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Abstract

During the period 2006 to 2012, French competition authorities pressed charges against the country's top 11 firms for engaging in a price-fixing cartel in the fresh dairy store brand segment. Using an empirical vertical bargaining model, this paper studies the effects of the "yogurt cartel" on the price of store brand and national brand products, on the profit sharing between dairy dessert companies and retailers, and consumer welfare. We find that data supports collusive behavior in the dairy dessert market. The cartel leads to price effects for store brands varying from 7.3% for other dairy desserts to 11.3% for yogurts, and those price effects would even be stronger if the cartel also affects the ability of retailers to negotiate with manufacturers. We also show that in a hypothetical situation without the collusion of private label providers, the prices of national brands would have been higher and manufacturers' profits for the sales of their national brand products would have been lower. The cartel thus benefits manufacturers both in the national brand and private label markets. We show that the national brand dairy dessert market should be taken into account when evaluating the damages to the private label dairy dessert market, which the French competition authorities failed to do.

JEL codes: L13 Oligopoly, other imperfect markets, L41 monopolizaton, horizontal anticompetitive practices, L66 food industry

Key words: Yogurt, cartel, private label, bargaining, profit sharing, food, collusion.

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1 Introduction

French competition authorities pressed charges against the country's top 11 firms (March 2015) for engaging in a price-fixing cartel in the fresh dairy product market, named the "yogurt cartel", for six years during the period 2006 to 2012 (involving yogurts, fresh cheese, liquid dairy cream and other dairy dessert sold under store brands).[1] With the exception of Danone which do not produce dairy products sold under store brands, the ten main dairy producers (among them Yoplait and Lactalis) were involved in fixing the price of supermarket own-brand dairy desserts and cream. The cartel was uncovered thanks to a special procedure that allows companies to report their own price-fixing activity to regulators in exchange for reduced punishment. Yoplait, majority-owned by US-based General Mills Inc., was the first company to report the activity, and was given no fines in return for exposing the cartel. The authorities found evidence on how companies agreed to price increases and divided up volumes (using recovery or compensation volumes, volume freezing agreements or agreements on quotations in tenders). They also found evidence that competing producers coordinated calls for tender, in order to strengthen the incumbent producer position: they offered higher prices than the incumbent's or ensured that the other producer sold the product but compensated the incumbent firm that lost the contract. The French competition authorities thus concluded that such a coordination in the fresh dairy product sector led to market sharing between firms, a non free market pricing behavior, limiting the free exercise of competition. Concerned companies were thus severely fined with a total amount of 192.7 million euros for their illegal coordination behavior for the entire cartel duration period. Fines were computed on the basis of total national store brand sales in retail stores. Yoplait was totally exempted from fines as the first applicant for leniency and thus escaped a fine of 44.7 million euros. Senagral, who faced a penalty of 101.3 million euros, benefited from a reduction in the penalty as a secondary-ranked leniency applicant. We refer to the definition of cartel in Levenstein and Suslow (2015), where cartels are seen as coordination behaviors between members aiming to reduce competition and increase profits through output restrictions or price setting, which is prohibited by article 101(1) of the EC treaty for the functioning of the European Union (TFEU). By setting up a cartel, dairy firms colluded explicitly to achieve a situation close to monopoly equilibrium in the

[1] Autorité de la concurrence: Décision 15-D-03 du 11 mars 2015 relative á des pratiques mises en œuvre dans le secteur des produits laitiers frais

private label (PL) market.[2] Collusion in an industry leads to market price effects that deserve greater attention in the literature. They are often measured as the increase in price caused by a sellers' cartel compared to a competitive benchmark market outcome (often called overcharge).[3] Levenstein and Suslow (2015) found evidence that cartels often form in response to falling prices for a particular good caused by different events occurring in a specific market. It is worth noting that the anticompetitive behavior found in the dairy dessert market occurred in a particular context, where the retail food sector had became concentrated.[4] In fact, successive mergers have increased food retail concentration during the last 30 years, which has increased the buying power of strong retail chains (see Allain et al. (2017) and Dobson, Waterson, and Davies (2003)). To countervail the buying power of the retail sector, manufacturers in many food markets –and in particular in the dairy market– have reinforced their bargaining position with respect to retail chains through a vast consolidation movement in the early 2000s (European-Commission (2014), OECD (2014)). Simultaneously, PLs were introduced in retail chains stores. The introduction of PLs by retailers has differing strategic objectives. First, retailers do not sell identical PLs while national brands (NBs) can be sold in different retail chains. This implies that PLs enable a retailer to differentiate between competing retailers (Berges-Sennou, 2006) and relax competition. Second, PLs can be used to reinforce a retailer's bargaining position with respect to their suppliers, in order to improve its profit sharing in the vertical chain. The introduction of the PLs –or the threat of their introduction– decreases the market power of NB suppliers, and hence the wholesale price negotiated with the NB manufacturers (see Mills (1995) for instance). According to Steiner (1990), the relative power between producers and retailers depends on the loyalty of consumers to particular brands or stores. The bargaining power of a retailer is reinforced when consumers are more willing to switch brands within a store than stores within a brand. The substitution pattern between brands and retailers' stores is thus a key feature when analyzing the bargaining position in the vertical chain. Third, the retailers own and control their PLs; therefore, they have the exclusive rights over the PL products. Then, if manufacturers want to enter the PL market, they will have no/low bargaining power from their sales. In this case, they may have incentives to coordinate in order to

[2] Private labels are store brands which can be sold under the retailer's own name or a name created exclusively by the retailer.

[3] Connor and Bolotova (2006) define price-fixing overcharge as "a transfer of income or wealth from buyers to the members of the cartel that occurs as a result of a collusive agreement. The overcharge rate is calculated by comparing actual cartel-enhanced price changes to some competitive benchmark".

[4] We will refer to the dairy dessert market as the dairy market where the collusive behavior has been detected, that is, the yogurt, fresh cheese and other dairy dessert market segments.

increase their bargaining position. On the one hand, dairy firms may benefit from the cartel as PL dairy desserts are a much less differentiated product compared to NB dairy desserts, which implies more intense competition between PL providers in the absence of a cartel. On the other hand, the buyer power of retailers in the PL market can limit the benefit to dairy firms of setting up a cartel, which limits their ability to increase prices.

Market power through collusion or mergers has been extensively analyzed in the literature (see for instance Ivaldi and Verboven (2005)). Some articles deal with the food industries. For instance, Dubé (2005) simulated the effect of hypothetical mergers in the carbonated soft drink in one particular US city (Denver) but where retailers were considered as exogenous, such that their strategic behaviors were not taken into account. More generally, there are few studies on the implication of collusive behavior on profit sharing in vertical chains. In this article, we follow such a merger simulation methodology (Budzinski and Ruhmer (2009)) but we rather simulate a hypothetical non-collusive situation, starting from a situation where food firms may behave anti-competitively towards retailers in the food chain. As emphasized by Berto Villas-Boas (2007), "competition authorities should consider incorporating the role of retailers in upstream merger analyses, especially in the presence of increasingly consolidated retail food markets". Bonnet and Dubois (2010) extend Berto Villas-Boas (2007) using a take-it-or-leave-it non-linear contract framework but such a model cannot deal with profit sharing between manufacturers and retailers, and PL markets are considered as perfectly integrated. Our merger analysis approach then follows a second strand of the literature based on Nash bargaining game methodologies, as in Draganska, Klapper, and Villas-Boas (2010). Bargaining frameworks have been widely used to analyze buyer-seller relationships in a number of different industries. Such a methodology allows us to properly model the existence of retailers' bargaining power in the wholesale price decision and its incidence on profits, for both the food manufacturing and the retailing firms. In our framework, manufacturers and retailers bargain bilaterally and simultaneously over linear wholesale price contracts without observing the trading terms of other bilateral negotiations (secret contracts). Given the existence of interactions between the NB and the PL markets, this paper studies the implications of the "yogurt cartel" on both the PL and NB national markets and not only on the PL market, as has been done by the competition authorities. We also assess profit sharing between retailers and manufacturers, and margins at both the manufacturer and retailer levels for both NBs and PLs. Using a one year panel data of food purchases in France, we test for the collusive

behavior of the PL providers. The availability of such a large and detailed panel data set that provides information on product characteristics (brands, prices, purchase retail stores, etc.) enables us to estimate a sophisticated model of collusion behavior (see Aguirregabiria and Slade (2017)), from which we infer the implication on final prices, profit sharing and consumer welfare.

We find that the data supports collusive behavior in the dairy dessert market. The cartel leads to price effects for PLs varying from 7.3% for dairy desserts to 11.3% for yogurts. Price effects on PL products are even stronger if the cartel also affects the ability of the retailer to negotiate with the manufacturer when bargaining over the wholesale price (bargaining weights). Interestingly, results show that it is important to consider the market for NB dairy desserts, as the cartel also affects the prices of NBs and the margins at the manufacturer and retail levels. Indeed, when simulating a no-collusion scenario, we find an umbrella effect at the wholesale level: the margins of manufacturers for NB products would be higher under collusion such that manufacturers benefit both on the sales of NBs and PLs through collusion. Indeed, when PL providers collude, they are able to reduce the share of PLs on the market, which reduces the bargaining position of retailers. If the negotiation fails with NB manufacturers, the profit they can make with the use of their PLs is lowered (the retailers' disagreement payoff is reduced). However, the umbrella effect does not show up at the retail level. We find that the higher NB wholesale prices are not transmitted into higher NB final prices because of the differentiation strategies of retailers. Overall, retailers are differently affected by the cartel. Finally, we also show that when the cartel can also change the ability of retailers to negotiate with manufacturers, the impacts on prices and profits for both NBs and PLs are even stronger.
The paper is organized as follows. In Section 2, we present the dairy dessert market. We develop in Section 3 the empirical strategy for the evaluation of the cartel impacts on the dairy dessert market. In Section 4, we then provide empirical results on the impact on prices, margins and surplus for manufacturers, retailers and consumers. We conclude in Section 5.

2 Background on the "yogurt cartel" case and data description

To be consistent with an analysis on the food chain up to consumer level, we focus on the dairy dessert market. We exclude dairy creams from the analysis because the cream segment is a separate consumption market. In 2011, dairy desserts accounted for around 16% of dairy product purchases in supermarkets and hypermarkets in France (Agrimer, 2016). We use a 2009 home-scan data set from a French representative consumer panel data of 22,508 households and 1,348,946 purchases, collected by Kantar Worldpanel. It provides information on a product's characteristics, such as brand, dessert type such as yogurt, fresh cheese (quark and cream cheese) and other dairy desserts, the retailer chain in which the purchases have been made, as well as price and quantity.

We consider the five main retail chains operating in the French grocery retailing sector for which the market share varies from 9 to 20%, an aggregate of the remaining retailer chains that reach 12% of the total sales as well as an aggregate of hard discounter (HD) chains. Hard discounters represent 11% of market shares in the dairy dessert market and sell them at an average price (1.89 euro/kg), which is much lower than other retail chains, thus reflecting the larger share of private labels in HD stores that is 82% (see Table 1). The retailers' market share for PLs differs from one retailer to another. The share of PLs varies between 40.4% (R4) to 60.8% (R2) for traditional retailers. Both the size and the proportion of PL products in store will affect the impact of the cartel formation on retailers' profit. Retailers offer a set of brands to consumers, including national brands and private labels for three categories

Table 1: **Average price and market share by retailers**

	Price in euros per kg	Market share in %	PL market share in %
Retailer 1.	2.27	16.19	8.09
Retailer 2	2.29	13.76	8.35
Retailer 3	2.44	9.58	3.93
Retailer 4	2.50	20.33	8.23
Retailer 5	2.55	12.24	7.19
Retailer 6	1.89	10.74	8.89
Retailer 7	2.45	11.77	4.92

of product; yogurt, fresh cheese and other dairy desserts, which accounts for 50%, 18% and 22% market share in our sample, respectively.

The dairy dessert sector is highly concentrated in France. Danone, Yoplait, Senagral (Senoble), Lactalis (Nestlé) and Novandie (Andros) are the main players in the NB markets, with very well-established brands, such as Danone and Yoplait, for instance. These players are active and compete in the three categories of products where one or

several brands compete.

Table 2: **Average price and market share by brands**

	Category			Price	Market share
	Yogurts	Fresh Cheese	Other desserts	in euros per kg	in %
Manufacturer 1				2.56	25.98
Brand 1	X			2.70	4.42
Brand 2		X		3.41	0.46
Brand 3		X		4.31	0.35
Brand 4		X		2.75	0.78
Brand 5			X	2.50	4.37
Brand 6		X		3.14	1.61
Brand 7	X			1.83	2.98
Brand 8	X	X		2.49	3.24
Brand 9	X			2.55	7.77
Manufacturer 2				3.51	6.77
Brand 10	X	X	X	2.87	1.25
Brand 11	X		X	4.13	3.55
Brand 12			X	3.18	0.92
Brand 13	X			2.51	1.06
Manufacturer 3				2.35	8.65
Brand 14	X	X	X	2.17	2.49
Brand 15		X		2.17	0.77
Brand 16		X		3.08	1.04
Brand 17		X		3.21	0.65
Brand 18	X			2.15	3.69
Manufacturer 4				3.99	1.30
Brand 19	X	X	X	3.99	1.30
Manufacturer 5				4.13	2.32
Brand 20	X	X	X	4.13	2.32
PL providers				1.97	49.59
PL- Other desserts			X	2.72	11.84
PL- Fresh cheese		X		2.08	11.15
PL- Yogurts	X			1.58	26.60
Outside good					5.44

We include in the analysis the twenty main NBs produced by the five main manufacturers in France, among which one manufacturer (M1) accounts for 26% of the market as shown in Table 2.[5] Market shares at the brand level are low with less than 3% of market shares, except for a few brands (brands 1, 5, 8, and 9 –all offered by manufacturer 1–, 11, and 18). Brands 3 and 11 are the most expensive brands in the sample but brand 11 has a large market share while brand 3 has a market share of less than 0.5%. Prices seem to be more dependent on the category; they are the lowest on average for yogurt, varying from 1.81 to 3.25 euro/kg, and higher for the fresh cheese category, varying from 2.92 to 5.45 euro/kg, and the other dairy dessert category, varying from 2.42 to

[5]For confidential reasons, we cannot link data to brand or firm names.

6.33 euro/kg. They are then heterogeneous within categories, reflecting a high differentiation of products between brands (flavor, ingredient, recipe, type of milk).

NB products compete with products sold under PL brands. PLs account for almost half of the market (49.6%). The market share of PLs is higher in the fresh cheese sector with 60% of the total market share for this category (see Table 3) and it is the lowest for the yogurt category with 48.5%. For the NBs, the price of the PL is the lowest for the yogurt category followed by fresh cheese and then other dairy desserts. Prices of PLs are generally lower than for NBs (see Table 2).

Other brands (brands provided by other dairy manufacturers) represent only a small market share. We aggregate purchases of these other NBs in an outside good that represents 5.5% of the market, implying that consumers can substitute one of the dairy dessert brands with this alternative option. Defining the choice alternative as a combination of a brand, a product category, and a retailer, we obtain 219 differentiated products that compete on the market.

Table 3: **Average price and market share by categories for NB and PL products**

	Yogurts	Fresh cheese	Other dairy desserts
Price in euros par kg			
NB	2.42	3.16	3.57
PL	1.58	2.08	2.72
Market share in %			
NB	28.27	7.27	9.48
PL	26.60	11.15	11.84

3 Empirical strategy for the evaluation of the economic impact of the "yogurt cartel"

Our empirical strategy for the evaluation of the economic impact of the "yogurt cartel" relies on a three-step methodology. We first model the consumer behavior for dairy desserts using a structural model of demand that allows for estimating substitution patterns between all 219 products. Using a structural supply model which takes into account price contracting between manufacturers and retailers in the vertical chain, we then estimate bargaining power and profit sharing. Modeling the procurement of PLs through a bargaining framework allows us to

consider the possible existence of collusion in the market and allows for no or positive margins at the wholesale level. With a call of tender, absent of collusion, price competition between manufacturers should lead to wholesale PLs prices at the marginal production costs, and retailers should get the entire bilateral profit from the sales of PLs. If data does not support all the bargaining power in the hand of retailers, then manufacturers in this sector are able to extract some of the bilateral profits. We consider four possible model structures. In the two first models, we consider bilateral negotiations between each retailer and its PL provider. In the first, we assume no coordination among PL manufacturers, while in the second, we allow for possible collusion between PL manufacturers: one manufacturer provides the PLs for all retailers. In the two alternative models, we consider a more extreme supply structure –with and without collusion– where manufacturers can increase their bargaining power in the bilateral negotiation, such that the PL manufacturing firms have all the bargaining power and have thus the ability to impose the wholesale prices on retailers (take-it-or-leave-it offers by the PL manufacturers to retailers). Such a situation can arise, for instance, when firms can get more information when colluding with competing manufacturers such that they can extract more favorable terms in the contract. We find that the model where a "merged firm" negotiates with retailers fits better with the data, meaning that some form of collusion between PL manufacturers prevails in the market but not to the extent that they can extract all of the industry profit. Then, in the third stage, we simulate a counterfactual scenario where collusion is removed to evaluate the potential impact of the collusion on prices and profit sharing.

3.1 Demand Model

To moel the consumer behavior, we use a random coefficient logit model and we estimate the demand and the related price elasticities. In such a random utility approach, we assume that the consumer chooses the product that provides the highest utility. We suppose that the indirect utility funtion V_{ijt} for consumer i buying product j in period t is given by:

$$V_{ijt} = \beta_{r(j)} + \beta_{c(j)} + \alpha_{ij} p_{jt} + \gamma_N N_{jt} + \gamma_L L_{jt} + \gamma_C C_{jt} + \varepsilon_{ijt}, \tag{1}$$

where $\beta_{c(j)}$ and $\beta_{r(j)}$ are, respectively, category and retailer fixed effects that capture the (time invariant) unobserved category and retailer characteristics, p_{jt} is the price of product j in period t, α_{ij} is the marginal disutility

of the price for consumer i, N_{jt} represents the percentage of plain items of the product j in period t, L_{jt} represents the percentage of diet items of the product j in period t, and C_{jt} represents the percentage of chocolate items of the product j in period t, and γ_N, γ_L and γ_C are the parameters associated, ε_{ijt} is an unobserved error term.

We assume that α_{ij} varies across products and consumers. Indeed, consumers can have different price disutilities depending on the product's category. We assume that distributions of α_{ij} have the following specification:

$$\alpha_{ij} = \alpha_{c(j)} + \sigma_\alpha \nu_i, \tag{2}$$

where v_i follows a standard normal distribution and its cumulative distribution function is denoted respectively by $P_v(.)$. $\alpha_{c(j)}$ represents the mean price sensitivity of consumers when they buy the product category c and σ_α represents its deviation from the mean.

We can break down the indirect utility into a mean utility $\delta_{jt} = \beta_{r(j)} + \beta_{c(j)} + \alpha_j p_{jt} + \gamma_N N_{jt} + \gamma_L L_{jt} + \gamma_C C_{jt} + \xi_{jt}$, where ξ_{jt} captures all unobserved product characteristics and a deviation from this mean utility $\mu_{ijt} = p_{jt}\sigma_\alpha \nu_i$. The indirect utility is given by $V_{ijt} = \delta_{jt} + \mu_{ijt} + \varepsilon_{ijt}$.

The consumer can decide not to choose one of the considered products. Thus, we introduce an outside option that permits substitution between the considered products and a substitute. The utility of the outside good is normalized to zero. The indirect utility of choosing the outside good is $V_{i0t} = \varepsilon_{i0t}$.

Assuming that ε_{ijt} is independently and identically distributed like an extreme value type I distribution, we are able to write the market share of product j at period t in the following way:

$$s_{jt} = \int_{A_{jt}} \left(\frac{\exp(\delta_{jt} + \mu_{ijt})}{1 + \sum_{k=1}^{J_t} \exp(\delta_{kt} + \mu_{ikt})} \right) dP_\nu(\nu), \tag{3}$$

where A_{jt} is the set of consumers who have the highest utility for product j in period t, a consumer being defined by the vector $(\nu_i, \varepsilon_{i0t}, ..., \varepsilon_{iJt})$.

The random coefficient logit model generates a flexible pattern of substitutions between products that is driven by the different consumer price disutilities α_{ij}. Thus, the own- and cross-price elasticities of the market share s_{jt} can be written as:

$$\frac{\partial s_{jt}}{\partial p_{kt}} \frac{p_{kt}}{s_{jt}} = \begin{cases} -\frac{p_{jt}}{s_{jt}} \int \alpha_{ij} s_{ijt}(1 - s_{ijt})\, \phi(v_i) dv_i & \text{if } j = k \\ \frac{p_{kt}}{s_{jt}} \int \alpha_{ik} s_{ijt} s_{ikt}\, \phi(v_i) dv_i & \text{otherwise.} \end{cases} \tag{4}$$

3.2 Supply Model

We consider the dairy dessert vertical channel as a two-tier industry consisting of n_f upstream firms and n_r downstream retailers. Each upstream firm produces a set of goods G^f and each downstream firm sells R^r products. We consider a market that is composed of J differentiated products where a product is a brand in a product category sold by a retailer. The marginal cost of producing a product j is denoted by μ_j while the marginal cost at the retail level is denoted c_j. We denote as p_j the retail price of the product j and w_j its wholesale price. Retailers and manufacturers' profit are respectively given by Π^r and Π^f with:

$$\Pi^r = \sum_{j \in R^r} (p_j - w_j - c_j) M s_j(p) \tag{5}$$

$$\Pi^f = \sum_{j \in G^f} (w_j - \mu_j) M s_j(p), \tag{6}$$

where the subscript t is omitted to simplify the notation and M is the total market size.

We follow Draganska, Klapper, and Villas-Boas (2010) and first derive the retail margins. We assume a Bertrand-Nash competition game between retailers in the final dairy dessert market. Then, retail margins result from the retailers' choice of final prices. We then turn to the wholesale price equilibrium, which results from the negotiation between firms and retailers. We assume that the negotiation on wholesale prices is modeled as a Nash bargaining game where each pair of firms and retailers secretly, independently and simultaneously contract over the wholesale price of the product j.[6]

Retail Bertrand-Nash equilibrium condition: each retailer r maximizes its profit Π^r leading to the following first-order condition:

$$s_k(p) + \sum_{j \in R^r} (p_j - w_j - c_j) \frac{\partial s_j(p)}{\partial p_k} = 0, \forall k \in R^r. \tag{7}$$

Using equation (7), the vector of retailer margins $\gamma_j = p_j - w_j - c_j$ for retailer r can be written in matrix notation:

$$\gamma_r = (I_r S_p I_r)^{-1} I_r s(p), \tag{8}$$

[6]We assume that firms and retailers have rational expectations, such that the ultimate equilibrium outcome is anticipated by both parties. In this case, the wholesale prices are determined independently of possible changes to retail prices as in (Draganska, Klapper, and Villas-Boas, 2010).

where I_r is an ownership diagonal matrix $(J \times J)$ with element 1 if product j is sold by the retailer r and 0 otherwise, S_p is the matrix $(J \times J)$ of the market share derivatives with respect to retail prices with general element $\frac{\partial s_j(p)}{\partial p_k}$, and $s(p)$ is the vector of market shares.

Wholesale price Nash bargaining solution: The bargaining for each product maximizes the two players' joint profit, taking as given all other negotiated contracts. Moreover, we assume that each player earns its disagreement payoff (i.e., what it would earn from the sales of its other products if no agreement on this product is reached) plus a share $\lambda_j \in [0,1]$ (respectively $1-\lambda_j$) of the incremental gain from trade going to the retailer (respectively to the manufacturer). λ_j is called the bargaining weight of the retailer with respect to the manufacturer on product j and captures the ability of the retailers to negotiate with the manufacturers. We follow Draganska, Klapper, and Villas-Boas (2010), and we assume that a manufacturer negotiates with a given retailer for each of its products, and that each product is negotiated separately with the manufacturer. We also assume that retail prices are not observable when bargaining over the wholesale prices. Then, retail prices are considered as fixed when solving for the bargaining solution.[7].

The equilibrium wholesale price for product j is derived from the bilateral bargaining problem between a firm and a retailer such that each firm and retailer pair maximizes the Nash product:

$$\left[\pi_j^r(w_j) - d_j^r\right]^{\lambda_j} \left[\pi_j^f(w_j) - d_j^f\right]^{(1-\lambda_j)}, \tag{9}$$

where $\pi_j^f(w_j)$ and $\pi_j^r(w_j)$ are, respectively, the profits of the firm and the retailer for product j. They are given by:

$$\begin{aligned} \pi_j^f(w_j) &= (p_j - w_j - c_j) M s_j(p) = \gamma_j M s_j(p) \\ \pi_j^r(w_j) &= (w_j - \mu_j) M s_j(p) = \Gamma_j M s_j(p). \end{aligned} \tag{10}$$

The payoffs the manufacturer and the retailer can realize outside of their negotiations are denoted, respectively, by d_j^f and d_j^r. The retailer could gain d_j^r if it delists the supplier's product j from its stores but contracts with other suppliers. Similarly, the firm could get profits d_j^f from the sales of its other products as well as from the sales of

[7]We thus assume that manufacturers cannot precisely determine the retail price; which can be justified by the fact that retail price monitoring is too costly for manufacturers see Iyer and Villas-Boas (2003))

products to other retailers if the negotiation fails. If the retail prices are fixed during the negotiation process, the disagreement payoffs d_j^f and d_j^r are given by:

$$\begin{aligned} d_j^r &= \sum_{k \in R^r - \{j\}} \gamma_k M \Delta s_k^{-j}(p) \\ d_j^f &= \sum_{k \in G^f - \{j\}} \Gamma_k M \Delta s_k^{-j}(p), \end{aligned} \tag{11}$$

where the term $\Delta s_k^{-j}(p)$ is the change in market shares of product k that occurs when the product j is no longer sold on the market. Those quantities can be derived through the substitution patterns estimated in the demand model as follows:

$$\Delta s_k^{-j}(p) = \int \frac{\exp(\delta_{kt} + \mu_{ikt})}{1 + \sum_{l=1 \setminus \{j\}}^{J_t} \exp(\delta_{lt} + \mu_{ilt})} - \frac{\exp(\delta_{kt} + \mu_{ikt})}{1 + \sum_{l=1}^{J_t} \exp(\delta_{lt} + \mu_{ilt})} dP_\nu(\nu). \tag{12}$$

Solving the bargaining problem in equation (9) leads to the following first-order condition:

$$\lambda_j \left(\pi_j^f - d_j^f \right) \frac{\partial \pi_j^r(w_j)}{\partial w_j} + (1 - \lambda_j) \left(\pi_j^r - d_j^r \right) \frac{\partial \pi_j^f(w_j)}{\partial w_j} = 0. \tag{13}$$

Under the assumption that the matrix of prices for final commodities is treated as fixed when the wholesale prices are decided during the bargaining process, we have $\frac{\partial \pi_j^r(w_j)}{\partial w_j} = -Ms_j(p)$ and $\frac{\partial \pi_j^f(w_j)}{\partial w_j} = Ms_j(p)$ from equation (10). Equation (13) can thus be written $\pi_j^f - d_j^f = \frac{1-\lambda_j}{\lambda_j}(\pi_j^r - d_j^r)$. Using equations (10) and (11) the following expression can be derived for the bargaining solution:

$$\Gamma_j M s_j(p) - \sum_{k \in R^r - \{j\}} \Gamma_k M \Delta s_k^{-j}(p) = \frac{1 - \lambda_j}{\lambda_j} \left[\gamma_j M s_j(p) - \sum_{k \in G^f - \{j\}} \gamma_k M \Delta s_k^{-j}(p) \right]. \tag{14}$$

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Using equation (14) for all products j, we obtain the matrix of firms' margins:

$$\Gamma = \sum_{f=1}^{n_f} \left(I_f S I_f \right)^{-1} \left[\sum_{r=1}^{n_r} \frac{1 - \lambda}{\lambda} * \left(I_r S I_r \right) \gamma \right].^{8} \tag{15}$$

[8] The $*$ means an element by element multiplication between the vectors $\frac{1-\lambda}{\lambda}$ and $[(I_r S I_r)\gamma]$.

The vector of retail margins of general element $\gamma = \sum_{r=1}^{n_r} (I_r S_p I_r)^{-1} I_r s(p)$ is derived from equation (8), I_f is the $(J \times J)$ ownership diagonal matrix with element 1 if the products j is sold by the firm f and 0 otherwise, and S is the $(J \times J)$ matrix with market shares as diagonal elements and changes in market shares otherwise:

$$S = \begin{bmatrix} s_1 & -\Delta s_2^{-1} & \cdots & -\Delta s_J^{-1} \\ -\Delta s_1^{-2} & s_2 & \cdots & -\Delta s_J^{-2} \\ \vdots & \vdots & \ddots & \vdots \\ -\Delta s_1^{-J} & -\Delta s_2^{-J} & \cdots & s_J \end{bmatrix}. \tag{16}$$

Equation (15) shows the relationship between the wholesale margin on the one hand and the retail margin on the other hand. This relationship first depends on the disagreement payoffs and thus on the market share changes that are determined by the substitution patterns estimated in the demand model. It also depends on the exogenous parameter λ_j, that is, the ability of the retailer to negotiate with the firm over the wholesale price of the product j. The higher λ_j, the lower the share of the joint profit the firm will get from the bargaining.

Adding equations (15) and (8) yields the total margin of the firm/retailer pair over product j:

$$p - c - \mu = \left[\sum_{f=1}^{n_f} \left(I_f S I_f \right)^{-1} \left[\sum_{r=1}^{n_r} \frac{1-\lambda}{\lambda} * (I_r S I_r) \gamma + I \right] \right] (I_r S_p I_r)^{-1} I_r s(p), \tag{17}$$

where I is the $(J \times J)$ identity matrix and $\lambda = (\lambda_1, ..., \lambda_J)$.

Because we do not directly observe firms' marginal production costs as well as retailers' marginal distribution costs, we are not able to analytically determine the bargaining weight parameter λ_j. Rather, we conduct an estimation specifying the overall channel marginal cost C_{jt} for each product j, which is the sum of the marginal cost of production and the marginal cost of distribution for each product j at each period t. We follow the following specification for the total marginal cost:

$$C_{jt} = \theta \omega_{jt} + \eta_{jt}, \tag{18}$$

where ω is a vector of cost shifters and η is a vector of error terms that accounts for unobserved shocks to marginal cost. The final equation to be estimated is thus given by:

$$p = \theta \omega + \left[\sum_{f=1}^{n_f} \left(I_f S I_f \right)^{-1} \left[\sum_{r=1}^{n_r} \frac{1-\lambda}{\lambda} * (I_r S I_r) \gamma + I \right] \right] (I_r S_p I_r)^{-1} I_r s(p) + \eta. \tag{19}$$

We are then able to get an estimate of λ for each product. Hence, we can deduce manufacturers' margins from equation (15). Moreover, from the estimates of the cost shifters and the error term of equation (19), we get the

estimated total marginal cost. In practice, we use the price index of the raw milk as cost shifters to estimate the equation (19), a dummy for the other dairy dessert category, the percentage of plain items and chocolate items that could affect the cost, and manufacturer dummies.

Note that the model remains unchanged when we consider the merger case where only one PL manufacturer is active on the market. The only difference is the number of manufacturers considered, which drops from 12 to six, and the same manufacturer is negotiating with all retailers for the PL products. For the third and fourth cases, we also consider a Nash Bargaining game for national brand products and the bargaining weights are recovered from equation (19) only for national brands. Regarding private label products, we consider a take-it-or-leave-it offer where either six PL manufacturers or a unique PL manufacturer proposes a contract for their PLs to retailers as in Villas-Boas (2007).

In order to test the existence of a cartel between private label providers, we apply non nested tests between the three supply models. Rivers and Vuong (2002) allows us to statistically determine the best supply model between any two alternative models for which we have obtained total marginal costs. The test statistics are based on the difference between the lack-of-fit criterion of each cost equation (18), obtained from the marginal cost function (19) estimated for each model. [9]

3.3 Impact of eliminating the cartel of private label providers

In this section, we simulate the fact that the cartel does not exist and that manufacturers of private label products can no longer collude. We use the estimated marginal costs from the best supply contract model and the estimated parameters from the demand model. We denote by $C_t = (C_{1t}, .., C_{jt}, .., C_{Jt})$ the vector of marginal costs for all products in period t. To model the change in the structure of the industry, we assume that each retailer now negotiates with an independent private label manufacturer for their PL and that the parameters λ have the same values as in Table 5.[10] As wholesale prices depend on retail prices, demand estimates, and the bargaining weight between firms and retailers (as seen in equation (15)), we then only have to determine the vector of new equilibrium

[9] Details about the Rivers and Vuong test are provided in Bonnet and Dubois (2010).

[10] We also perform some robustness checks to see how the results will be changed if the bargaining weight is affected by the change in market structure.

retail prices consistent with the vector of estimated marginal costs. We solve the following program for each time period:

$$\min_{\left\{p^*_{jt}\right\}_{j=1,..,J}} \quad \left\| p^*_t - \Gamma^*_t\left(p^*_t\right) - \gamma^*_t\left(p^*_t\right) - C_t \right\|, \tag{20}$$

where $\|.\|$ is the Euclidean norm in R^J, and γ^*_t and Γ^*_t correspond respectively to the retailer and manufacturer margins for the supply model where the private label producers do not collude.

4 Results

We estimate four models. In the first, named "NB no cartel", different manufacturers negotiate wholesale prices for the PLs with retailers; in the second, "NB cartel", PL manufacturers act as a merged firm when negotiating wholesale prices of PL products; in the third, "TL no cartel", different PL manufacturers make a take-it-or-leave-it wholesale price contract offer to retailers for their PL products; and in the fourth scenario "TL cartel", a merged PL manufacturer makes a take-it-or-leave-it offer.

Table 4: **Rivers and Vuong test**

	NB cartel	TL no cartel	TL cartel
NB no cartel	**-3.8**	28.2	3.8
NB cartel		**28.5**	**28.4**
TPT no cartel			5.9

Note: Value are the test statistics of model "in row" against model "in column"

The Rivers and Vuong's test shows that "NB cartel" is the best supply model, as the test statistics is higher than the critical value of 1.64 (for a 5% significance) with models "TPT no cartel" and "TPT cartel" and the test statistics is lower than the critical value of -1.64 (for a 5% significance) with model "NB no cartel" as shown in Table 4.[11] Using this model as a baseline, we then simulate the absence of the cartel and by comparison with the baseline scenario, we will be able to assess the effect of the cartel in terms of prices, profits and consumer welfare.

[11] Note that if the market structure of the NB cartel model is not exactly the observed situation, it is the structure which is the closest to the situation observed.

4.1 Demand and supply estimates

The estimation results of the demand and supply models corresponding to the "NB cartel" model are summarized in Table 5.[12] From the demand estimates, we are able to compute demand own-price elasticities at the brand level. They are heterogeneous among brands, varying from 3.6 to 7.7 for NBs and 3.2 and 5.8 for PLs in absolute values. They are relatively high as they are calculated at a very disaggregated level. At the category level they are lower at least for yogurt (2.45) and other dairy desserts (3.4) and remain high for fresh cheese (5.4). This indicates that many substitutions occur between brands and categories. At the aggregate level, the own-price demand elasticity for NB products is slightly higher than for PLs in absolute value (2.3 and 1.9 respectively). Another interesting result is that substitution between NB products and PL products is asymmetric. The cross-price elasticity of the demand of NB products with respect to the PL price is 2.48 while the cross-price elasticity of the PL products with respect to the NB price is 1.87. This means that NB products are more sensitive to a change in PL prices than PL products are when the prices of NB products change. Then, if the cartel removal leads to a decrease in the prices of PLs, it will also affect the demand for NB products and their prices.

Estimates of the supply model show that the bargaining weight is on average in favor of manufacturers for NBs, as expected. As a result, margins are higher (and even much higher for many of them) for manufacturers for all brand products, except for brands 7, 13, 14 and 18 (see Figure1). For PLs, one may expect bargaining weights to be in favor of retailers. However, our results suggest that the bargaining weight is in favor of the retailers in the yogurt category (0.9) only, but this result is not true for the fresh cheese and other dairy dessert categories. For these two categories, manufacturers indeed have more bargaining weight than retailers. For those categories, the percentage margins for manufacturers are more than twice the margins for retailers (brands 21, 22 in Figure 1) while percentage margins for products in the yogurt category (brand 23 in Figure 1) are higher for retailers.[13] This reflects the expected result that retailers could obtain lower supply prices in the absence of collusion. Actually, if we compare the total profit sharing between retailers and manufacturers, profit sharing on PL products is in favor of retailers for yogurt (53 %) while it is in favor of manufacturers for the other categories (27% and 25%).

[12] In the Appendix, we provide the estimation methodology of the demand and the related results.

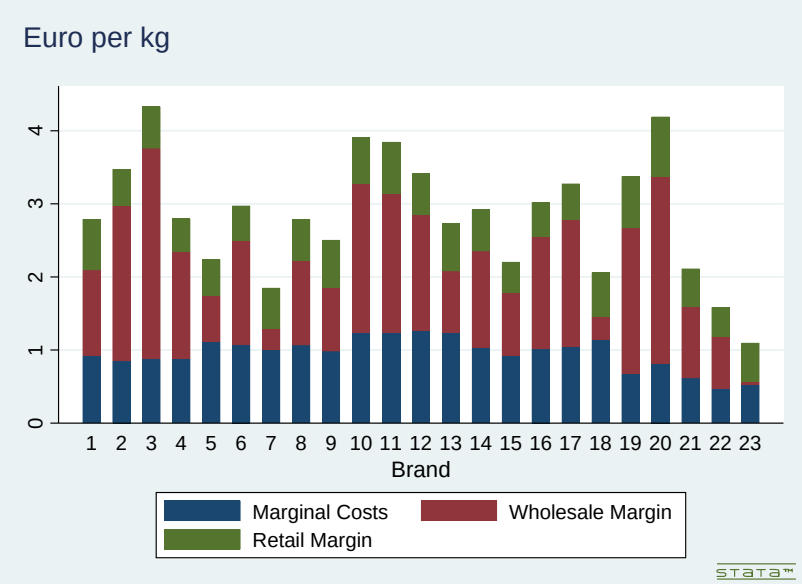
[13] This result is consistent with results on percentage margins for PLs found in the literature summarized in Chakraborty (2018).

Table 5: **Results of the demand and supply estimates**

	Own-price elasticities	Retail margins (%)	Bargaining weight* λ	Manufacturer margins (%)	marginal costs (€/kg)
Brand 1	-4.27	26.79	0.44	37.26	0.93
Brand 2	-7.94	15.49	0.19	59.23	0.84
Brand 3	-8.63	14.04	0.16	64.95	0.88
Brand 4	-7.13	17.52	0.24	51.00	0.86
Brand 5	-5.73	20.96	0.40	33.13	1.11
Brand 6	-7.63	16.13	0.23	49.14	1.05
Brand 7	-3.58	32.49	0.92	12.24	0.97
Brand 8	-4.58	26.69	0.55	27.72	1.07
Brand 9	-4.21	27.20	0.48	32.80	0.99
Brand 10	-5.01	24.35	0.53	29.48	1.19
Brand 11	-6.15	19.46	0.31	47.68	1.23
Brand 12	-6.39	18.69	0.31	41.05	1.24
Brand 13	-4.15	27.65	0.62	21.33	1.22
Brand 14	-4.35	28.98	0.83	17.63	1.04
Brand 15	-6.16	20.31	0.37	35.77	0.92
Brand 16	-7.59	16.24	0.23	50.09	1.01
Brand 17	-7.67	16.07	0.23	50.73	1.03
Brand 18	-3.90	29.58	0.82	14.61	1.15
Brand 19	-5.69	21.27	0.26	59.00	0.70
Brand 20	-5.75	21.91	0.31	54.97	0.79
PL- Other desserts	-5.83	19.79	0.30	56.50	0.61
PL- Fresh cheese	-5.99	20.28	0.32	56.26	0.47
PL- Yogurts	-3.24	34.70	0.89	30.83	0.53

* Bargaining weights correspond to the power of retailer relative to the manufacturer in the bilateral relationship when bargaining over the wholesale price.

Figure 1: Margin and marginal cost estimates



4.2 Impact of anticompetitive practices on the fresh dairy product market

To evaluate the impact of collusion between PL manufacturers on the economy, we evaluate the impact on quantity and prices for PLs and for NBs. The first column of Table 7 provides new retail prices per brand when the bargaining weights are not affected by a change in the industry structure, such that the bargaining weight values used in the simulation for PLs correspond to the estimated bargaining weights $\hat{\lambda}$ (see Table 5). The non collusion scenario when bargaining weights are unchanged leads to a price reduction for PLs from 7.3% for other dairy desserts to 11.3% for yogurts. The percentage reduction is stronger for the yogurt sector. In this category, the bargaining weight for retailers is high (0.89 in average). Then, retailers pay a much lower wholesale price for their PLs without collusion (a decrease in PL margins for yogurts by more than 70 percent as shown in Table 6), which allows them to further reduce the final prices of PL yogurts (a reduction in the double marginalization effect). On the contrary, the effect of the cartel is lower for other dairy desserts and fresh cheese categories as the bargaining weight is in favor of manufacturers.

We can expect that collusion may also have changed relative bargaining weights, that is the ability to negotiate between retailers and manufacturers. We are not able to estimate the possible change in bargaining weights.[14] However, we can analyze how the results are changed if non-collusion behavior results in higher bargaining weights for retailers. We consider two possible cases. First, we examine a case (column 2 of Table 7), where retailers have at least the same bargaining weight as manufacturers ($\lambda = 0.5$ if $\hat{\lambda} < 0.5$), and then the extreme case (column 3 of Table 7), where retailers recover a full bargaining weight ($\lambda = 1$). In this extreme case, PL wholesale prices are set up at wholesale marginal costs. A higher bargaining weight enables retailers to achieve larger price reductions for fresh cheese and other dairy desserts sold under store brands.

The price effect on PLs leads to important changes in market shares of PL products (see Table 6). As expected, lower PL retail prices lead to higher market shares for PLs. Note that the percentage of variation is high for PL fresh cheese and other dairy desserts but the estimated market share for PLs is much lower for these two categories compared to the market share of PL yogurts. With no collusion, manufacturers' margins for PLs decrease as expected, with a loss ranging from 26% to 77%. More interestingly, the change in retailers' margins for PLs is

[14] We have J equations and J unknowns in equation (20). Therefore, we cannot estimate any additional parameters, as the new bargaining weight that may result from a change in the structure of the industry.

Table 6: **Impact of the no collusion scenario on market shares, margins and firms' profits (in percentage)**

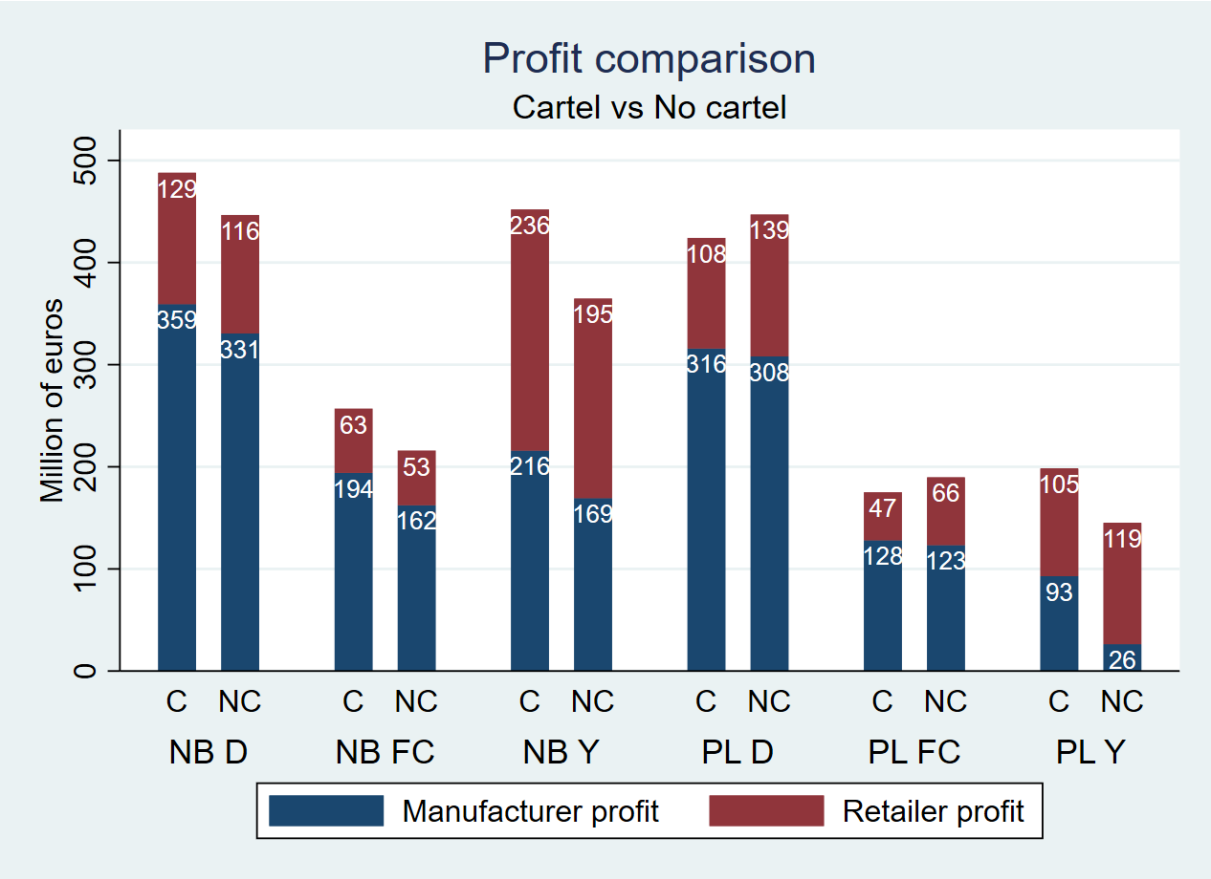
	National brands			Private labels		
	Yogurts	Fresh cheese	Other desserts	Yogurts	Fresh cheese	Other desserts
$\lambda = \hat{\lambda}$						
Price	0.73	0.54	1.74	-11.31	-9.28	-7.31
Market share	-19.24	-16.99	-13.00	15.02	43.58	30.19
Margins						
Retailer	3.52	1.91	3.49	-1.87	-1.38	-1.51
Manufacturer	-5.78	-0.29	0.74	-77.39	-33.47	-26.24
Total margin	0.77	0.35	2.14	-36.51	-24.77	-19.76
Profits						
Retailer	-17.10	-15.44	-9.44	12.60	41.04	28.05
Manufacturer	-21.36	-16.70	-7.56	-71.65	-3.84	-2.64
Industry	-19.14	-16.39	-8.06	-26.77	8.17	5.18
$\hat{\lambda}$ **or 0.50 if** $\hat{\lambda} < 0.50$						
Price	0.34	0.53	2.28	-7.36	-12.84	-14.19
Market share	-27.13	-25.79	-17.40	-15.69	55.11	80.94
Margins						
Retailer	4.27	2.59	5.10	-0.75	-2.64	-4.79
Manufacturer	-9.16	-0.67	1.19	-82.29	-68.47	-70.16
Total margin	0.23	0.28	3.16	-38.12	-50.77	-53.36
Profits						
Retailer	-25.51	-24.58	-12.51	-16.35	49.68	72.61
Manufacturer	-29.06	-26.52	-8.39	-8.38	-51.60	-47.01
Industry	-27.20	-26.04	-9.45	-47.81	-24.44	-16.50
$\hat{\lambda} = 1$						
Price	-0.00	0.19	2.93	-10.81	-19.10	-17.96
Market share	-37.71	-35.70	-15.76	-24.70	100.29	97.01
Margins						
Retailer	6.99	3.97	7.66	-0.46	-3.50	-5.17
Manufacturer	-10.68	-0.09	2.38	-	-	-
Total margin	1.48	1.09	5.08	-46.65	-73.95	-75.50
Profits						
Retailer	-35.50	-34.14	-11.36	-25.38	94.52	87.81
Manufacturer	-38.94	-36.50	-2.80	-	-	-
Industry	-37.14	-35.92	-5.07	-60.21	-47.85	-52.00

Table 7: **Change in prices per brand in the no collusion scenarios (in percentage).**

	Bargaining weights		
	$\hat{\lambda}$	$\hat{\lambda}$ or 0.50 if $\hat{\lambda} < 0.50$	$\lambda = 1$
Brand 1	2.76	3.56	5.12
Brand 2	1.36	2.99	2.97
Brand 3	1.27	2.45	5.06
Brand 4	-0.01	-0.45	-0.01
Brand 5	0.04	-0.51	-1.22
Brand 6	0.31	0.22	0.57
Brand 7	-1.29	-2.09	-2.83
Brand 8	0.45	0.16	-0.47
Brand 9	0.90	0.86	0.83
Brand 10	1.77	2.40	2.08
Brand 11	2.05	2.27	4.13
Brand 12	1.22	1.64	2.68
Brand 13	0.81	-0.00	3.08
Brand 14	0.71	0.51	-0.68
Brand 15	-0.38	-0.85	-3.00
Brand 16	0.86	0.69	-0.05
Brand 17	0.84	1.20	1.35
Brand 18	-0.52	-1.16	-1.42
Brand 19	5.92	8.50	7.81
Brand 20	2.17	2.48	3.18
PL- Other desserts	-7.31	-14.19	-17.96
PL- Fresh cheese	-9.28	-12.84	-19.10
PL Yogurts	-11.31	-7.36	-10.81
Consumer surplus	+0.25	+0.45	+0.73

also (slightly) negative, meaning that retailers do not perfectly transmit the decrease in PL wholesale prices to consumers. It follows that PL providers' profits are lower in the no cartel situation with the higher profit loss for the yogurt category, while retailers' profits on PL products are higher. As shown in Figure 2, the total industry profits for PLs increase in the no cartel situation for fresh cheese and other dairy dessert categories but not for yogurt. For this later category, the loss of PL providers is too high and cannot be compensated for by the gain in retailers' profits. This result is due to the high bargaining weight of retailers with respect to PL providers, as explained previously.[15]

Figure 2: Impact of the non collusion scenario on manufacturers and retailers' profits



We denote by NB and PL national brand and private label products, respectively.
We denote Y, FC, and D the yogurt, fresh cheese, and other dairy dessert categories.
Finally, we denote C and NC as the cartel and non-cartel scenarios.

Changes in PL prices will also affect the NB market. The theory (umbrella effect) predicts that when removing

[15] We can see in Table 6 that the same effect is obtained for fresh cheese and other dairy dessert PL products when the bargaining weight of those PL products is increased.

collusion, the increase in PL market shares should lead to a drop in the demand for NBs and thus NB prices (see Inderst, Maier-Rigaud, and Schwalbe (2014), for instance). We should see this outcome on NB market shares and prices, as NBs act as (imperfect) substitutes of PL products on the market. We find a lower market share for NBs (see Table 6) with the highest decrease for the yogurt category (-19%) but not a decrease in the average final prices in each category.[16] Contrary to what may be expected, final prices slightly increase (by 0.54% for the fresh cheese category to 1.74% for the other dairy dessert category). Nevertheless, we observe a decrease in wholesale prices for NBs when the collusion is removed, as the manufacturers' margins are reduced (except for the other dairy dessert category), which is consistent with the umbrella effect. Indeed, when PL providers collude, they are able to reduce the share of PLs on the market, which reduces the bargaining position of retailers: if the negotiation fails with NB manufacturers, the profit they can make with the use of their PLs is lowered (the retailers' disagreement payoff is reduced). There is an additional effect linked to the strategic reaction of retailers with respect to NBs. The NB wholesale price reduction is not translated into lower NB final prices. They provide both the NB and PL products on their shelves, which are differentiated. They thus have the incentive to charge higher NB price to take advantage of consumer segmentation (see Dobson and Chakraborty (2015)). By lowering PL prices and increasing NB prices, retailers can attract more consumers who are sensitive to low-priced products and increase the consumption of PL products, while extracting as high a price as possible from consumers who are more sensitive to NB brands. It results in the total industry margin (defined as the final price minus production and distribution costs) being higher under the non collusion scenario at the benefit of retailers for NB products. Globally, retailers' and manufacturers' profits on the NB markets are lower because of the decrease in market shares, such that the total industry profit decreases on the NB market (see Figure 2).

While manufacturers are clearly negatively affected by the impact of removing the cartel both on NB and PL products, the impact of profits is much more balanced for retailers. They lose profits on NBs but gain on the PL categories, such that the profit the retailers can gain when the collusion stops can be partially or totally offset by changes in the NB market (Table 8). However, the impact on retailers' profits differ from one retailer to another. We find that profits increase for retailers 5 and 6 by more than 2% whereas they slightly decrease for all other

[16] However, the impact of collusion on the prices of NB products is heterogeneous, varying from -1.29 to +5.9, which is the result of the substitution pattern between products.

retailers in the absence of collusion between PL manufacturers.[17] However, at the global retail level, the effect of the no-collusion scenario is very small and even slightly negative, as shown in Table 8. At the total industry level, the no-collusion scenario leads to a reduction in the total industry profits which is mainly due to the negative impact on NBs.

The more the bargaining weight is in favor of retailers for PLs, the larger the impact on PL market shares, such that the market and profits effects discussed above are reinforced as shown in Table 6: the qualitative results are unchanged while the magnitude of changes differ.

Finally, we find that removing the cartel benefits consumers as expected but the gain is relative low, even when the bargaining weights of retailers increase. The reason why this effect is not higher is linked with the counterbalancing impact on NB product prices (see Table 6). To conclude, it seems that the cartel does not affect consumers too much. It benefits PL manufacturers, but also large NB manufacturers, which have benefited from a spillover effect on to NBs. Retailers are not greatly affected by the cartel as they have indirectly benefited from higher profits for NB products.

Table 8: **Impact of the no collusion scenario on firms' profits in millions of euros**

	National brands	Private labels
$\lambda = \hat{\lambda}$		
Retailer	-63.6	63.5
Manufacturer	-110.8	-79.2
Industry	-174.4	-15.6
$\hat{\lambda}$ **or 0.50 if** $\hat{\lambda} < 0.50$		
Retailer	-94.6	86.4
Manufacturer	-150.7	-290.3
Industry	-245.4	-203.9
$\hat{\lambda} = 1$		
Retailer	-123.3	112.8
Manufacturer	-178.8	-537.0
Industry	-302.2	-424.2

[17] Profits decrease respectively by 0.09%, 2.18%, 0.48%, 0.54% and 0.75% for retailers 1, 2, 3, 4 and 7 and increase by 2.63% and 2.39% for retailers 5 and 6.

5 Conclusion

In this paper, we propose a three-step methodology to investigate the effects of the "yogurt cartel" in France on the dairy dessert market and assess the effect on prices and welfare of such a cartel. The methodology consists of developing a structural demand and supply model and testing alternative supply models where PL manufacturers can collude (or not). We find empirical evidence for collusive behaviour between PL providers. Using the empirical results on demand and supply, we simulate a non-collusive counterfactual scenario and find that PL prices would effectively decrease as expected. In addition, we highlight the indirect effects on the NB products and show that the umbrella effect leads to a decrease in NB wholesale prices which would not be transmitted to final prices. On the contrary, it seems that retailers would have an incentive to segment even more the NB and PL markets such that NB prices would even increase. Regarding profit, we find that not only PL providers but also NB manufacturers lose when the cartel is dismantled. Due to strategic reaction on NB and PL segments, retailers were not so much affected by the cartel. This means that PL providers (that are also suppliers of NBs) would gain from the cartel not only on PL products but also on NB products. This result gives new perspectives for competition policy and the analysis of cartels' anticompetitive practices in the food manufacturing and retailing sectors. We highlight the fact that competition authorities should take into account the effect on NB products as well, which has not been the case in the "yogurt cartel" situation. Indeed, the French competition authorities only take into account the damages for PL products while the damages could be different when taking into account the NB dairy dessert market. The competition between NB and PL products reduces the impact of the collusive behaviour for both retailers and consumers. The methodology we provide in this article could be more generally used for analysing collusive practices in vertically related industries and to infer the impacts for both providers and sellers. The limit of the analysis however is that, with the available data, it would be a challenge to precisely identify the providers of PLs for each retailer. Such data would allow us to develop models that take into account the joint procurement of PLs and NBs and identify the true impact for each provider.

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6 Appendices

6.1 Demand: estimation method and results

To estimate the set of demand parameters, we maximize the log likelihood function which can be written as $LL(\theta) = \sum_{i=1}^{I} ln(P_{ijt})$ where $P_{ijt} = \int s_{ijt} dP_v(v)$ is the unconditional probability for household i to buy product j at time t and $s_{ijt} = \frac{\exp(\delta_{jt}+\mu_{ijt})}{1+\sum_{k=1}^{J_t}\exp(\delta_{kt}+\mu_{ikt})}$.

When unobserved heterogeneity in household preferences is introduced via random parameters, the choice probabilities no longer have a closed-form expression. The log likelihood function is an integral that can be difficult to solve analytically. In this case, the Simulated Maximum likelihood method is used as in Revelt and Train (1997). We estimate the demand model (1) using a random subsample of 100,000 observations.

This estimation method relies on the assumption that all product characteristics X_{jt} are independant of the error term ε_{ijt} in the utility function (1). However, assuming $\varepsilon_{ijt} = \xi_{jt} + e_{ijt}$ where ξ_{jt} is a product-specific error term varying across periods and e_{ijt} is an individual specific error term, the independence assumption cannot hold if unobserved factors included in ξ_{jt} (and hence in ε_{ijt}) such as promotions, displays, and advertising are correlated with observed characteristics X_{jt}. For instance, we do not know the amount of advertising that firms expend each month for their brands. This effect is thus included in the error term because advertising might play a role in the choice of dairy desserts by households. As advertising is an appreciable share of dairy dessert production costs, it is obviously correlated with prices. To solve the problem that omitted product characteristics might be correlated with prices, we use a two-stage residual inclusion approach as in Petrin and Train (2010) and Terza, Basu, and Rathouz (2008). We then regress prices on instrumental variables as well as exogenous variables of the demand equation:

$$p_{jt} = W_{jt}\gamma + \kappa_{r(j)} + \kappa_{c(j)} + \tau_N N_{jt} + \tau_L L_{jt} + \tau_C C_{jt} + \eta_{jt} \tag{21}$$

where W_{jt} is a vector of input price variables, γ is the vector of associated parameters, η_{jt} is an error term that captures the remaining unobserved variations in prices, and $\kappa_{c(j)}$, $\kappa_{r(j)}$, N_{jt}, L_{jt} and C_{jt} are the exogenous variables from the demand equation. The estimated error term $\widehat{\eta}_{jt}$ of the price equation includes some omitted variables such as advertising variations, promotions, and shelf displays that are not captured by the other exogenous variables of

the demand equation and by the cost shifters. Introducing this term in the mean utility of consumers δ_{jt} allows us to capture unobserved product characteristics varying across time. Prices are now uncorrelated with the new error term $\xi_{jt} + \varepsilon_{jht} - \pi\widehat{\eta}_{jt}$. We then write:

$$\delta_{jt} = \beta_{r(j)} + \beta_{c(j)} + \alpha_j p_{jt} + \gamma_N N_{jt} + \gamma_L L_{jt} + \gamma_C C_{jt} + \xi_{jt} + \pi\widehat{\eta}_{jt} \tag{22}$$

where π is the estimated parameter associated with the estimated error term of the first stage.

In practice, we use the price indexes for the main inputs used in the production of dairy desserts, that is, raw milk and packaging. Cost variables in equation (22) include the price indexes of cow milk, and plastic as it is unlikely that input prices are correlated with unobserved determinants of demand for dairy desserts.[18] The dairy dessert industry only represents a very small share of the demand for those inputs, which justifies the absence of a correlation between input prices and unobserved determinants of the demand for fluid milks. The raw milk price index is interacted with the manufacturer dummies because we expect that manufacturers obtain different prices from suppliers for raw materials . Estimation results of the price equation (22) are presented in Table 9. We can see that the instruments are not weak since the F-test show that instruments are statistically significant. The results of the demand estimation are presented in Table 10.

[18]These indexes are provided by the French National Institute for Statistics and Economic Studies.

Table 9: **Results on price equation**

	Coefficient (standard error)
Cow milk	-0.91 (0.42)**
Cow milk × M2	0.94 (0.16)***
Cow milk × M3	-0.93 (0.15)***
Cow milk × M4	2.49 (0.20)***
Cow milk × M5	5.36 (0.20)***
Cow milk × M6	-2.73 (0.19)***
Plastic	0.018 (0.00)***
Retailer fixed Effects	
R1	-0.11 (0.05)**
R2	0.07 (0.05)
R3	0.00 (0.05)
R4	0.09 (0.05)*
R5	0.37 (0.05)***
R6	-0.31 (0.06)***
Category fixed Effects	
Yogurts	0.84 (0.75)
Fresh cheese	2.05 (0.75)***
Other dairy desserts	1.75 (0.75)**
Plain (N_{jt})	-0.85 (0.06)***
Diet (L_{jt})	-0.17 (0.05)***
Chocolate (C_{jt})	0.41 (0.09)***
F-test of IVs	**205.75***** **(0.00)**
R-squared	0.94
Number of observations	2,628

***significant at 1%; **significant at 5%;*significant at 10%

Table 10: **Demand results**

	Coefficient (standard error)
Price × Yogurts	-1.81 (0.00)***
Price × Fresh cheese	-2.88 (0.00)***
Price × Other dairy desserts	-2.46 (0.00)***
Std Price	0.84 (0.00)***
Error term	1.86 (0.00)***
Retailer fixed Effects	
R1	0.24 (0.00)***
R2	0.22 (0.00)***
R3	0.37 (0.00)***
R4	0.92 (0.00)***
R5	0.66 (0.00)***
R6	-0.43 (0.00)***
Category fixed Effects	
Yogurts	2.66 (0.00)***
Fresh cheese	6.54 (0.00)***
Other dairy desserts	5.93 (0.00)***
Plain (N_{jt})	-1.35 (0.00)***
Diet (L_{jt})	-0.33 (0.00)***
Chocolate (C_{jt})	1.68 (0.00)***
LL	331,663
Number of observations	100,000

***significant at 1%; **significant at 5%;*significant at 10%