive. The explanation for this finding is that as our dependent variable is the logarithm of sales (measured in monetary terms), under a multi-buy promotion sales decrease since consumers can get some units for free.

Hence, the value of sales is lower when the product is on a multi-buy promotion, conditional on prices. In addition, the presence of the product in the end-of-aisle is positively associated with sales. Finally, coupons are not significant.

As for the effect of the time-invariant observable product characteristics, the estimation results of the Pooled model indicate that the aggregate sales of products pertaining to the *Mixed* group are higher than the ones in the *Extra Virgin* group. *Hojiblanca* brand seems to be the most preferred by consumers, followed by *Carbonell* and *Alteza* (compared to *Elosua*, which acts as the reference category). Furthermore, sales of olive oil products in less than one litre containers are higher than the corresponding ones for products in one-litre containers.

The two regressions include weekly dummies to control for possible time effects. They are not displayed for the sake of space but are available from the authors upon request.

5.2 *Dynamic model*

We now turn to the estimation of the dynamic specification presented in (4). By construction, unobserved individual effects (a_i) are correlated with the lagged dependent variable, making standard OLS estimators both biased and inconsistent. Accordingly, we estimate equation (4) using the GMM procedure developed by Arellano and Bond (1991). This procedure firstly removes the individual effects by first-differencing and then constructs an instrument matrix using lags of the dependent and explanatory variables as instruments. The third column in Table 3 reports the estimation results from this dynamic panel data specification with unobserved heterogeneity.

The first lag of sales is positive and statistically significant, suggesting the existence of a carryover effect in the aggregate sales of olive oil, thus confirming our prior beliefs about the dynamic nature of the process. Given that $\gamma=(1-\eta)$, the speed of adjustment to the long-run equilibrium is 1-0.169=0.831. According to this estimate, it seems that consumers adjust relatively fast to the long-run equilibrium. Furthermore, the impact of the explanatory variables is not just contemporaneous but carries over time by multiplying the short-run marginal effect by 1.2=1/0.831.

The price variable is once again negative and statistically significant. A one-percent increase in price leads to a 2.6 percent decrease in aggregate sales, which implies that the price elasticity of demand under the dynamic framework is -3.6. In the long-run, a one-percent price increase would translate into a 3.1 percent (-2.6x1.2) decrease in sales. This means that the price elasticity of sales is higher in the long-run than in the short run. This result can be explained by the fact that under a HILO price strategy, consumers might hold expectations of future price deals, which make them become more price sensitive (Mela et al. 1997). Accordingly, this shift in the price elasticity (which is given by the estimated speed of adjustment γ) is likely to be gradual.

The appearance of the product in the store flyer has a positive and significant impact on sales. Everything else being equal, sales are *on average* 85 percent higher on the week the product is featured in the store flyer [(exp(0.616)–1)x100]. However, the negative sign of the estimated parameter for *weeks_flyer* indicates that the positive effect of the flyer is attenuated as the product is featured repeatedly. To be more specific, our results show that, a unitary increase in the number of weeks in the flyer reduces its effect on sales by 13.5 percent. As for the store-flyer long-run effect, the carryover effect on sales is 109 percent [(exp(0.616/0.831)–1)x100]. This result suggests that flyers do not only exert a contemporaneous effect but also play a significant role at increasing long-run sales.

The variable that captures the degree of substitutability between brands (*flyer_comp*) is negative. This result might suggest that flyers lead to brand-switching between products with similar characteristics, as previously documented in the marketing literature (Gázquez-Abad and Sánchez-Pérez 2009a, 2009b; Gázquez-Abad and Martínez-López 2016). Given preferences for certain type of products, consumers appear to brand-switch when a similar product is being featured in the flyer.

Again, multi-buy promotions are negatively associated with sales. Everything else being equal, sales are 15.2 percent lower under multi-buy promotions ([exp(-0.142)-1]x100). Additionally, being at the end-of-aisle has a positive and significant effect on sales, in line with the results of Garrido-Morgado and González-Benito (2015). More specifically, the end-of-aisle rises sales by 13.8 percent ([exp(0.13)-1]x100). Conversely, targeted coupons are not significant for explaining sales. Although this result seems to contradict previous evidence about the positive effect of coupons (Venkatesan and Farris 2012), it is important to bear in mind that the effectiveness of promotional strategies varies depending on the product category being analysed. Our empirical results thus suggest that coupons are not significant for increasing sales in the olive oil category once having controlled for prices and flyer appearance.

In terms of model fit, the R-squared in the dynamic panel data model (0.78) is larger than in the corresponding one in the FE model (0.68).

Two final remarks need to be stated at this point. Firstly, the standard Arellano-Bond estimation procedure assumes that there is no correlation in the idiosyncratic errors. To check this, we implemented the Arellano-Bond test for first, second and third order autocorrelation in the first-differenced errors. The test statistic clearly rejects the null of zero correlation in both the first (z=–8.63, p-value=0.00) and the second differences (z=–4.37, p-value=0.00) and rejects it for the third differences (z=0.08, p-value=0.93). According to this test, second-order serial correlation in differenced errors implies that the idiosyncratic errors are first-order serially correlated (i.e. ε_{it}~ MA(1)). Hence, the standard moment conditions are not valid. Because of this, the estimates of the

Arellano-Bond model in Table 3 have been obtained only considering lags of order three or higher as instruments for the level equation[11].

Secondly, moment conditions derived by Arellano-Bond for the estimation of the dynamic panel data model are based on the assumption of strict exogeneity. Explanatory variables are strictly exogenous if $E[X_{it}\ \varepsilon_{is})]=0$ for all t and s. Note that this assumption seems to be quite restrictive, as it implies that covariates are independent of the random shocks at any period of time. For the price variable in logs (ln p), we believe this assumption is not valid as prices might change according to past shocks (i.e. the error terms at period t have some feedback on future values of the prices). If $E[\ln p_{it}\ \varepsilon_{is})]=0$ only for $s\geq t$ and therefore $E[\ln p_{it}\ \varepsilon_{is})]\neq 0$ for $s<t$, then $ln\ p_{it}$ is said to be a predetermined variable. Our Arellano-Bond estimates treat *ln p* as predetermined instead of strictly exogenous.

6. Conclusions

In this study, we have examined the effect of store flyers on sales while controlling for prices and other promotional strategies. We have not only examined the contemporaneous effect of products being featured in store flyers on supermarket sales but also how this effect depends on whether it is the first week the product is on promotion or not. We have proposed a partial adjustment model that incorporates the existence of some inertia in consumption by means of a lag of the dependent variable.

Using a dataset that comprises information about prices, sales and different promotion strategies for 16 products in the olive oil category for 52 weeks, we have estimated a dynamic panel data model and compared the results with the ones obtained from a static one.

Overall, our results point to a positive and significant effect of appearing in store flyers on contemporaneous aggregate sales. Everything else being equal, olive oil sales are 85 percent higher when the product is featured in the flyer. In the long-run, this effect translates into a 109 percent increase. However, this positive effect decreases when the product is promoted in the flyer repeatedly. The price elasticity of sales is -2.6 in the short-run but -3.1 percent in the long-run. Therefore, price changes do not only affect current sales but have a significant effect in the long-run. This finding can be attributed to the fact that in the short-run consumers have less scope for adjusting their purchase decisions to price changes due to the existence of habits and inertia. However, in the long-run they have more possibilities to change their consumption patterns. Accordingly, their price elasticity in the long-run is higher.

[11] The estimates have been conducted in Stata14 using the *xtdpd* command.

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