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Do preferences for private labels respond to supermarket loyalty programs?

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Abstract

This paper examines the effects of supermarket loyalty programs on the demand for private labels (PLs). Using transaction level data on grocery purchases and individual level information on the membership of loyalty programs, I estimate a model of demand in which membership may affect the consumers' valuation for PLs, their sensitivity to price changes and have spillover effects on both named brands (NBs) and rivals' PLs. My identification strategy of the membership effect exploits observed variation in shopping patterns at the consumer level over time and across customer types (i.e., members and non-members) in each period to control for as much exogenous variation as possible, and includes a control function using characteristics of loyalty programs as instrumental variables to account for a potential selection bias related to unobserved factors of the membership decision. I find a significant effect of loyalty programs on consumer preferences for PLs. Compared to non-members, membership reduces consumers' price sensitivity for the products sold by the supermarket they are members of, but increases it for products sold by supermarkets they are not members of. These effects are weaker for households that are members of the loyalty programs of multiple supermarkets. Counterfactual simulations show that when a supermarket modifies its loyalty program while competitors keep their own unchanged, it loses about 19% of customers to its rivals, on average. Furthermore, if loyalty programs were changed altogether, the demand for PLs would considerably decrease, while the demand for NBs would increase.

Keywords: Supermarket chains, loyalty programs, private labels, discrete choice, random coefficients.

JEL Codes: D12, L13, L66.

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1 Introduction

Supermarkets have long used private labels (PLs) and loyalty programs (LPs) to attract new customers, induce repurchase and increase store loyalty. In recent years, they have focused more on a bigger challenge, namely, how to discourage customers from shopping at multiple stores. Efforts include the proliferation of superstores with huge floor areas, the supply of a larger product range, and joint locations with suppliers offering parallel services (e.g., shopping malls, beauty salons, restaurants, car wash facilities, gas stations, and playgrounds for children). Recently, the emphasis has been placed on improving and expanding PLs[1] and the redesign of loyalty programs.[2] There are cases in which supermarkets combine the two strategies by offering loyalty rewards (almost) exclusively on PLs' purchases. This is the case for most supermarket chains in France, where customer rebates range from 5% to 10% on the value of the purchase of most PLs.[3] Recently, Hannaford, a supermarket chain that operates in Northeastern United States, relaunched its rewards program (so-called *My Hannaford rewards*) as one that rewards customers with a 2% rebate on PL purchases.

Why do retailers give rebates on their lower-price own-brands rather than on the whole range of products they sell? Given that PLs are exclusive products to the supermarket that owns them, focusing frequent shopper programs on PLs appears to be a way to increase the attractiveness of PLs, reinforce consumer feelings of differentiation across products and stores, and more effectively increase store loyalty. The contribution of this paper is to empirically examine the effects of supermarket loyalty programs on the demand for PLs and consumer shopping behavior, by analyzing the case of supermarkets in France.

Private labels have evolved from cheap alternatives to named brands (NBs), to products that can match NBs in terms of quality; yet they are supplied at lower prices.[4] Because of this, PLs have increased market share steadily during the last decade, attaining important levels in 2016: 17.7% in

[1] In a recent report, Nielsen (2018) states that PLs are at the center of a "new retail revolution" and that supermarkets aim to make PLs a good value for a good price, introducing innovative and premium PLs, allocating more shelf space to them, and focusing on fresh foods instead of packaged goods.

[2] In the United Kingdom, for instance, some of the largest supermarket chains (e.g., Tesco, Sainsbury's and Waitrose) have recently revised their loyalty programs in order to, among other things, discourage customers from shopping at discounters Aldi and Lidl. Sainsbury's' program, for example, now rewards repeat purchases rather than expenditures. See: https://www.telegraph.co.uk/news/2018/04/05/sainsburys-punish-customers-shopping-elsewhere-new-nectar-card.

[3] Most retailing chains give lagged rebates based on current purchases of selected PL products. In order to be able to benefit from loyalty rewards, customers must signed up for the program, which is free of charge, and present the membership card at the check out at each purchase. Rebates are accumulated in a customer's account and after a certain money threshold is reached, the accumulated amount of money is given to the customer in the form of a purchase coupon to be spent in any of the chain's stores.

[4] According Nielsen (2018) "…When consumers consider quality, many view private-label products as good and getting better".

North America, and 31.4% in the European Union, (Nielsen, 2018).[5] Previous literature has widely documented the gains made by improving and expanding PLs. For supermarkets, PLs yield higher retail margins, making them less dependent on branded products. This gives supermarkets increased bargaining power *vis-á-vis* manufacturers. Furthermore, given their exclusive nature, PLs help induce consumer store loyalty (Ailawadi, Pauwels and Steenkamp, 2008). For the market as a whole, PLs increase the range of products available for consumers, intensify intra-brand competition and may stimulate upstream competition. On the other hand, loyalty programs, which have traditionally worked as frequent shopper programs, play a number of roles: first, they impose artificial switching costs on customers and favor customer retention (Cremer, 1984; Klemperer, 1987a,b; Caminal and Matutes, 1990; Chen and Pearcy, 2010); second, they serve as a device to price discriminate between old and new customers (Caillaud and De Nijs, 2014); last, they facilitate tacit collusion as they allow firms to increase prices and profits (Banerjee and Summers, 1987; Fong and Liu, 2011).

My empirical strategy consists of exploiting rich transaction-level data on grocery purchases made by households, plus supplementary information on household membership of supermarket loyalty programs, in order to provide both reduced-form and causal evidence on the effects of loyalty programs on the demand for PLs. I carry out two empirical exercises. First, using data on purchases from 344 different product categories sold by grocery stores, I obtain reduced-form evidence on the relationship of individual membership of loyalty programs with two indicators of store loyalty, namely, the share of wallet (SOW) spent at a particular store, and the number of times a household visits the same supermarket during a week. Further, I obtain evidence on the relationship of individual membership of loyalty programs with PL purchases by regressing the individual weekly expenditure on a particular supermarket's PLs on the membership indicator and other controls.

In the second exercise, I focus on a particular market and obtain causal evidence on the effects of loyalty programs on consumer preferences for PLs. Based on discrete-choice methods, I develop a structural model of demand that includes interactions of the household-specific membership indicator with product characteristics, such as price and a PL indicator, so as to capture the way in which loyalty programs affect consumer preferences in a flexible way. Therefore, I allow consumer membership of loyalty programs to potentially alter the consumers' valuation for PLs, their sensitivity to price changes and have spillover effects on both NBs and rivals' PLs.

[5] The European countries with the highest market shares for PLs are Spain (42%), the United Kingdom (41%), Germany (35%) and France (26%) (Nielsen, 2018).

There are two challenges to identification. The first is related to the potential endogeneity of prices and the second concerns the potential selection bias arising from the fact that household membership of loyalty programs is not randomly determined. My identification strategy combines two approaches: first, I exploit the richness of my micro data to control for both observed and unobserved exogenous variation, and second, I include control functions for both prices and the individual membership indicator. Concerning the identification of the price parameters, I define choice alternatives as "option packages" (i.e., as a combination of brand, supermarket, and other characteristics such as the type of container (plastic or other), the sugar contents and the type of milk), and exploit within brand variation in prices across periods. Further, I correct for both aggregate shocks to brand demand and unmeasured product characteristics, by including brand-month dummy variables in the estimation stage. Moreover, in a first stage, I use Hausman instruments to account for any remaining source of endogeneity. Therefore, after accounting for observed and unobserved household individual demographics, aggregate shocks to demand and unobserved time varying product characteristics, exploiting differential price schedules across varieties of the same brand and including a control function, prices are uncorrelated with individual demand shocks.

For the identification of the parameters related to the interactions with the LP membership dummy, I follow a similar strategy than in the case of prices: first, in order to avoid a potential selection problem, I allow two types of consumers in the final sample, namely, members of LPs and non-members. Further, I exploit the observed variation in the shopping patterns both of each household over time and across consumer types (i.e., members and non-members) in each period. An second, I include a control function that uses characteristics of the LPs and their interactions with regional prices as instruments. The key identifying assumption is, therefore, that after controlling for brand (i.e., supermarket)-time effects and household demographics, the observed differential variation in household level shopping patterns and the control function allow me to isolate the effect of LP membership on consumer choice decisions. Further, I deal with a potential omitted variable bias, arising from a possible correlation between individual membership and unobserved characteristics of supermarkets and products, by including time-varying brand dummies and individual observed and unobserved household characteristics. At the supermarket-level, the brand-time dummies capture promotional activities that are fixed across periods (e.g., the percentage of the loyalty rebates and the threshold to be reached in order to obtain a redeemable coupon) as well as time varying (seasonal) promotional activities, and will absorb aggregate shocks to both brand and supermarket demand.

I use the estimated demand model to evaluate the effects on demand of two counterfactual policies. First, I simulate a situation in which one supermarket changes its loyalty program's terms and conditions to make rewards more difficult to claim for customers, while rival supermarkets keep their own unchanged. The same exercise is completed for each of the supermarkets included in this sample. Further, I examine the extent to which a price decrease on the supermarket's PLs offsets the effects that the change of the rewards program has on the demand for plain yogurt.[6] In a second counterfactual experiment, I consider the case of supermarkets changing loyalty programs altogether. Similar to the first exercise, I measure the effects on the demand of this policy under three price scenarios: the first in which prices remain at their observed levels, the second in which PL prices decrease by 10%, and the third in which PL prices decrease by 30% simultaneously for all supermarkets.

The structural analysis yields several interesting findings. First, the marginal valuation of PLs is significantly higher for households that are members of the loyalty program of the supermarket that owns the brand, relative to non-members. Second, compared to non-members, loyalty program membership decreases consumers' sensitivity to changes in the prices of both PLs and NBs, as long as they shop at the supermarkets they are members of. Alternatively, results show that customers with at least one membership are considerably more elastic to changes in the prices of both PLs and NBs when they shop at supermarkets they are not members of. In fact, the average own price elasticities of a loyalty program member in the former case are 33.1% for PLs and 32.2% for NBs lower than those of a member in the latter case. Third, the willingness to pay for PLs of customers that are members of a single loyalty program is 15% higher relative to a non-member. However, this difference decreases with the number of memberships to separate loyalty programs: the willingness to pay of a customer with two memberships is 5% higher than that of a non-member, and the willingness to pay of a customer with four memberships is 21% lower than that of a non-member. Precisely, I find that the effects of loyalty programs are weaker for those households with multiple loyalty program cards; this is, the marginal valuation of PLs decreases with the number of memberships, and customers are more sensitive to price changes as compared to households with a single loyalty program membership. Further, counterfactual simulations indicate that when a single supermarket changes its LP, it loses an important proportion of demand to rivals; this decrease

[6] I simulate two price decrease scenarios. One in which prices drop by 10%, which is based on the fact that French supermarkets often offer either 5% or 10% reward to loyalty program members on the value of their purchases of PLs. This can be a small reduction if customers considerably value the loyalty programs. Thus, I simulate a second scenario in which prices decrease by 30%.

ranges from 13.7% and 25.1% in demand and is positively correlated with the supermarket's share of members. Finally, I find that if supermarkets changed their loyalty programs altogether, the demand for PLs would decrease by 74.8% while the demand for NBs and the outside good would increase by 13.9% and 7.6%, respectively.

This paper relates to a strand of literature that examines the effects of loyalty programs on demand in several retailing markets. For frequent flyer programs (FPPs), Lederman (2007) finds a positive effect of improvements in FPPs on an airline's demand. In regards to credit card rewards programs, Bolton, Kannan and Bramlett (2000) find that loyalty program members are more likely to repeat buy, and are less sensitive to quality changes and lower prices offered by competitors. For health and beauty retailing, Bridson, Evans and Hickman (2008) find that membership is positively related to store loyalty. Lal and Bell (2003) show that for grocery retailing loyalty programs are more important for lower spending customers. Lewis (2004) finds that loyalty programs induce higher spending and repeat purchasing. This work also relates to a strand of literature that empirically examines the determinants of PL demand (Dhar and Hoch, 1997; Batra and Sinha, 2000; Ailawadi, Neslin and Gedenk, 2001; Erdem, Zhao and Valenzuela, 2004; Hansen, Singh and Chintagunta, 2006; Steenkamp, Van Heerde and Geyskens, 2010; Lamey et al., 2012). Recently, Dubé, Hitsch and Rossi (2018) explore how income and wealth affect PL demand using data from purchases during the Great Recession (2007-2009), and find a negative effect, although this is smaller than that reported by previous literature. Finally, this paper relates to a strand of literature that focuses on the relationship between PL use and the so-called *behavioral* store loyalty (see, for example, Corstjens and Lal (2000), Bonfrer and Chintagunta (2004), Koschate-Fischer, Cramer and Hoyer (2014), Seenivasan, Sudhir and Talukdar (2015) and Do-Vale, Matos and Caiado (2016)). In particular, this paper relates to Ailawadi, Pauwels and Steenkamp (2008), who study the relationship between PL use and supermarket loyalty measured as SOW, share of items purchased and share of shopping trips. They find a "virtuous cycle" between household PL share and behavioral store loyalty for "mild" shoppers only, as "heavy" buyers of PLs are more loyal to price savings.

The remainder of this paper is structured as follows. Section 2 describes the scanner data used in the paper. Section 3 presents the structural analysis with an application to the market for plain yogurt in France. Also described is the empirical framework, the final data used for estimation, the identification strategy, the estimation results, and the counterfactual simulations completed using the demand estimates. Finally, Section 4 concludes and discusses directions for further research.

2 The effects of loyalty programs on store loyalty

The goal of this section is to obtain empirical evidence on consumer shopping behavior in the presence of loyalty programs without imposing structure on the data. Of particular interest is the relationship of individual membership of loyalty programs and PL purchases with two indicators of store loyalty that have been traditionally used in the literature; namely, the share of wallet spent at a particular store chain, and the number of times a household visits the same supermarket during a week.

2.1 Overview of the data

This study uses the Kantar Worldpanel database. This is homescan data relating to grocery purchases made by a representative sample of 14,529 randomly selected households in France during 2006. These data were collected by household members using scanning devices.[7] The data set contains information on 344 grocery product categories from approximately 102 grocery stores, including supermarket chains, hard discounters and specialized stores. An entry in the data set records the purchase of a specific product from a given store on a particular date. Further, the data set includes information on household characteristics.

The homescan data is supplemented with information on household membership of supermarket loyalty programs, collected by Kantar in 2006 for the households in their sample, and loyalty program characteristics collected from each supermarket loyalty program's Terms and Conditions.[8]

2.2 Descriptive and reduced-form evidence

Table 1 displays summary statistics on household demographics, household grocery shopping behavior, and information on store loyalty. From all of the purchases observed in the data, 34% correspond to the purchase of private labels. A household spends approximately 28% share of its total weekly expenditure on supermarket-branded products. The data show some interesting results about household involvement in supermarket loyalty programs. For instance, 85% of households are members of at least one supermarket loyalty program, and on average, consumers are enrolled in two separate supermarket loyalty programs. This is consistent with the fact that consumers are, on

[7] The Kantar Worldpanel is a continuous panel database that commenced in 1998. Most households that comprise the panel have been randomly sampled since 1998. Every year, new randomly selected households are added to the panel, either to replace other households that rarely report data or to increase the sample size.

[8] Unfortunately, the data do not contain further information on supermarket loyalty programs (such as loyalty coupons issuing) nor household loyalty-related behavior (such as amounts accumulated in the loyalty account, redemption rates or when the household joined the program).

average, two-stop shoppers, i.e., they make purchases from two different supermarkets in the same week. Concerning supermarket choice, households allocate 26% of store visits to supermarkets where they are loyalty program members with a share of 27.3% of total expenditure on groceries bought there. Moreover, the share on PLs purchased from these supermarkets is about 30%.

Table 1: Summary statistics on household characteristics

Variable	Mean	Median	Sd	Min	Max	N
Demographics						
Household size	2.63	2	1.39	1	9	14,529
Income (€/month)	2337	2100	1175	150	7000	14,421
Hh head's age	47.84	45	15.66	18	99	14,529
Car (=1 if yes)	0.92	1	0.27	0	1	14,529
Live in urban areas (=1 if yes)	0.75	1	0.43	0	1	14,529
Shopping behavior						
Private label (=1 if yes)	0.34	0	0.47	0	1	10,604,617
Total expenditure (€/week)	63.80	53.78	46.47	0.09	2249	447,560
PL share (% on total expenditure)	27.61	23.51	22.02	0	100	447,560
Number of visits to the same store in a week	1.54	1	0.88	1	7	730,126
Number of different stores visited	1.72	2	0.88	1	9	730,126
Duration (days) between visits to stores	5.73	4	6.69	1	315	715,597
Loyalty-related information						
Membership of at least one loyalty program (=1 if yes)	0.85	1	0.36	0	1	14,519
Number of memberships[a]	2.21	2	1.65	0	12	14,519
Exp. share in stores if membership (% tot. exp.)[b]	27.28	0.00	41.37	0	100	447,560
PL exp. share in stores if membership (% tot. exp.)[c]	29.91	24.43	25.02	0	100	156,244
Share of stores visited if membership (%)[d]	26.02	0	37.40	0	100	730,126

Notes: [a] The number of loyalty program memberships accounts for the number of separate supermarkets to which the household is a loyalty program member and was computed by summing up household-supermarket specific indicator variables taking on the value one if the household was member of a supermarket's loyalty program and zero otherwise.
[b] Computed as the sum of expenditures in stores where the hh is a loyalty program member in a week, divided by total expenditure in all supermarkets that week.
[c] Computed as the sum of expenditures on private labels in a week in supermarkets where the hh is a LP member, divided by the total weekly expenditure in supermarkets where the hh is a loyalty program member.
[d] Computed as the number of stores visited where the hh is a loyalty program member in a week, divided by the total number of separate stores visited that week.
Source: Kantar Worldpanel database 2006. Author's calculations.

I use the whole data set to obtain preliminary empirical evidence on the relationship of household membership of supermarket loyalty programs with measures of behavioral store loyalty that are commonly used in the literature, namely, the share of wallet (SOW), which is computed as the household's expenditure in a supermarket chain in a week, divided by the total expenditure on supermarket products in that week, and the total number of visits to the same chain in the same week. Further, I use the weekly expenditure of a household on a specific supermarket's PLs as an additional indicator of store loyalty. I perform regressions using the data at the transaction level with each of these measures in turn as the dependent variable and, as regressors I use the LP membership dummy, the number of separate supermarket LP memberships, indicator variables for store format and household characteristics. All specifications also include dummies for both supermarket chain and week to capture retailer and time fixed effects. In order to correct standard errors for the correlation across transactions made by the same household, I cluster observations at the household level. I report the results of these three regressions in Table 2.

The results in column 1 show that a household's SOW in a particular store is higher if the household is a member of that supermarket's LP. By contrast, the SOW decreases with the number of separate memberships of the household. This indicates that LPs motivate individuals to spend more at the supermarket they are members of, while multiple memberships induce them to distribute any additional expenditure among all of the supermarkets they are members of. Thus, average expenditure is made lower at each supermarket. An interesting effect is captured by the positive coefficient of the total number of visits to the same supermarket in a week, which suggests that households spend a higher share in those stores that they visit more frequently. Conversely, the more supermarkets a household visits in a week, the lower the share of wallet at each store. Further, the positive coefficient for the hypermarket format indicator suggests that households spend more at larger store formats. This is most likely due to lower prices and the fact that this type of store (located towards the city borders) is often sourced for bulk shopping, whereas the negative coefficient on the convenience format indicator is consistent with people spending less in a store that supplies a limited range of products at higher prices.

The estimates in column 2 show that households tend to make more visits to the supermarkets they are connected to through a LP. However, membership of multiple separate supermarket LPs reduces the previous effect, because consumers have several alternatives to obtain rewards on their purchases. Multistop shoppers (i.e., people who visit several supermarkets in a week) tend to also make repeat purchases from the same store chain. Finally, visiting larger store formats (e.g., hypermarkets) is negatively related to the number of visits, given that, as previously mentioned, consumers often go to this kind of store for bulk shopping, which reduces the need to make top up trips. This is, as expected, in contrast with the positive relationship between sourcing convenience stores and the number of visits because of the limited product range, which thus makes it necessary to make top up trips more frequently.

Finally, the results in column 3 show that consumers enrolled in a supermarket LP tend to spend more on the PLs of that supermarket than non-members. This may capture precisely the effect of the marketing strategy used by supermarkets: linking loyalty rewards to PLs induces consumers to buy larger volumes of this type of products or be willing to pay higher prices for them. Moreover, the expenditure decreases with the number of memberships of separate supermarket LPs, which indicates that, to some extent, *multi-homing* weakens the effects of loyalty programs. Lastly, repeat purchasing in a week increases expenditure on PLs of a particular supermarket, while patronizing multiple supermarkets decreases it.

Table 2: Preliminary descriptive results[a]

	Store loyalty measures		Expenditure on
Variable	Share of wallet[b]	Number of visits[c]	private labels[d]
LP membership (=1 if yes)	0.025***	0.045**	3.614***
	(0.002)	(0.021)	(0.471)
Number of subscriptions	-0.004***	-0.009**	-0.350***
	(0.000)	(0.004)	(0.080)
Number of visits to a store	0.034***		2.889***
	(0.001)		(0.134)
Number of stores visited	-0.229***	0.023***	-2.677***
	(0.002)	(0.005)	(0.098)
Log of hh's age	-0.025***	0.305***	-6.024***
	(0.002)	(0.016)	(0.326)
Household size	0.000	0.033***	3.780***
	(0.001)	(0.004)	(0.112)
Live in urban (=1 if yes)	-0.006***	0.142***	-1.926***
	(0.001)	(0.010)	(0.265)
Car (=1 if yes)	0.002	-0.200***	2.375***
	(0.003)	(0.033)	(0.399)
Log of Income	-0.001	0.003	-0.917***
	(0.001)	(0.012)	(0.224)
Hypermarket	0.014***	-0.181***	0.935***
	(0.002)	(0.023)	(0.359)
Convenience	-0.017***	0.170***	-1.938***
	(0.004)	(0.038)	(0.636)
Constant	1.260***	0.297**	36.896***
	(0.013)	(0.117)	(2.229)
R^2	0.594	0.065	0.310

Notes: [a]Standard errors, clustered by household, are given in parentheses. Regressions are based on 10.5 million observations. All specifications include supermarket chain and week fixed effects.***, **: Significant at 1% and 5%, respectively.
[b] The dependent variable is the share of wallet of customer i on store s in week t.
[c] The dependent variable is the number of visits to each supermarket chain within a week.
[d] The dependent variable is the weekly expenditure of a household on private labels in a particular supermarket.
Source: Kantar Worldpanel database 2006. Author's calculations.

3 The effects of supermarket loyalty programs on consumer preferences: evidence from the plain yogurt market

3.1 Consumer demand model

The demand model presented in this section is in the spirit of the discrete-choice literature (in particular, Berry, Levinsohn and Pakes (1995) and Nevo (2001)). Consumers, indexed by $i = 1, 2, \ldots, I$ face a multiple-choice decision among J products on each shopping occasion. Assume that the conditional indirect utility of consumer i from choosing product j at supermarket $s \in \{1, 2, ..., S\}$ at time t is given by:

$$\begin{aligned}
u_{ijst} &= V_{ijst} + \varepsilon_{ijst} \\
&= \mathbf{x}_{js}\boldsymbol{\beta_1} - \alpha_{1i} p_{jst} + \mathbf{D}_i \times (PL_{js}\boldsymbol{\beta}_2 + p_{jst}\boldsymbol{\alpha}_2) \\
&+ \left[\gamma_i M_{is} + \beta_{3i} PL_{js} \times M_{is} + \alpha_3 p_{jst} \times M_{is} + \beta_4 PL_{js} \times \sum_{l \neq s} M_{il} + \alpha_4 p_{jst} \times \sum_{l \neq s} M_{il}\right] \\
&+ \eta_{jst} + \varepsilon_{ijst},
\end{aligned} \tag{1}$$

where $\mathbf{x}_{js}$ is a (row) vector of observable product-store characteristics, PL_{js} is a dummy variable taking on the value 1 if the alternative j is a PL of supermarket s, $\mathbf{D}_i$ is a vector of household characteristics, p_{jst} is the unit price of product j in supermarket s, and η_{jst} captures the mean valuation of the unobserved product and supermarket characteristics that vary with time. My main focus is on the effects of individual membership of a specific supermarket's loyalty program on brand choice (the terms in square brackets). To capture this, I allow a consumer-store specific variable, M_{is}, that takes on 1 if the individual i is member of supermarket s's loyalty program, to enter the utility function in two ways: directly in levels, and through interactions with the indicator variable for brand ownership, PL_{js}, and price. The coefficient γ_i captures the individual valuation of being a member of supermarket s's loyalty program, β_{3i} captures a differentiated marginal effect of the consumer valuation of supermarket s's PL for members of that specific supermarket LP with respect to non-members. The coefficient α_3 captures a differentiated marginal effect of the consumer sensitivity to price changes for members of that specific supermarket LP with respect to non-members. Further, I include interactions of these two characteristics with the additional number of separate LPs the individual is member of.

The number of additional memberships of supermarkets other than s is potentially important to explain the consumer valuation of s's PLs. The coefficients β_4 and α_4 capture how the marginal effects of brand preferences and price shift with multiple memberships. Finally, ε_{ijst} is an additively separable mean-zero random shock that captures idiosyncratic individual preferences.

In order to capture preference heterogeneity across consumers, I allow unobserved individual attributes to enter the utility function as interactions with price, the membership indicator, and the private label-membership interaction through individual specific parameters. Following the literature, I assume that the distribution of the individual-specific coefficients α_{1i}, γ_i and the log of β_{3i} is multivariate normal:

$$(\alpha_{1i}, \gamma_i, \log(\beta_{3i}))' \sim N(\boldsymbol{\mu}, \boldsymbol{\Sigma}), \tag{2}$$

where $\boldsymbol{\mu}$ is a 3×1 vector of mean coefficients and $\boldsymbol{\Sigma}$ is a variance-covariance matrix. Notice that by imposing a distributional assumption on the log of β_{3i}, I am implicitly assuming that the coefficient of the interaction between the private label dummy and the membership dummy is log-normally distributed and, therefore, all values for that coefficient are positive. This restriction is motivated by conventional wisdom according to which loyalty programs are a strategy used by supermarkets to make products more appealing to consumers and to induce consumer retention.[9] This is consistent with the descriptive evidence shown in column 3 of Table 2 and in Table 3 below according to which loyalty program members tend to spend more on PLs relative to non-members.

The model includes an "outside good" as part of the consumers' choice set, which may capture all other alternatives not considered in this analysis. It also accounts for the no purchase option. Normalizing its mean utility to zero, the indirect utility derived by consumer i from the outside option writes as $u_{i0t} = \varepsilon_{i0t}$.

A key assumption of this model is that consumers choose at most one unit of the brand that gives the highest utility. For given unobserved consumer attributes, $(\mathbf{v}_i, \boldsymbol{\varepsilon}_{it})$, consumer i will choose brand j if:

$$u_{ijst} \geqslant u_{iks't}, \ \forall\, k = 0, 1, \ldots, J; \ s' = 0, 1, \ldots, S.$$

Assuming that the shocks to utility ε_{ijst} are independent of the product characteristics and of each other (i.i.d.), and drawn from a type 1 extreme value distribution, the probability that

[9] In particular, the fact that a supermarket is focusing its rewards program on a particular set of products suggests that it is expecting consumers to respond positively to those incentives.

consumer i selects product j at store s at time t is given by:

$$s_{ijst}(\mathbf{X}, \mathbf{p}_t, M_{is}) = \frac{\exp(V_{ijt})}{1 + \sum_{k,s'} \exp(V_{iks't})}, \tag{3}$$

where $\mathbf{X}$ is the matrix of characteristics of all products, and $\mathbf{p}_t = (p_{11t}, \ldots, p_{JSt})'$ denotes the vector of all prices in period t.

3.1.1 The effects of membership of loyalty programs on brand choice

Past literature has identified the effects of loyalty rewards on consumer retention, the exercise of market power and consumer sensitivity to price changes. To capture some of these effects, I specify a model that is flexible enough in the sense that it allows interactions of the price with the membership indicator and the additional number of memberships of LPs. This means that the membership status of a consumer in relation to a particular store will directly affect her price elasticities. Moreover, I allow interactions of a PL dummy with the indicator of membership, which directly affects the willingness to pay of the consumer for PLs. The individual level price elasticities, for $s = 1, \ldots, S$, are given by:

$$\frac{\partial s_{ijst}}{\partial p_{ks't}} \frac{p_{ks't}}{s_{ijst}} = \begin{cases} \left(-\alpha_{1i} + \mathbf{D}_i'\boldsymbol{\alpha_2} + \alpha_3 M_{is} + \alpha_4 \sum_{l\neq s} M_{il}\right)(1 - s_{ijst})p_{jst} & \text{if } \; j = k, \; s = s' \\ -(-\alpha_{1i} + \mathbf{D}_i'\boldsymbol{\alpha_2} + \alpha_3 M_{is} + \alpha_4 \sum_{l\neq s} M_{il}) s_{iks't} p_{ks't} & \text{if } \; j \neq k, s' = 1, \ldots, S. \end{cases}$$

Provided that the type of product enters the utility model as a dummy variable taking on 1 if the product is a PL of the supermarket where the consumer is purchasing from and zero otherwise, the willingness to pay for a PL is given by:

$$WTP_{ijst}(M_{is}) = \frac{\Delta u_{ijst}/\Delta PL_{js}}{\partial u_{ijst}/\partial p_{jt}} = \frac{\beta_1^{PL} + \mathbf{D}_i\boldsymbol{\beta}_2 + \beta_{3i} M_{is} + \beta_4 \sum_{l\neq s} M_{il}}{-\alpha_{1i} + \mathbf{D}_i \boldsymbol{\alpha} q_2 + \alpha_3 M_{is} + \alpha_4 \sum_{l\neq s} M_{il}}, \tag{4}$$

where β_1^{PL} is the parameter associated with the product characteristic "private label" (PL) included in the vector $\mathbf{x}_{js}$.[10]

Notice that the willingness to pay for a PL of a consumer who is a member of the loyalty program of the supermarket owning the brand is different from that of a consumer who is not a member. *A priori*, we cannot determine what the direction of this relationship will be because the

[10] Equation (4) is a ratio of two non-centered normally distributed random variables that may not have well defined mean and variance. Therefore, in the Results section below, I report the median of the estimated distribution of WTPs across individuals, product types and periods.

membership indicator is in both the numerator and the denominator (it can be positive or negative, and depends on the sign of the estimated coefficients). However, we expect it to be positive so that it is consistent with the conventional wisdom of LPs making consumers more eager to consume PLs.

3.1.2 Aggregate demand

Market-level demand is obtained by aggregating up consumer-level demands implied by the choice probabilities given by (3), over the distribution of consumer attributes in the population. Denote this distribution $P(\mathbf{M}, \mathbf{D}, \mathbf{v}, \boldsymbol{\varepsilon})$ and assume that observed and unobserved household attributes are independent. The market share of the jth product purchased from store s at t as a function of the mean utility levels of all the $J+1$ products, given the parameters, is:

$$s_{jst}(\mathbf{x}, \mathbf{p_t}) = \int dP(\mathbf{M}, \mathbf{D}, \mathbf{v}, \boldsymbol{\varepsilon}) = \int \frac{\exp(V_{ijst})}{1 + \sum_{k,s'} \exp(V_{iks't})} dP(\mathbf{v}) dP(\mathbf{D}) dP(M). \tag{5}$$

3.2 Empirical implementation

I apply the model to the market for plain yogurt in France. The yogurt market is well suited to identify the role of loyalty programs on PL use for several reasons. First, plain yogurt is a product of regular consumption by French households, and accounts for 33% of total yogurt sales in France in 2006;[11] second, a number of brands of the two types (NBs and PLs) and of similar quality are available to consumers; third, supermarkets generally include yogurt among the products that offer loyalty rewards to customers; and last, the fact that yogurt is a perishable product that needs to be stored in the fridge, along with the high frequency of purchase observed in the data suggest that stockpiling is not a concern. Moreover, yogurt can be considered a good of unit demand in the sense that individuals do not generally consume more than one serving at a time, which is useful given the empirical framework used here.[12]

The plain yogurt data set (hereafter, the data) contains information on 52,460 transactions made by 7,048 households during 2006 at French supermarkets. I define a purchase occasion as a week, and use these two terms interchangeably in what follows.

[11] In these data I observe purchases of 174 brands of yogurt sold by an average of 20 separate grocery stores in the 94 metropolitan *departements* of France. In addition, many of these brands are available in different flavors, which overall, amounts to 144 different flavors available including plain yogurt.

[12] Households often buy several varieties of yogurt in the same shopping trip in order to have multiple choices at home (different flavors, fruit contents, thickness, etc.). However, I claim that in general an individual consumes one serving at a time, so that the choice is discrete in this sense. Of course there could be cases in which some people consume more than one brand of yogurt at a time. In such cases, the assumption should be seen as an approximation to the real demand problem.

3.2.1 Household shopping behavior

In the data, I observe purchases made by two types of households: those that hold memberships with at least one supermarket (which I call "members" and correspond to 93.6% of households in the sample) and households that do not hold any loyalty membership (which I call "non-members" which correspond to 6.4% of households in the sample). Moreover, there is heterogeneity in the number of LP memberships: while most members hold two memberships, there is an important proportion with three memberships, and a small number of households holding up to nine memberships (see Figure 1).

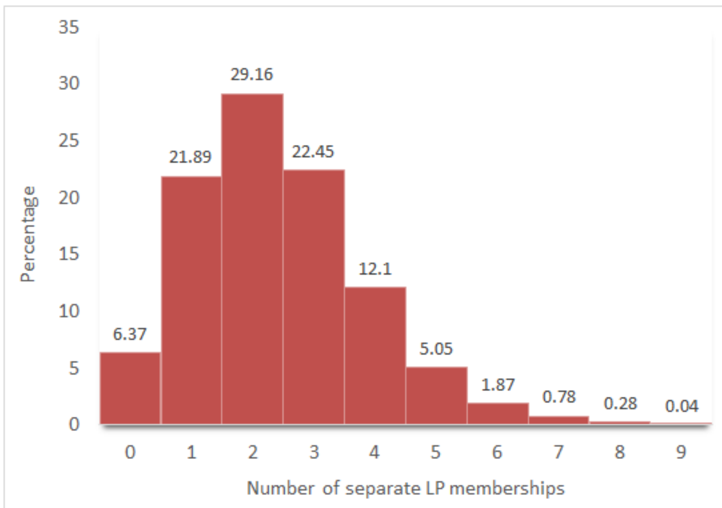

Figure 1: Distribution of households by the number of memberships of loyalty programs

Notes: The figure shows the distribution of the 7,048 households in the sample by the number of LP memberships held by each household. The number of LP memberships accounts for the number of separate supermarkets to which the household is a LP member and was computed by summing up household-supermarket specific indicator variables taking on the value one if the household was member of a supermarket's LP and zero otherwise.
Source: Kantar Worldpanel database 2006. Author's calculations.

Table 3 presents summary statistics of household shopping patterns and loyalty information by subgroup of population (members and non-members). Consistent with conventional wisdom, the number of transactions relating to the purchase of PLs of plain yogurt is higher for members (62%) than for non-members (52%). Similarly, the share of total weekly expenditure on plain yogurt purchases is, on average, 65% against 61.4% for non-members. However, it is important to note that households from the two groups of population devote an important share of expenditure to PL products, on average, which can be explained by their lower price and reportedly good quality. Further, in both groups one can find both one- and multi-stop shopping behaviors, although households tend to make all of their weekly purchases of plain yogurt from a single store (according to the mean and median values). Notice that the distributions of the number of visits to the same store and the number of different stores visited in a week are similar across the two subgroups of households, except for the maximum. In the subgroup of non-members it is observed that there are households that make up to three visits to the same supermarket in one week, and can deal with at most two supermarkets. In the group of members, both figures are larger: some households make up to four visits to the same supermarket and can deal with at most three different supermarkets in the same week. While the higher number of visits can be induced by loyalty program membership, the higher number of supermarkets visited to purchase the same product can be motivated by the multiple memberships observed for some households.

Among the subgroup of members, the median number of memberships of separate loyalty programs is two, and the average of this number is slightly higher given the high proportion of households holding memberships with more than two different programs (see Figure 1). In this subgroup, households make yogurt purchases mainly from supermarkets where they receive loyalty rebates: on average, an 86.8% share of total weekly expenditure is made at supermarkets where memberships are held. This figure is similar to the proportion of supermarkets visited, conditional on holding a membership. Alternatively, there are households that make yogurt purchases from supermarkets where they are not LP members even though a LP is available. This generates within group time series variation in shopping patterns that helps with the identification of the effects related to the LP membership dummy (see the discussion below).

Finally, in order to illustrate the rich variation in shopping patterns observed both across groups and within groups, I show the monthly time series of expenditures and number of stores visited for three example households: households 1 and 2 are part of the subgroup of members (household 1 holds memberships to three separate LPs while household 2 holds just one), and household 3 is a non-member. There is time series variation both in the total expenditure made by each household and in the number of different supermarkets each household deals with. For example, sometimes the total expenditure of a member household is higher than that of a non-member household, and other times it is lower. Further, there is variation in the number of different stores visited. Interestingly, household 2 consistently visits more supermarkets than household 1, even though the latter holds more memberships than the former. This evidence suggests that the shopping behavior of households is not obviously explained by their loyalty profile (i.e., number of memberships), and that the rich observed variation across periods is helpful for the identification of the effects of LP membership.

Table 3: Summary statistics on the shopping behavior of households in the yogurt data

Variable	Mean	Median	Sd	Min	Max	
Non-members						
Private label (=1 if yes)	0.52	1	0.50	0	1	2776
Total expenditure (€/week)	2.25	1.98	1.40	0	16.97	449
PL share (% on total expenditure)	61.38	100	44.62	0	100	449
Number of visits to the same store in a week	1.07	1	0.28	1	3	2776
Number of different stores visited in a week	1.01	1	0.10	1	2	2776
Members						
Private label (=1 if yes)	0.62	1	0	0	1	49684
Total expenditure (€/week)	2.09	1.91	1.01	0.44	10.59	6599
PL share (% on total expenditure)	65	100	43	0	100	6599
Number of visits to the same store in a week	1.06	1	0.25	1	4	49684
Number of different stores visited in a week	1.02	1	0.14	1	3	49684
Loyalty-related information						
Number of memberships[a]	2.57	2	1.35	1	9	6599
Exp. share in stores if membership (% tot. exp.)[b]	86.81	100	30.59	0	100	6599
PL exp. share if membership (% tot. exp.)[c]	65.23	100	42.63	0	100	5999
Share of stores visited if membership (%)[d]	86.79	100	30.60	0	100	6599

Notes: [a] The number of loyalty program memberships accounts for the number of separate supermarkets to which the household is a loyalty program member and was computed by summing up household-supermarket specific indicator variables taking on the value one if the household was a member of a loyalty program and zero otherwise.
[b] Computed as the sum of expenditures in stores where the hh is a loyalty program member in a week, divided by total expenditure in all supermarkets that week.
[c] Computed as the sum of expenditures on private labels in a week in supermarkets where the hh is a loyalty program member, divided by the total weekly expenditure in supermarkets where the hh is a loyalty program member.
[d] Computed as the number of stores visited where the hh is a loyalty program member in a week, divided by the total number of separate stores visited that week.
Source: Kantar Worldpanel database 2006. Author's calculations.

3.2.2 Prices and product definition

A particularity of the yogurt market is that each brand is available in a number of varieties, and prices can vary considerably across varieties of the same brand. Some salient characteristics are the serving size, the type of container (plastic or other), whether or not it contains sugar, and the type of milk (whole milk or other). In this data, the 125 g serving size is the most frequently purchased (81.3% of transactions), whole milk yogurts account for 36.2% of purchases, yogurts without sugar account for 82.7% of purchases, and those in a plastic container account for 84.2% of purchases. In order to illustrate how prices vary across varieties of the same brand, I take three of the leading brands of plain yogurt on the French market (one NB and two PLs, selected according to their national market share in the last quarter of 2006), and for each brand I compute the mean price of a 125 g serving of yogurt according to each of the characteristics mentioned above. As French supermarkets tend to have local-market pricing policies, I compute mean prices using data from

Figure 2: Shopping patterns in the plain yogurt market of three example households in 2006

Notes: the left figure displays the total monthly expenditure on plain yogurt brands made by three example households in 2006. The right figure plots the number of separate supermarkets visited each month during 2006 by each of the three households. Households 1 and 2 are part of the subgroup of members (household 1 holds three loyalty memberships while household 2 holds just one), and household 3 is part of the subgroup of non-members.
Source: Kantar Worldpanel database 2006. Author's calculations.

the Paris area. Furthermore, in order to isolate the price variation from the fact that different supermarkets have different pricing policies, in the case of the national brand I compute mean prices using data from a specific supermarket chain (see Table 4).

Yogurt in a plastic container is cheaper than yogurt in other types of container (e.g., glass) in the three cases. While in two out of three cases yogurt with sugar is more expensive than yogurt without sugar, there is a PL in which the reverse case is observed. Moreover, whole milk yogurt is more expensive, on average, than yogurts made with other types of milk. Finally, in order to capture the price variation across supermarkets, I use data from the Paris area and compute the mean price and some measures of dispersion for a yogurt with particular characteristics, namely, a 125 g serving size, in a plastic container, with sugar and whole milk. Table 4 shows a considerable dispersion of prices across supermarkets in the same local market. In fact, the 75th percentile supermarket charges a mean price that is three times higher than that charged by the 25th percentile supermarket. Similarly, the 90th to 10th percentile ratio indicates a difference of 3.6 in prices. Moreover, the extrema of the distribution show a difference in prices of about seven times.

In order to take variety differentiation within brands into account, and the fact that brand varieties typically exhibit different price schedules, I define products as combinations of brand and a set of characteristics: namely, the supermarket selling the product, the type of milk, the type of container and whether or not the yogurt contains sugar. Defined this way, these products can

Table 4: Mean price according to some characteristics

Characteristic	National Brand	Private Label 1	Private Label 2
Container			
Mean price			
Plastic	28.25	18.73	14.89
Other	44.43	20.13	26.94
% difference	-57.26	-7.42	-80.88
Sugar contents			
Mean price			
With sugar	44.38	30.97	13.31
Without sugar	28.79	15.09	15.57
% difference	35.14	51.27	-17.03
Type of milk			
Mean price			
Whole milk	35.46	21.29	17.10
Other	30.87	14.86	13.82
% difference	12.92	30.21	19.18
Supermarket			
Mean price	33.67	—	—
Coefficient of variation	0.50	—	—
75th to 25th percentile ratio	3.01	—	—
90th to 10th percentile ratio	3.58	—	—

Notes: The table shows mean prices by categories of some salient characteristics of plain yogurt for three leading brands: one NB and two PLs, that were selected according to their national market share in the last quarter of 2006. The figures in the table (except those in the bottom panel) were computed for each brand with data from a specific supermarket chain in the Paris area. The bottom panel corresponds to the mean price computed using different supermarkets' prices of the same brand of a plain yogurt with the following characteristics: 125 g serving size, in a plastic container, with sugar and whole milk. Mean prices are in euro cents.
Source: Kantar Worldpanel database 2006. Author's calculations.

be thought of as what Bajari and Benkard (2005) refer to as *option packages*. They show that when prices vary across option packages of the same brand, the price parameter of a demand model is identified. This strategy was recently implemented by Dubois, Griffith and O'Connell (2018). I closely follow these papers to show that in the context of this paper, the definition of yogurt varieties as option packages is useful for the identification of the price parameter (see Section 3.2.3 below).

To circumvent dimensionality problems due to the large number of resulting products, in the estimation of the structural model of demand, I restrict my attention to the six leading supermarket chains in France in 2006, which I select according to their national market share on yogurt sales. Altogether, they account for 69.7% of total sales (see Table 5). All of these supermarket chains sell their own brand of plain yogurt in addition to a large set of NBs. I restrict my focus to the sales of the leading 25 products (as defined previously), which account for 66.5% of the total sales of plain yogurt in France in 2006. Of these 25 products, 11 are PLs (see Table 5). A common feature of the included supermarket chains is that they all offer loyalty programs with similar characteristics. I report the share of each of the included supermarkets on the total number of loyalty members in Table 5. Altogether, they account for 88.1% of memberships.

Table 5: Information of the included supermarkets

	Market share	Share on loyalty	Products in sample		Mean price	
Supermarket	(%)	members (%)	NBs	PLs	NBs	PLs
1	16.67	21.92	3	2	27.97	13.92
2	14.19	17.08	4	2	30.01	17.59
3	13.95	13.76	2	2	30.87	14.58
4	11.57	18.41	3	2	27.88	15.07
5	7.64	9.43	1	2	27.49	16.56
6	5.69	7.48	1	1	32.09	17.13
Total	69.70	88.08	14	11	29.10	15.67

Notes: Market shares are computed as the percentage share on the total sales of yogurt in France in 2006. Shares on the total number of loyalty program members are computed as the number of households with a membership to the loyalty program of the supermarket on the total number of households with a membership to any program. Mean prices is given in euro cents and are computed by taking the average of prices by supermarket and across markets.
Source: Kantar Worldpanel database 2006. Author's calculations.

Table 6 reports summary statistics for market shares and prices by type for the products in the sample. Given that in the data the most frequently purchased serving size is 125 g, I convert weekly volume sales into number of 125 g servings sold, and assume this as the serving size of a unit demand (consumption) of plain yogurt. Accordingly, I compute the price per serving by dividing total expenditure by the number of servings purchased in each transaction I observe.

3.2.3 Identification

My general identification strategy follows the standard literature that estimates the demand of differentiated products. In particular, it closely follows Nevo (2001) and exploits the panel structure of the data to identify the parameters of the demand model independent of the supply side. Given that the data is at the transaction level, I further exploit the rich observed variation in key variables, such as prices, and supermarket and brand choice across individuals for the identification of the demand parameters. There are, however, two challenges to identification. The first is related to the potential endogeneity of prices, which is common to the literature of demand estimation and

Table 6: Summary statistics for price and market shares of products in the sample

Variable	Mean	Median	SD	Min	Max
Total					
Price (Euro cents per serving)	21.48	18.62	9.85	2.07	328
Market share (%)	14.46	10.35	13.78	0.43	100
Private labels					
Price (Euro cents per serving)	15.67	14.79	4.97	2.07	328
Market share (%)	13.61	9.53	13.65	0.44	100
National brands					
Price (Euro cents per serving)	29.10	26.63	9.46	5.12	88.40
Market share (%)	15.56	11.43	13.87	0.43	100

Notes: One serving of plain yogurt corresponds to 125 g. Market shares are computed as the total expenditure observed in a particular product in period t, divided by the sum of expenditures on the brands included in the sample in that period. Prices and market shares presented in the table are averages across products by type and across periods.
Source: Kantar Worldpanel database 2006. Author's calculations.

stems from the potential correlation of prices with unobserved product characteristics or shocks to demand, which are common to all consumers in a local market. The second challenge concerns the potential selection bias arising from the fact that household membership of loyalty programs is not randomly determined, and the data does not contain information on household shopping behavior before subscription nor on the moment at which each household makes its membership(s) decision(s). In what follows, I discuss the way in which I deal with each of this challenges in turn.

A common concern in the identification of the price parameters is that firms often adjust prices in response to changes in local market preferences for product characteristics that are unobserved to the econometrician (Berry, Levinsohn and Pakes, 1995; Nevo, 2001). Furthermore, Chintagunta, Dubé and Goh (2005) show that when using transaction level data, prices tend to be correlated with unmeasured brand characteristics that vary over time. To correct for both aggregate shocks to brand demand and unmeasured product characteristics, I include brand-month dummy variables. A feature of my empirical strategy that is key for the identification of the price parameters with transaction level data is the way in which products are defined.[13] Following Bajari and Benkard (2005) and Dubois, Griffith and O'Connell (2018), defining choice alternatives as "option packages" allows the researcher to exploit within brand variation in prices across periods. In fact, there is considerable observed variation in prices across these characteristics within stores and of prices of

[13]As a combination of brand, supermarket, and other characteristics such as the type of container (plastic or other), the sugar contents (yes or not) and the type of milk (wholemilk or not).

NBs of yogurt across supermarkets. This variation is described in Section 3.2.2.

Turning to the identification of the parameters related to the interactions with the loyalty program membership dummy, my key strategy is to exploit the richness of the micro data and, in particular, the variation in shopping patterns across consumer types (i.e., members and non-members), as well as the observed within household times series variation in shopping patterns. The key identifying assumption is, therefore, that after controlling for brand (supermarket)-time effects and household demographics, the observed differential variation in household-level shopping patterns allows me to isolate the effect of LP membership on consumer choice decisions.

The membership status of loyalty programs used in these estimations is fixed for each household during the entire period, and is predetermined, in the sense that a household's decision to become a member of a particular loyalty program was made before 2006, and does not change depending on contemporary demand shocks (such as changes in prices and promotional activities).[14] Nonetheless, there are at least two concerns about the identification of the effect of loyalty program membership on demand. One is that a selection bias may arise from the fact that membership of a particular loyalty program is not random. The other is that there may be unobserved information explaining why a consumer has joined a loyalty program in the past that is now being captured by the idiosyncratic error term. In other words, consumer taste shocks for specific supermarkets or products may be causing her to be prone to have a preference for a supermarket and its PLs (and explaining membership) rather than the LP itself. Next, I discuss how I deal with these two concerns.

To avoid a potential selection problem, I allow both types of consumers in the final sample. As shown in Section 3.2.1, of the 7,048 households observed purchasing plain yogurt in 2006, 6.4% are non-members. Though they cannot benefit from loyalty programs' rebates, their consumption of PLs is important: 52% of the total transactions observed for this subgroup of population are purchases of PLs. Moreover, the share of PLs on total weekly expenditure is 61.4%, on average (see Table 3). Further, the presence of these two subgroups of consumers in the data allows me to deal with an additional problem related to my counterfactual experiments, in which I unilaterally set the membership indicator to zero for all consumers. The potential issue is whether it is possible to identify the shape of demand when loyalty programs are absent so that counterfactual simulations do not correspond to out of sample predictions (Dubois, Griffith and O'Connell, 2018). There are

[14] Given the structure of the loyalty programs in France, the membership status of a customer is unlikely to change after joining the program; this is, a consumer who become a member in the past would rarely ask the supermarket to remove her from the program. Instead, a consumer that no longer feels motivated by a supermarket or a product may change her shopping behavior by substituting stores or products.

two sources that allow me to deal with this issue. On the one hand, the presence of non-loyal consumers, whose estimated demand function does not contain either the loyalty program dummy or the number of separate memberships. On the other hand, about 37% of consumers in the final sample shop at at least two separate supermarkets in the entire period, where they need not be members of all of the supermarkets they visit. This permits the observation of demand from loyal customers in locations where they cannot benefit from loyalty rewards (see Table 3).

I deal with the potential omitted variables problem in two ways. First, I include time-varying product dummies which will absorb aggregate shocks to both brand and supermarket demand (recall that a product in this paper is a combination of a brand of yogurt and the supermarket where it is sold). In particular, at the supermarket-level, the product-time dummies will capture promotional activities that are fixed across periods, such as the basic characteristics of the loyalty program that are written in the terms and conditions of each supermarket's program (e.g., the percentage of the loyalty rebates, the threshold to be reached in order to obtain a redeemable coupon, etc.), as well as time varying (seasonal) promotional activities. Second, to deal with the fact that membership of a LP is an individual decision that may be correlated with unobserved characteristics of supermarkets and brands captured in the individual random shock, ε_{it}, I exploit the individual time-series variation in shopping behavior. As mentioned above, in these data there are consumers of both types that deal with different supermarkets on different shopping occasions, who purchase both PLs and NBs, and allocate shares of expenditure to each product type that varies over time (see Figure 2 and Table 3). In particular, among the subgroup of members, some households purchase PLs at supermarkets where they are not members on some shopping occasions. This adds additional variation to the consumer shopping patterns.

In spite of the richness of my micro data, there may still be concerns about endogeneity given that the set of controls I include in the model may not fully account for all of the sources of variation of the potentially endogenous variables. As a consequence, I estimate the demand model including control functions for both prices and the membership indicator. In the case of the price variable, in a first stage I use Hausman instruments (Hausman, 1997), which I define as the price of the same product at the same supermarket in other local markets (i.e., geographic regions) of France, excluding the region in which the price to be instrumented was observed. The identifying assumption is, therefore, that after controlling for market-level aggregate shocks and unobserved product and supermarket characteristics, the prices at other local markets contain information of the prices observed in a particular region, but are not correlated with the basket-level idiosyncratic shocks to demand of that region. Similarly, in the case of the membership indicator, in a first stage I use characteristics of the LPs of each of the supermarkets that are included in my sample as instruments, such as the number of members of a particular LP in other local markets of France, excluding the region in which the individual lives, whether the loyalty card has an expiration date or not, whether customers can join the LP online or not, whether the program gives rewards also on purchases of NBs or not, the average reward per 100 € spent, etc. Table A.1 of the Appendix reports summary statistics of the LP characteristics used as instruments. The identifying assumption in this case follows previous literature that uses product characteristics as instruments for endogenous variables such as price (see Berry (1994) and Berry, Levinsohn and Pakes (1995)), and consists of exploiting the fact that supermarket LPs are the same over the whole country, which makes most LP characteristics predetermined and invariant across consumers; this is, LP characteristics are not set in response to individual specific deviations of the mean valuation of either the program or PLs, which means that these characteristics are not correlated with the basket-level idiosyncratic shocks to demand but are informative about why a consumer might have decided to join a specific LP in the past. Finally, in order to identify the parameters of the interactions between price and LP membership (α_3 and α_4 in equation (1)) I include interactions between LPs' characteristics and the regional prices used as instruments for price.

Endogeneity would still be a concern if prices and/or the membership dummy were correlated with the idiosyncratic shock to demand, ε_{ijt}. In the case of prices, this would arise in situations in which firms can set personalized prices and adjust them according to changes in individual preferences. Supermarkets have strategies that favor consumers' self-selection (such as a menu of product qualities and private labels), and can identify consumers through their LPs (as long as the access to benefits of such programs requires individual registration), which then allows supermarkets to target groups of consumers and price-discriminate through special rebates (such as loyalty discounts). Despite this, there is no evidence of supermarkets implementing personalized pricing schedules in the market for plain yogurt up to 2006. Similarly, in the case of the membership dummy, this situation would arise if supermarkets offered specific promotions to individual consumers. While supermarkets require individual registration to the LP, which involves sharing personal information with the supermarket (which can then track each consumer's purchases), there is no evidence (up to end 2006) of supermarkets offering individual-specific promotional schedules to customers. They do, however, target subgroups of consumers with their loyalty rebates, but not individuals.[15] Therefore,

[15] Loyalty discounts are fixed (5% reduction for purchases of selected products) and are not specific to any consumers.

after accounting for observed and unobserved household individual demographics, aggregate shocks to demand and unobserved time varying product characteristics, exploiting both differential price schedules across varieties of the same brand and differences in shopping patterns across members and non-members, and including control functions for both prices and the membership dummy, prices and LP membership are plausibly uncorrelated with individual demand shocks.

Once the main model is estimated, I recover the mean coefficients of the observed product characteristics by carrying out a generalized least squares (GLS) regression, in which the dependent variable is a vector that contains the estimates of the brand-time dummy variables, the independent variables are the observed fixed product characteristics of interest and time dummies. The error is the term capturing the unobserved characteristics in the demand specification (see Nevo (2001) for details).

3.2.4 Estimation

I estimate the demand model using simulated maximum likelihood (SML). When I estimate, I randomly sample 702 households for which I observe a total of 4,546 transactions. This accounts for 10% of the observations in the plain yogurt data. The estimation of the demand model using microdata requires a dataset containing, for each household, information both on the product chosen and on the alternatives available at each shopping occasion. However, in the plain yogurt data I only observe the information on the product purchased but not on the alternatives. To overcome this shortcoming, I form choice sets for each consumer at each shopping occasion by exploiting observed prices and product characteristics at other shopping locations. This set of alternatives includes an outside option.

A. Choice sets

Given that I do not observe the true set of alternatives available for each consumer at the moment of a purchase, I assume that all of the products included in my analysis were available for all consumers at each shopping occasion. Therefore, I supplement the observed transaction made by each household in each week with the remaining alternatives.

Constructed this way, the final data set for estimation contains, for each household in each week,

There are loyalty promotions for specific days or weeks of the year, but these are targeted to groups of consumers and not to specific individuals. Therefore, these promotions are captured by the brand-time dummies and are not likely to be correlated with the individual shock to demand for yogurt (plus, yogurt is a staple for French households and staples do not have heavy promotions).

a set of alternatives, one of which is the observed choice. This involves an issue as long as the prices of those products that were not purchased by a household in a given week are not observed. In order to deal with this, I replace the unobserved price of each product with the average price of that product in the same week and local area (administrative *Departement*). If I do not observe the purchase of that product in a given *departement*-week, then I replace the price of that product by the average price of the same product in the administrative region in which that *departement* is located. Last, in the very few cases in which I do not observe purchases of that particular product in a given region-week, I replace its price by the national average price of that product in that week.

B. The outside good

In order to flexibly capture the fact that consumers can substitute plain yogurts for other flavors of yogurt or other goods in a particular week, I allow an additional alternative (product "26" or the *outside good*) to enter each consumer's choice set at each shopping occasion. Thus, whenever I do not observe a purchase made by a household, I assume that it opted for the outside good. Moreover, I follow the literature and normalize the utility of the outside good to zero. Consistent with this definition, in the context of this paper the outside good accounts for all of the following: *i)* the consumption of plain yogurts purchased from excluded stores, *ii)* the excluded varieties of plain yogurt purchased from the included stores, *iii)* other types of yogurt, *iv)* other grocery products, and *v)* the no purchase option.

3.3 Results

3.3.1 Demand estimates

I report the estimation results in Table 7. The second column includes control functions for both price and the LP membership dummy. The two regressions include time varying product-supermarket fixed-effects. Estimates are basically of the expected sign and statistically significant. In particular, the price coefficient is negative and significant, meaning that demand of plain yogurt is downward slopping.

The dummy variable indicating membership of a particular LP has a positive effect, suggesting that loyalty program members value positively this kind of programs. Moreover, the interaction of the membership dummy with price is positive, indicating that membership of LPs make customers less sensitive to changes in the price of any kind of brand. The estimates of the interactions with household characteristics also suggest some interesting features: the interaction of price with household size is negative, suggesting that the larger the household the more price sensitive their members are to changes in prices; by contrast, the interaction with the log of income is positive, which indicates that wealthier households are less sensitive to changes in the price of plain yogurt. On the other hand, the interaction between the PL dummy and household size is positive, suggesting that bigger households have stronger preferences for PLs, on average. Finally, the fact that the estimated standard deviations of the individual-specific coefficients are significant suggests that consumers' unobserved characteristics are important to explain the observed heterogeneity in tastes.

My preferred specification is the model with a control function for price and the membership indicator (second column of Table 7). I use the results of this specification to obtain the results that are reported below.

3.3.2 Demand elasticities

Table 8 displays the means of the estimated own-price elasticities of PLs and NBs by supermarket chain. In most cases, own-price elasticities are larger than one in absolute value and averages range from 0.93 to 1.41 for PLs, and between 1.98 and 2.82 for NBs. Interestingly, the mean own-price elasticities of PLs are lower than those of NBs. This may reflect the fact that consumers perceive PLs as somewhat exclusive products, as an identical alternative cannot be found at competing supermarkets, which makes such alternatives imperfect substitutes for the PLs of a particular supermarket chain.

3.3.3 The effects of loyalty programs on the demand for private labels

Demand estimates show that LPs increase consumer preferences for PLs. In order to quantify this effect, I compute the average own-price elasticities for consumers with a membership, conditional on whether the customer purchases some product at a supermarket she is a member of or not, and for those who do not hold any membership. Comparing customers within the group of members suggests that purchasing at the supermarket where the customer is a member makes her less elastic for all types of products (PLs and NBs) relative to a customer purchasing at a supermarket where she is not a member. Furthermore, members are, on average, inelastic to changes in the prices of PLs while the other type of customers has an elasticity of 1.3 in absolute value, which is higher than the average elasticity for PLs computed across all consumers. Furthermore, consumers that make purchases at the store where they are members of are about 33% and 32% less sensitive to

Table 7: Results from the estimation of the demand model

Covariate	Uncorrected	With control function
Mean coefficients		
Price	-27.11	-19.51
	(2.42)	(3.07)
Private label (=1 if yes)[a]	1.74	0.43
	(0.58)	(0.64)
Membership (=1 if yes)	0.96	1.04
	(0.14)	(0.14)
Private label × Membership	1.65	1.35
	(0.06)	(0.06)
Price × Membership	4.38	3.11
	(0.47)	(0.51)
Sugar (=1 if yes)[a]	5.07	4.90
	(1.57)	(1.68)
Wholemilk (=1 if yes)[a]	-0.46	-0.44
	(0.13)	(0.13)
Constant[a]	-5.93	-5.93
	(0.29)	(0.31)
Interactions with demographics		
Price × hh size	-0.51	-1.90
	(0.13)	(0.13)
Price × Log of income	2.81	2.12
	(0.31)	(0.41)
Price × No. additional memberships	-1.21	-0.04
	(0.14)	(0.03)
Private label × hh size	0.19	0.08
	(0.03)	(0.03)
Private label × Log of income	-0.23	-0.01
	(0.07)	(0.08)
Private label × No. additional memberships	-0.02	0.01
	(0.03)	(0.01)
Standard deviations		
Price	7.54	6.33
	(0.21)	(0.19)
Membership	1.44	1.34
	(0.05)	(0.05)
Private label × Membership	2.85	1.99
	(0.16)	(0.07)

Notes: Robust standard errors are given in parentheses. Except where noted, parameters were estimated using SML. All regressions include brand-month dummies. $^{***} \leqslant 1\%$, $^{**} \leqslant 5\%$, $^{*} \leqslant 10\%$.
[a]Estimated using a Generalized Least Squares regression.

changes in the price of PLs and NBs, respectively, relative to members that make purchases at stores where they are not members. Finally, compared with non members (customers not holding any membership of LPs) members are less elastic when purchasing at their rewarding supermarket and more elastic when purchasing at a supermarket different to the one where they are members

Table 8: Own-price elasticities by brand type (means by supermarket chain)

	Private labels		National brands	
Supermarket	Mean	Standard deviation	Mean	Standard deviation
1	-0.93	0.92	-2.00	2.14
2	-1.24	1.21	-2.20	2.41
3	-1.13	1.07	-2.59	2.49
4	-1.05	1.07	-2.09	2.23
5	-1.26	1.17	-1.98	1.76
6	-1.41	1.31	-2.82	2.65
All	-1.15	1.12	-2.22	2.32

Notes: Numbers in the table are the means across individuals, products and periods by type and supermarket, and the standard deviations of the distributions of the estimated elasticities.

of.

Table 9: Effect of loyalty program membership in market own-price elasticities

Customer type	Private label	National brand
Member (No. of total memberships >0)		
Purchasing from a supermarket she is a member of	-0.87	-1.71
Purchasing from a supermarket she is not a member of	-1.30	-2.52
Percentage difference	-33.05%	-32.22%
Non member (No. of total memberships = 0)	-1.19	-2.32

Notes: The table reports the mean own-price elasticity for each type of brand (PL and NB) for members (those who hold at least one loyalty program membership) and non-members (those who do not hold any memberships), and the percentage difference for each type of product between subgroups of customers. Averages are taken across products in the same type, households in the same subgroup and periods.

I also compute the willingness to pay for PLs conditional on LP membership. Using equation (4) and the estimates of the demand parameters, I compute this for each household for a change in the type of brand (i.e., from a NB to a PL). Given that my focus on a characteristic that is discrete (the PL dummy takes on 1 if the brand is a private label and 0 otherwise), I interpret the figures so obtained as the willingness to pay for PLs. Table 10 reports the difference in the medians of the distributions of willingness to pay between customers with one or more loyalty program memberships and that of customers with zero memberships. Consumers with a single membership are willing to pay 1.05 cents (15%) more than a consumer with zero memberships (non-member); those with two memberships are willing to pay 0.36 cents (5%) more than non-members, and those with four memberships are willing to pay 1.52 cents (10%) less than a non-member. Notice that the difference in willingness to pay decreases with the number of different memberships held by a household, which suggests that the positive effects of LPs in increasing consumers' preferences for PLs are weakened when the consumer holds multiple memberships.

Table 10: Effect of membership of loyalty programs on willingness to pay for private labels

	Distribution of loyalty program memberships		
Difference in willingness to pay for PLs	10th percentile (1 memership)	Median (2 memberships)	90th percentile (4 memberships)
In Euro cents	1.05	0.36	-1.52
In percentage	15%	5%	-21%
As a percentage of mean price	7%	2%	-10%

Notes: The table presents the difference in the medians of the distributions of willingness to pay for PLs between customers with one or more loyalty program memberships and that of customers with zero memberships.

3.3.4 Counterfactual analysis of the effects of loyalty programs on demand

Loyalty programs are costly for firms.[16] Anecdotal evidence suggests that giving rewards on all purchases is not the most effective way to discourage multistop shopping, which suggests that a LP that rewards purchases on a reduced set of products (e.g., private labels) may be a better retention device. Nonetheless, giving rewards on a particular set of products does not seem to be enough. In particular, evidence shows that most households hold memberships to multiple LPs and the estimation results of this study show that when customers are able to obtain rewards from several supermarkets, the effects of LPs are weaker. Some supermarkets appear to respond to this by revisiting the terms of their LPs' schemes and, in some cases, making conditions to obtain rewards more difficult to meet.[17] In order to have a measure of the value of LPs for customers, I employ the esti-

[16]In a study of 2014, the Boston Consulting Group found that the return on investment of a loyalty program is normally below 10% and often can go negative. See: https://on.bcg.com/2BmhRIv.

[17]In the United Kingdom, for instance, some of the largest supermarket chains (e.g., Tesco, Sainsbury's and Waitrose) have recently revised their loyalty programs in order to attract back the increasing number of customers that are sourcing discounters Aldi and Lidl for their lower prices. For example, Sainsbury's, the second largest supermarket chain in the United Kingdom, announced big changes in the way its loyalty program will reward customers. It will now focus rewards on frequent repeat purchases regardless of the amount of money spent at

mated model to explore the demand-side effects of a counterfactual situation in which supermarkets make LPs rewards harder to obtain for customers. To do this, I undertake two exercises. First, I assume that one particular supermarket changes its own LP while rival supermarkets keep theirs unchanged. Second, I suppose that all supermarkets simultaneously introduce a similar change in their LPs.For each case, I quantify the direct effects on demand by assuming that prices do not endogenously adjust to a new equilibrium. I avoid imposing structure on the supply side. Instead, I investigate what would happen if supermarkets reduced PLs prices by 10% and 30%.

A. Counterfactual 1: only one supermarket changes its loyalty program

In this exercise, I assume that the members of a particular supermarket LPs no longer give a higher value to purchasing the PLs of that specific supermarket relative to non-members; this is, I unilaterally set the consumer-store specific interaction between the PL and membership dummies to zero for all of the members of that supermarket LP. This situation can be thought of as the consequence of a supermarket changing the terms and conditions of its LP to make loyalty rewards very difficult to claim for customers. I perform the same exercise for each of the supermarkets included in the sample in turn.

I simulate three scenarios: the first in which one supermarket modifies its LP but does not adjust its prices; the second in which, in order to reduce the negative impact on own demand, the supermarket reduces the price of its PL products by 10%; and the third situation in which the price reduction is 30%. In all cases it is assumed that prices of NBs in all supermarkets remain at their observed levels. The scenarios in which the supermarket changing the program reduces its PLs' prices are consistent with the findings of previous literature, according to which LPs allow firms to increase prices (see, in particular, Banerjee and Summers (1987) and Fong and Liu (2011)).

Table 11 reports the percentage changes in row supermarket market shares with respect to the observed shares, when the column supermarket changes its LP. The general pattern is that the demand of the supermarket modifying its LP decreases while it increases for rival supermarkets and the outside good. Moreover, those supermarkets with the highest share of members (stores 1, 2 and 4) are precisely those who bear the highest decreases in demand (greater than 20%) after changing their loyalty programs. In effect, the drop in demand ranges from 13.7% to 25.1% in the first scenario (see top panel of Table 11). Alternatively, if a supermarket reduces the prices of its

each shopping occasion, rather than giving points to customers for every pound spent in Sainsbury's stores. See: https://www.telegraph.co.uk/news/2018/04/05/sainsburys-punish-customers-shopping-elsewhere-new-nectar-card.

PLs, the decrease in demand is slightly lower: for a 10% reduction in the prices of PLs, the decrease in demand ranges from 10.9% to 23.7% (see middle panel of Table 11). On the other hand, if the supermarket reduced its PLs' prices by 30%, the decrease in demand would remain important for supermarkets 1, 2 and 4, but it would considerably reduce with respect to the other two scenarios for the remaining store chains; the decrease in demand ranges now from 2.9% to 19.97% (see bottom panel of Table 11).

Table 11: Effect of a change in loyalty programs on supermarket demand

	Store 1	Store 2	Store 3	Store 4	Store 5	Store 6
Counterfactual 1: Absence of supermarket i's LP with no price adjustment						
Store 1	**-25.07**	3.28	2.88	4.91	1.81	0.91
Store 2	2.09	**-22.49**	1.14	2.54	0.94	0.79
Store 3	3.17	1.89	**-14.44**	2.88	0.70	0.63
Store 4	4.39	2.85	1.74	**-20.57**	1.16	0.79
Store 5	2.64	2.18	1.11	2.14	**-15.49**	0.96
Store 6	4.11	2.04	1.08	1.99	1.12	**-13.69**
Outside option	1.01	0.83	0.76	1.49	0.62	0.27
Counterfactual 2: Absence of supermarket i's LP with 10% reduction in i's PLs prices						
Store 1	**-23.67**	3.29	2.87	4.90	1.81	0.91
Store 2	2.09	**-20.88**	1.14	2.54	0.94	0.80
Store 3	3.17	1.90	**-11.99**	2.88	0.70	0.64
Store 4	4.39	2.86	1.74	**-18.46**	1.16	0.80
Store 5	2.64	2.18	1.10	2.14	**-12.89**	0.96
Store 6	4.11	2.06	1.08	1.99	1.12	**-10.85**
Outside option	1.00	0.81	0.74	1.47	0.60	0.26
Counterfactual 3: Absence of supermarket i's LP with 30% reduction in i's PLs prices						
Store 1	**-19.97**	3.28	2.85	4.89	1.79	0.90
Store 2	2.08	**-16.23**	1.13	2.54	0.93	0.80
Store 3	3.16	1.90	**-5.59**	2.88	0.69	0.63
Store 4	4.38	2.86	1.72	**-12.86**	1.15	0.79
Store 5	2.63	2.18	1.08	2.13	**-5.79**	0.96
Store 6	4.11	2.07	1.06	1.99	1.12	**-2.86**
Outside option	0.97	0.75	0.69	1.42	0.56	0.24

Notes: The table shows the average percentage change in row store's demand when a column store's loyalty program is not available. The term "Store" means supermarket chain. Averages are taken across products and geographic areas by supermarket.

B. Counterfactual 2: All supermarkets simultaneously change their loyalty programs

What would be the effects on demand if all supermarkets simultaneously decided to modify their rewards programs? I undertake similar simulations to those presented previously, but this time I assume that loyalty programs are modified altogether. Specifically, I simulate three scenarios: one in which none of the supermarkets adjust prices after the change of the programs; a second in which all of the supermarkets simultaneously reduce PLs' prices by 10%; and a third in which all of the supermarkets simultaneously reduce PLs' prices by 30%. In all cases, I assume that prices of NBs in all supermarkets remain at their observed levels.

Table 12 reports the average percentage changes in demand by product category (PL and NB). My simulations predict a considerable drop in demand for PLs and an increase in demand for NBs and the outside good. When LPs no longer represent the same value for consumers, the demand for PLs decreases by 75.1% (assuming that supermarkets do not adjust PLs' prices), while that of NBs and the outside good increase, on average, by 12.8% and 7.7%, respectively. If all supermarkets reduced their own-brands' prices by 10%, the drop in demand would be marginally lower (less than 1% lower). Finally, a more aggressive price reduction does not appear to be very effective as the demand for PLs still decreases by more than 70% while the demand for NBs and the outside good increase by 13.2% and 7.3%, on average.

Table 12: Effect of membership of loyalty programs on brand demand

	Counterfactuals: absence of loyalty programs with		
Brand type	Same prices	10% price reduction	30% price reduction
Private labels	-75.14	-74.21	-71.85
National brands	12.75	12.76	13.16
Outside option	7.69	7.60	7.32

Notes: Numbers show the average percentage change in product demand computed with respect to the observed demand. Averages are taken across products and geographic areas by type of product. "Same prices" refers to a counterfactual situation in which supermarkets modify loyalty programs but prices are held at their observed levels. The other two columns refer to counterfactual situations in which PLs' prices are exogenously and simultaneously reduced by 10% or 30% in all supermarkets while NBs prices are held at their observed levels.

Finally, Table 13 reports the overall impact of changing supermarket LPs on aggregate quantities and expenditure, averaged across French *departements* and periods. I assume that the size of each local market is given by the size of the population of each administrative *departement* of France times a potential consumption of yogurt servings per capita-week. Based on official statistics of the average consumption of yogurt by a French individual in 2006, I define this potential as 3.3 servings of yogurt per capita-week.[18] Results show that both quantities of and total expenditures on PLs decrease by more than 70%. Alternatively, NBs experience an increase in both quantities sold and expenditures in all scenarios by more than 13%. Overall, total quantities sold decrease by more than 40% and total expenditure drops by nearly 25% in all cases, on average.

Table 13: Effect of membership to loyalty programs on quantities and expenditures by brand type

		Counterfactuals: absence of supermarket LPs with		
	Base case	Same prices	10% price reduction	30% price reduction
		Quantity (million servings of 125 g size)		
Private labels	19.24	4.76	4.94	5.36
% change		*-75.3%*	*-74.4%*	*-72.2%*
National brands	11.02	12.35	12.33	12.38
% change		*12.1%*	*11.9%*	*12.4%*
Total	30.27	17.11	17.26	17.74
% change		*-43.5%*	*-43.0%*	*-41.4%*
		Expenditure (million euros)		
Private labels	2.91	0.74	0.69	0.58
% change		*-74.6%*	*-76.4%*	*-80.1%*
National brands	3.78	4.24	4.23	4.25
% change		*12.2%*	*11.9%*	*12.4%*
Total	6.69	4.98	4.92	4.83
% change		*-25.8%*	*-26.8%*	*-28.1%*

Notes: Numbers are averages taken across products and markets by type of product. Percentage changes appear below numbers. "Base case" refers to the situation observed in the data. "Same prices" refers to a counterfactual situation in which supermarkets modify loyalty programs but prices are held at their observed levels. The other two columns refer to counterfactual situations in which PLs' prices are exogenously and simultaneously reduced by 10% or 30% in all supermarkets while NBs' prices are held at their observed levels.

[18] According to the National Statistics Institute of France (*Institut National de la Statistique et des Etudes Economiques* —INSEE), in 2006 weekly yogurt consumption per capita was 415.4 g which divided by the serving size of 125 g is equivalent to 3.3 servings per capita per week.

C. Discussion

In these counterfactual experiments, it is implicitly assumed that supermarkets do not optimally adjust their prices. In other words, given my focus on the demand side effects of supermarket LPs, I do not impose any structure to the supply side and thus supermarkets' optimal reactions to changes of loyalty programs cannot be endogenized. Therefore, the results capture the direct effect on demand of supermarkets' actions only, but do not reflect the final effect which arises when firms adjust their prices to a new equilibrium. Hence, the results of these counterfactual experiments should be considered as an upper bound of the effects on demand. Finally, the results obtained in those simulations in which PL prices decrease should be also taken with caution as long as it is assumed that either rival supermarkets do not react to a price reduction of the supermarket changing the program, or that they all decrease prices in the same proportion. A model of supply that takes into account loyalty discounts as a strategic variable in addition to prices, would allow me to capture the demand and supply effects of an elimination of loyalty programs. This is out of the scope of this paper and is left for future research.

4 Conclusions

This paper empirically studies the effects of supermarket loyalty programs on the demand for private labels. Using transaction-level data on grocery purchases by a representative sample of households in France in 2006, I conduct two empirical exercises: first, I derive descriptive and reduced-form statistics on consumer shopping behavior, and their relationship with individual membership of loyalty programs and the type of product purchased (i.e., PL or NB). In particular, I compute two measures of store loyalty which are commonly used in the marketing literature. These are the share of wallet at a particular store and the number of visits to a particular supermarket in a week. I regress each of these on an individual-store specific indicator of membership of the store's loyalty program, household demographics, and store and product characteristics. Results show that household membership of supermarket loyalty programs is positively related to both the share of wallet spent at, and the number of visits made to, the supermarket that the household is a member of. Further, I find a negative correlation between the number of separate memberships of a household with the two measures of store loyalty. This, along with the fact that the individuals observed in the data source more than one supermarket in the same week, on average, suggests that the possibility of being a member of multiple loyalty programs may counteract the effects of the programs on store loyalty.

On the other hand, I obtain causal evidence on the effects of membership of loyalty programs on the demand for private labels. To do this, I restrict my focus to the market for plain yogurt in France, and estimate a flexible structural model of demand. Results show that loyalty program members have a significantly higher valuation for PLs compared to non-members. For those households enrolled in multiple supermarket loyalty programs, the effects of membership of a particular supermarket are weaker: the marginal valuation of PLs decreases with the number of loyalty cards held by a household, and customers are more price sensitive. The results from the structural model are thus consistent with the descriptive evidence.

I use the estimated demand model to explore two counterfactual situations. First, I simulate a situation in which one supermarket changes its loyalty program while rival supermarkets keep their own unmodified. This is done for each of the six supermarkets included in the sample. Next, I examine how effective a price decrease on the supermarket's PLs would be in order to soften the effects on demand after the change of the rewards program. I simulate two scenarios: one in which the supermarket changing its loyalty programs reduces PLs' prices by 10%, and another in which the PLs' decrease by 30%. Results show that the supermarket changing its loyalty program loses an important proportion of demand to rivals and that this decrease in demand is positively correlated with the supermarket's share of members. In a second counterfactual experiment, I consider the case of supermarkets changing loyalty programs altogether. I measure the effects on demand of such policy. Similar to the first exercise, I suppose that all supermarkets decide to decrease PLs' prices in order to soften the effects on demand. This is done by supposing that PLs' prices decrease by 10% and 30% simultaneously for all supermarkets, while NBs' prices are held at their observed levels. I find that PL demand decreases by more than 70%, on average. Furthermore, I find that less attractive loyalty programs in terms of PLs lead to an increase in the demand for NBs by more than 13%, on average.

This article adds to the literature on both private labels and loyalty programs by providing new empirical evidence and possible explanations as to why some supermarkets are focusing loyalty programs on their PLs. Perhaps the biggest limitation of this paper is related to the limited information about loyalty programs observed in the data. Nevertheless, the results show interesting differences in the way members and non-members value private labels.

There are several avenues for future research. The first is the potential strategic use of loyalty programs and private labels in order to gain a better bargaining position *vis-à-vis* manufacturers of national brands. In fact, by improving and expanding PLs, and investing in more attractive rewards programs with a focus on PL purchases, supermarkets may induce more customer loyalty to the store and discourage multistop shopping, which may empower supermarkets to obtain better deals on NB manufacturers. The demand model developed in this paper could be used to address this question, along with a full model of supply that includes both the vertical and horizontal dimensions of the supply chain. Another potential avenue may be to empirically study the theory result according to which loyalty programs serve as a collusive device. In particular, it may be interesting to quantify the level of observed prices, with respect to those that supermarkets would set in the absence of loyalty programs, and compare the costs this imposes on customers with the benefits they receive from loyalty rewards, in order to determine whether or not loyalty programs may be harmful for consumers.

References

Aguiar, Mark, and Erik Hurst. 2007. "Life-cycle prices and production." *The American Economic Review*, 97(5): 1553–1559.

Ailawadi, Kusum L, Koen Pauwels, and Jan-Benedict EM Steenkamp. 2008. "Private-label use and store loyalty." *Journal of Marketing*, 72(6): 19–30.

Ailawadi, Kusum L, Scott A Neslin, and Karen Gedenk. 2001. "Pursuing the value-conscious consumer: store brands versus national brand promotions." *Journal of marketing*, 65(1): 71–89.

Bajari, Patrick, and C. Lanier Benkard. 2005. "Demand Estimation with Heterogeneous Consumers and Unobserved Product Characteristics: A Hedonic Approach." *Journal of Political Economy*, 113(6): 1239–1276.

Banerjee, Abhijit, and Lawrence Summers. 1987. "On frequent flyer programs and other loyalty inducing arrangements." Harvard University Discussion Paper 1337.

Batra, Rajeev, and Indrajit Sinha. 2000. "Consumer-level factors moderating the success of private label brands." *Journal of retailing*, 76(2): 175–191.

Berry, Steven. 1994. "Estimating discrete-choice models of product differentiation." *The RAND Journal of Economics*, 25(2): 242–262.

Berry, Steven, James Levinsohn, and Ariel Pakes. 1995. "Automobile prices in market equilibrium." *Econometrica*, 63(4): 841–890.

Bolton, R., P. Kannan, and M. Bramlett. 2000. "Implications of loyalty program membership and service experiences for customer retention and value." *Journal of the Academy of Marketing Science*, 28(1): 95–108.

Bonfrer, Andre, and Pradeep Chintagunta. 2004. "Store Brands: Who Buys Them and What Happens to Retail Prices When They Are Introduced?" *Journal of the Academy of Marketing Science*, , (24): 195–218.

Bridson, Kerrie, Jody Evans, and Melissa Hickman. 2008. "Assessing the relationship between loyalty program attributes, store satisfaction and store loyalty." *Journal of Retailing and consumer Services*, 15(5): 364–374.

Caillaud, Bernard, and Romain De Nijs. 2014. "Strategic loyalty reward in dynamic price discrimination." *Marketing Science*, 33(5): 725–742.

Caminal, Ramon, and Carmen Matutes. 1990. "Endogenous switching costs in a duopoly model." *International Journal of Industrial Organization*, 8(3): 353–373.

Chen, Yongmin, and Jason Pearcy. 2010. "Dynamic pricing: when to entice brand switching and when to reward consumer loyalty." *The RAND Journal of Economics*, 41(4): 674–685.

Chintagunta, Pradeep, Jean-Pierre Dubé, and Kim Yong Goh. 2005. "Beyond the endogeneity bias: the effect of unmeasured brand characteristics on household-level brand choice models." *Management Science*, 51(5): 832–849.

Corstjens, Marcel, and Rajiv Lal. 2000. "Building store loyalty through store brands." *Journal of Marketing Research*, 37(3): 281–291.

Cremer, Jacques. 1984. "On the economics of repeat buying." *The RAND Journal of Economics*, 15(3): 396–403.

Dhar, Sanjay K, and Stephen J Hoch. 1997. "Why store brand penetration varies by retailer." *Marketing Science*, 16(3): 208–227.

Do-Vale, Rita, Pedro Matos, and Jorge Caiado. 2016. “The impact of private labels on consumer store loyalty: An integrative perspective.” *Journal of Retailing and Consumer Services*, 28: 179–188.

Dubé, Jean-Pierre, Günter J Hitsch, and Peter E Rossi. 2018. “Income and wealth effects on private-label demand: evidence from the great recession.” *Marketing Science*, 37(1): 22–53.

Dubois, Pierre, and Helena Perrone. 2015. “Price Dispersion and informational frictions: Evidence from supermarket purchases.”

Dubois, Pierre, and Sandra Jódar-Rosell. 2010. “Price and Brand Competition between Differentiated Retailers: a Structural Econometric Model.” *IDEI Working Paper Series*, , (64): 42.

Dubois, Pierre, Rachel Griffith, and Martin O’Connell. 2018. “The effects of banning advertising in junk food markets.” *Review of Economic Studies*, , (85): 396–436.

Erdem, Tülin, Ying Zhao, and Ana Valenzuela. 2004. “Performance of store brands: A cross-country analysis of consumer store-brand preferences, perceptions, and risk.” *Journal of Marketing Research*, 41(1): 86–100.

Fong, Yuk-fai, and Qihong Liu. 2011. “Loyalty rewards facilitate tacit collusion.” *Journal of Economics & Management Strategy*, 20(3): 739–775.

Hansen, Karsten, Vishal Singh, and Pradeep Chintagunta. 2006. “Understanding store-brand purchase behavior across categories.” *Marketing Science*, 25(1): 75–90.

Hausman, Jerry. 1997. “Valuation of new goods under perfect and imperfect competition.” In *The Economics of New Goods.* , ed. Timothy Bresnahan and Robert Gordon, Chapter 5, 207–248. National Bueau of Economic Research.

Klemperer, Paul. 1987a. “Markets with consumer switching costs.” *The Quarterly Journal of Economics*, 102(2): 375–394.

Klemperer, Paul. 1987b. “The competitiveness of markets with switching costs.” *The RAND Journal of Economics*, 18(1): 138–150.

Koschate-Fischer, Nicole, Johannes Cramer, and Wayne D Hoyer. 2014. “Moderating effects of the relationship between private label share and store loyalty.” *Journal of Marketing*, 78(2): 69–82.

Lal, Rajiv, and David Bell. 2003. "The impact on frequent shopper programs in grocery retailing." *Quantitative Marketing and Economics*, , (1): 179–202.

Lamey, Lien, Barbara Deleersnyder, Jan-Benedict EM Steenkamp, and Marnik G Dekimpe. 2012. "The effect of business-cycle fluctuations on private-label share: what has marketing conduct got to do with it?" *Journal of Marketing*, 76(1): 1–19.

Lederman, Mara. 2007. "Do enhancements to loyalty programs affect demand? The impact of international frequent flyer partnerships on domestic airline demand." *The RAND Journal of Economics*, , (1): 179–202.

Lewis, Michel. 2004. "The influence of loyalty programs and short-term promotions on customer retention." *Journal of Marketing Research*, 41: 281–292.

Nevo, Aviv. 2001. "Measuring market power in the ready-to-eat cereal industry." *Econometrica*, 69(2): 307–342.

Nielsen. 2018. "The rise and rise again of private labels." *Global Private Label Report*, http://www.nielsen.com/us/en/insights/reports/2018/the-rise-and-rise-again-of-private-label.html.

Seenivasan, Satheesh, K Sudhir, and Debabrata Talukdar. 2015. "Do store brands aid store loyalty?" *Management Science*, 62(3): 802–816.

Steenkamp, Jan-Benedict, Harald Van Heerde, and Inge Geyskens. 2010. "What Makes Consumers Willing to Pay a Price Premium for National Brands over Private Labels?" *Journal of Marketing Research*, 47(6): 1011–1024.

Appendix

A Loyalty program characteristics

Table A.1 reports summary statistics of the LPs' characteristics that I used as instruments for the membership indicator in the estimation of demand.

Table A.1: Summary statistics of some loyalty program characteristics

Variable	**Mean**	**Median**	**Sd**	**Min**	**Max**	**N**
Number of members	3862	3887	1207	2064	5718	126
Card validity (No. of months)	13.50	12.50	2.35	12	18	6
Online subscription (=1 if yes)	0.33	0	0.52	0	1	6
Average reward in euros per 100€spent	0.79	0.58	0.57	0.17	1.50	6
Points	0.33	0	0.52	0	1	6
NBs included (=1 if yes)	0.50	0.50	0.55	0	1	6
Reward cap (=1 if yes)	0.33	0	0.52	0	1	6

Notes: Numbers in the table were obtained from a cross-section data set with observations at the supermarket level (one observation per supermarket), except for "Number of members" which was obtained from a data set with observations at the region-supermarket level(one observation per supermarket for each of the 21 administrative regions of France).
Source: Kantar and Loyalty program's Terms and Conditions.