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An Empirical Analysis of Mergers: Efficiency Gains and Impact on Consumer Prices

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Abstract

In this article, we extend the literature on merger simulation models by incorporating its potential synergy gains into structural econometric analysis. We present a three-step integrated approach. We estimate a structural demand and supply model, as in Bonnet and Dubois (2010). This model allows us to recover the marginal cost of each differentiated product. Then we estimate potential efficiency gains using the Data Envelopment Analysis approach of Bogetoft and Wang (2005), and some assumptions about exogenous cost shifters. In the last step, we simulate the new price equilibrium post merger taking into account synergy gains, and derive price and welfare effects. We use a homescan dataset of dairy dessert purchases in France, and show that for two of the three mergers considered, synergy gains could offset the upward pressure on prices post. Some mergers could then be considered as not harmful for consumers.

1 Introduction

The merger of firms play an important role in an economy and are addressed by public policy. Annually, the Federal Trade Commission (FTC) receives notification from firms aiming to merge valued at over a trillion U.S. dollars in total (Farrell and Shapiro (2001)). During 2000 and 2010, the FTC triggered around 1,700 investigations for merger cases in order to assess possible anti-competitive effects. However, most mergers are ruled as being unproblematic, which suggests that most mergers are neutral or pro-competitive and only a small fraction are revised. The competition authorities first use market concentration tests, such as the Herfindahl-Hirschman-Index (HHI), to gauge whether or not prospective mergers would produce a firm of such a magnitude that it would adversely impact social welfare. The advantage of this test is that data on market shares can be observed, and the HHI and its change post merger can be easily computed. The merger guidelines of the European Commission state that mergers in markets with a post-merger HHI below 1,000 are generally unproblematic. Mergers with a post-merger HHI between 1,000 and 2,000, and a change in concentration below 250, are also considered to be unproblematic. When the post-merger HHI is higher than 2,000, the threshold for the critical change is 150. However, the HHI index is a very crude measure for likely competitive effects post merger and does not capture other important factors that that may increase or decrease consumer welfare. Among other factors, the particular focus of this paper is the strategic reaction of all firms in the industry and the synergy gains induced by a merger.

In the case of horizontal mergers, there are two opposing forces in terms of price. The higher market concentration exerts an upward pressure on prices as the merged firm has more market power. This in turn allows competitors outside the merger to increase their prices, such that in equilibrium the whole industry raises their prices. On the other hand, synergy gains in the form of lower marginal costs lead to a downward pressure on prices after a merger. The question is what is the net effect of these two forces? In Farrell and Shapiro (1990), one of the main results is that mergers without synergies always lead to price increases and consumers are worse off.

Since the mid 90's, merger simulation models based on the New Empirical Industrial Organization literature have been increasingly used in antitrust cases in the US and Europe as a complementary tool, in addition to classical methods that are based on market concentration. These simulations consist of describing consumer behavior in the market in terms of substitution patterns and the strategic behavior of firms, and then taking into account the strategic behavior of all competitors in the industry. Nevo (2000) estimates a random coefficient logit model in order to analyze merger effects in the ready-to-eat cereal industry. Ivaldi and Verboven (2005) use a nested logit model to represent the customers' preferences on the truck market and assess the effects of the merger between Volvo and Scania. In their study, they compare the merger effects without synergies and with a hypothetical 5% decrease in marginal costs. Bonnet and Dubois (2010) conduct a counter-factual analysis of a de-merger between Nestlé and Perrier in a structural model of vertical relationships between bottled water manufacturers and retail chains. Fan (2013) assesses the merger effects in the newspaper market allowing for adjustments in product characteristics as well as prices. Mazzeo et al. (2014) also look at merger effects when firms can reposition their products post merger. Earlier work on merger analysis is given, for example, by Baker and Bresnahan (1985), Berry and Pakes (1993), Hausman and Leonard (2005), Werden and Froeb (1994) and Werden and Froeb (1996). Even though the development of simulation models is still young, their importance is likely to grow in the future as computational power and the availability of data steadily increases. However, these models assume that either the cost structure does not change post merger and then there is no synergy effect, or ad hoc synergy gains as a 5% decrease in marginal cost. Without synergies, we only capture the force that exerts the upward pressure on prices due to a higher concentration, which implies that the results can be interpreted as a maximal benchmark in this case (Budzinski and Ruhmer (2009)). Ashenfelter et al. (2015) show empirical evidence that synergies can offset price increases, which supports our findings. They find that a merger in the beer industry actually produced enough synergy gains to offset the effect due to increased market concentration. They show that prices increase by 2% without synergies and that synergy countered this effect on average.

We propose a new approach to extend the merger simulation literature taking into account synergy gains in the case of horizontal mergers. This approach consists of a three-step method. First, we develop an empirical model of demand and supply as in Villas-Boas (2007) or Bonnet and Dubois (2010).[1] For the supply

[1] Also see Rosse (1970), Bresnahan (1989), Berry (1994), Goldberg (1995), Berry et al. (1995), Slade (2004), Verboven (1996), Nevo (1998), Nevo (2000), Nevo (2001) and Ivaldi and Verboven (2005)

side we consider a vertical structure as in Rey and Verge (2010), extended to multiple upstream and downstream firms. The retailers on the downstream level engage in price competition for consumers and are supplied by the upstream firms. It is assumed that two-part tariff contracts are used in the vertical relationship in order to avoid the double marginalization problem and maximize profits in the vertical chain. The demand side is estimated using a random coefficient logit model, which ensures the flexible substitution patterns of consumers. Using an integrated structural econometric model which takes into account the consumer substitution patterns and the strategic reaction of firms in the market considered, we are able to recover marginal costs for each product sold in the market. Using exogenous cost shifters, we are able to estimate the impact of some inputs on the marginal costs and then assess the quantity of inputs needed to produce one additional unit of product. The second step uses the Data Envelopment Analysis (DEA) method to estimate the potential efficiency gains of mergers following Bogetoft and Wang (2005). We then obtain an estimated amount of marginal cost savings for the merger. Finally, integrating the change in the structure of the industry induced by the merger and the change in marginal cost for each product, we are able, in a third step, to assess the total effect of the merger on consumer prices.

We apply this integrated approach to the French dairy dessert market. This sector is composed of six main manufacturers (Danone, Nestlé, Senoble-Triballat, Yoplait, Andros, Sojasun and Mom) which sell national brand products and some small to medium firms that sell private label products. We estimate the synergy gains for all 78 possible bilateral mergers. The derived synergy gains from the

Data Envelopment Analysis focus on merger gains that arise due to economies of scope, and leaves out other potential sources of gain, such as scale economies. There is a large heterogeneity of potential merger gains which shows that the 5% ad hoc rule can be very misleading. Considering all possible mergers, we find that around 44% of the mergers are expected to produce no synergies at all, while 18% of the mergers are expected to produce synergies higher than 5%. The remaining 38% produce synergies lower than 5%. Considering all bilateral mergers, the average marginal cost savings are 2.55% which would then be the best approximation ex ante for merger gains in this industry.

We choose to simulate the new price equilibrium for three selected mergers with low and high cost savings and for low and high changes in market concentration. To disentangle the effect of synergy gains and market concentration, we compare four scenarios for the three selected mergers. First, we simulate the mergers without any reduction in marginal costs, taking into account only the industry change; second we estimate the merger without the structural change in the industry considering only the lower marginal costs; and third, we take into account both the new industry structure and the estimated reductions in marginal costs of the merged entity. Finally, in order to compare with the common analyses of merger simulations, we simulate the 5% synergy gain assumption.

As expected, without synergy gains, all three mergers lead to an increase in industry prices, a decrease in consumer surplus and an increase in industry profits. In the case when we consider only the reduced marginal costs of the merging firms but not the change of the industry structure, prices decrease for both merging firms and outside firms. Firms that experience the savings always increase profits, while outside firms always lose in this scenario. Not surprisingly, consumer surplus increases.

Taking into account the structural changes of the industry and the reduction of the marginal cost delivers the net effect on the market of the two opposing forces. The three mergers we consider have a difference in HHI and a cost reduction of 390 and 7.84%, 195 and 1.88%, and 67 and 3.37%, respectively. The first merger represents a case of two main players in the market that have large potential savings. The second merger is a case where a major player merges with a private label producer. The last merger is a case of two private label manufacturers. We find that the downward pricing pressure can outweigh the upward pricing pressure, as is the case in the first and third merger. Our results suggest that merged firms may employ an asymmetric pricing strategy post merger in order to shift consumers from one manufacturer to the other. We find that the 5% ad hoc cost saving rule is not appropriate as a rule of thumb for the considered mergers as it does not reliably capture market outcomes post merger. Alongside the methodological contribution, we also aim to disentangle the effects of synergy gains and concentration effects. For most market outcomes, such as changes in prices, industry profits and consumer surplus, our results suggest that concentration and synergies have an equal weight on the direction of the effect. By comparing the net effect to the two benchmark cases we see that these effects lie in the middle of both extremes. However, this is not true for an important outcome; that is, the changes in the profits of the merged entities. We find that the changes in profits are practically only driven by synergy gains.

This is important as the changes in profits are the main incentive for managers to merge. This suggests it is not the expected profit increase due to concentration but rather to synergy gains that creates merger incentives.

In summary, we make several contributions. First, we propose a framework to estimate potential synergy gains of horizontal mergers. Second, we show that in the French dairy dessert industry, the 5% ad hoc rule overstates the pro-competitive effects of mergers. Third, we show that firms may use asymmetric pricing strategies post merger. Fourth, while for changes in consumer surplus post merger, upward and downward pricing pressure has a similar impact on the final effect, firms' incentives to merge are only driven by potential cost savings.

The rest of the article is organized as follows. Section 2 presents the facts of the considered market and summary statistics. Section 3 describes the methodological approach containing the supply and demand model, the DEA method and how it is used to estimate potential merger gains, and the simulation method that allows us to estimate the new price equilibrium. Section 4 shows the empirical findings, and last, Section 5 concludes.

2 The French dairy dessert market

As an application, we focus on the French dairy dessert market for two reasons. First, this market is composed of oligopolies with market power, in which manufacturers adjust margins when they face cost shocks. Second, dairy desserts are mainly composed of milk which simplifies the specification of the cost function in this sector.

We use home scan data on food products provided by the society Kantar TNS WorldPanel, 2011. These data include a variety of purchase characteristics, such as quantity, price, retailer, brand, and product characteristics. We consider the market of desserts to be composed of 30% of purchases of dairy desserts and 70% of purchases of other products, that we will call the "outside good".[2] The data set contains more than 2.5 million purchases over the year 2011. We consider seven retailers: five main retailers and two aggregates (one for the hard discounters and one for the remaining hypermarkets and supermarkets). We also consider six manufacturers of national brands and seven manufacturers of store brands, one for each retailer. Table 1 reports market shares by producer and category. Manufacturers 7-13, which represent the private label products, have a combined market share of around 41%. The market shares for national brand manufacturers vary from 1% to 24%. Table 2 presents average prices by manufacturer and category. On average, the private label products have the lowest retail prices followed by the three largest manufacturers 1 to 3. The small firms 4, 5 and 6 charge the highest retail prices on average. By category, yoghurts have the lowest retail prices followed by desserts and petit suisse, respectively.

We consider 26 brands including an aggregate brand for private labels for each of the three categories. As products are defined by the combination of brands and retailers, we get 162 products for each month.

[2]This outside option is composed of all other desserts, such as fruits, pastries, and ice creams.

Table 1: Market Shares by Producer and Category

	Category			
	Yoghurt	Dessert	Petit Suisse	Total
Manufacturer 1	0.38	0.21	0.13	0.24
Manufacturer 2	0.08		0.20	0.12
Manufacturer 3	0.11	0.22		0.08
Manufacturer 4	0.02	0.003	0.08	0.04
Manufacturer 5	0.02	0.05	0.03	0.03
Manufacturer 6	0.03			0.01
Manufacturer 7	0.07	0.09	0.11	0.09
Manufacturer 8	0.04	0.05	0.07	0.06
Manufacturer 9	0.05	0.07	0.06	0.06
Manufacturer 10	0.09	0.13	0.11	0.11
Manufacturer 11	0.03	0.04	0.05	0.04
Manufacturer 12	0.04	0.06	0.05	0.05
Manufacturer 13	0.05	0.08	0.09	0.08

Table 2: Average Retail Prices by Producer and Category

	Category		
	Yoghurts	Desserts	Petit Suisse
Manufacturer 1	1.90	2.44	2.00
	(0.59)	(0.26)	(0.12)
Manufacturer 2	2.19	.	3.02
	(0.43)	.	(0.51)
Manufacturer 3	1.75	2.20	.
	(0.15)	(0.19)	.
Manufacturer 4	2.45	2.25	4.42
	(0.27)	(0.04)	(0.39)
Manufacturer 5	3.30	2.83	6.28
	(0.39)	(0.29)	(0.69)
Manufacturer 6	2.92	.	.
	(0.16)	.	.
PL products	1.33	1.76	2.49
	(0.13)	(0.15)	(0.40)

Standard deviation are in parenthesis and represent variation across brands and periods.

3 Methodology

Here we introduce the methodology used for estimating the equilibrium model, efficiency gains of potential mergers, and counterfactual analysis. First, we introduce the demand and supply framework of Bonnet and Dubois (2010) that allows us to recover the marginal cost of each product in the market. Second, we show how Bogetoft and Wang (2005) use DEA to estimate efficiency gains of mergers and how we incorporate this method into the framework of Bonnet and Dubois (2010). Using the estimated marginal costs and exogenous prices of inputs, we are then able to recover the quantity of inputs needed to produce each product at each time period. Finally, we present the merger simulation method that also accounts for the new industry structure and synergy gains.

3.1 The equilibrium model

In this section, we introduce the demand and supply specification and present the identification and estimation strategy. For the demand, we use a random coefficient logit model as it allows for flexible substitution patterns for consumers between alternatives. Compared to the standard logit model, this leads to more realistic estimates of own- and cross-price elasticities, which in turn gives better margins and thus better estimates for marginal costs. For the supply model, we use two-part tariff contracts between manufacturers and retailers, as in Bonnet and Dubois (2010).

3.1.1 Demand model and identification

We use a random utility approach and in particular a random coefficient logit model, as in McFadden and Train (2000). We define the indirect utility function of consumer i of buying product j at time t as:

$$V_{ijt} = \beta_{b(j)} + \beta_{r(j)} + \alpha_i p_{jt} + \xi_{jt} + \epsilon_{ijt}, \tag{1}$$

where $\beta_{b(j)}$ and $\beta_{r(j)}$ are time invariant brand and retailer fixed effects, respectively, p_{jt} is the price of product j at time t, ϵ_{ijt} is an unobserved individual error term that is distributed according an extreme value distribution of type I, and ξ_{jt} is also unobserved by the econometrician and represents changes in product characteristics over time. We allow for consumer heterogeneity for the disutility of the price specifying the price coefficient α_i as follows:

$$\alpha_i = \alpha + \sigma v_i, \tag{2}$$

where α is the average price sensitivity, v_i follows a normal distribution that represents the deviation to the average price sensitivity and σ is the degree of heterogeneity.

We allow for an outside option, that is, the consumer can choose another alternative from amongst the J products of the choice set. The utility of the outside good is normalized to zero, which means $U_{i0t} = \epsilon_{i0t}$.

The mean utility is defined as $\delta_{jt} = \beta_{b(j)} + \beta_{r(j)} - \alpha p_{jt} + \xi_{jt}$ with a deviation defined as $\nu_{ijt} = -\sigma v_i p_{jt}$, such that we get:

$$V_{ijt} = \delta_{jt} + \nu_{ijt} + \epsilon_{ijt}. \tag{3}$$

The individual probability of buying the product j takes the logit formula as follows:

$$s_{ijt} \equiv \frac{exp\left(\delta_{jt} + \nu_{ijt}\right)}{1 + \sum_{k=1}^{J_t} exp\left(\delta_{kt} + \nu_{ikt}\right)}. \tag{4}$$

The aggregated market share of product j is thus given by:

$$s_{jt} = \int_{A_{jt}} s_{ijt}\, \phi\left(v_i\right) dv_i, \tag{5}$$

where A_{jt} is the set of consumers buying the product j at time t and ϕ is the density of the normal distribution.

The own- and cross-price elasticities are given by:

$$\frac{\partial s_{jt}}{\partial p_{kt}} \frac{p_{kt}}{s_{jt}} = \begin{cases} -\frac{p_{kt}}{s_{jt}} \int \alpha_i s_{ijt} \left(1 - s_{ijt}\right)\ \phi\left(v_i\right) dv_i & if \quad j = k \\ \frac{p_{kt}}{s_{jt}} \int \alpha_i s_{ijt} s_{ikt}\ \phi\left(v_i\right) dv_i & otherwise. \end{cases} \tag{6}$$

The unobserved term ξ_{jt} is likely to be correlated with price as it captures, for example the advertising expenses of the manufacturers. Advertising influences purchasing decisions by consumers, and as it is costly, it will certainly also affect the price. Failing to control for this unobserved product characteristic results in a correlation between price and the error term of the demand equation, leading to a biased estimate of the price coefficient. In order to deal with this issue, we use the two-stage residual inclusion approach (Terza et al. (2008); Petrin and Train (2010)). In the first step, we regress prices on a set of instrumental variables and exogenous variables of the demand equation. As instruments, we use input prices, noted W_{jt}:

$$p_{jt} = W_{jt}\gamma + \theta_{b(j)} + \theta_{r(j)} + \eta_{jt}, \tag{7}$$

where $\theta_{b(j)}$ and $\theta_{r(j)}$ are brand and retailer fixed effects, respectively. The error term η_{jt} captures the effect of the omitted variables, such as advertising costs. If we include this error term in the mean utility of the demand equation as regressor, it captures the effect of the unobserved characteristics on price. This means the error term of the demand equation, $\zeta_{jt} = \xi_{jt} - \lambda\hat{\eta}_{jt}$, will not be correlated with the price. We can then write the mean utility as:

$$\delta_{jt} = \beta_{b(j)} + \beta_{r(j)} - \alpha p_{jt} + \lambda\hat{\eta}_{jt} + \zeta_{jt}. \tag{8}$$

3.1.2 Supply model

This section presents the theoretical model we use for the supply side. Manufacturers and retailers engage in a vertical relationship. We know that linear pricing, where the downstream firm pays a per unit price to the manufacturer, leads to a double marginalization problem, and profits in this chain are not maximized. This is why the parties often use two-part tariffs. We then use the same empirical framework of Bonnet and Dubois (2010) to model the vertical relationships in the dairy dessert market. We also assume that manufacturers impose the final prices on the retailers. Bonnet et al. (2015) show that these kind of contracts are preferred to linear contracts or two-part tariff contracts without resale price maintenance in the dairy dessert market. Other empirical studies suggest that this contract is used in other markets as well (Bonnet and Réquillart (2013); Bonnet and Dubois (2010); Bonnet et al. (2015)). Furthermore, it is assumed that manufacturers have all the market power with respect to the retailers. The game between manufacturers and retailers is then described in the following:

Stage 1: Manufacturers simultaneously propose two-part tariff contracts to the retailers. It is assumed that those contracts are public[3] and consist of a per unit wholesale price, a fixed fee, and the final price of the products.

Stage 2: After observing the offers, the retailers simultaneously accept or reject them. In case of the rejection of a retailer, they earn an exogenous outside option. If all retailers accept, demand and contracts are satisfied.

Rey and Verge (2010) prove the existence of a continuum of equilibrium in which consumer prices are decreasing in wholesale prices.

Let there be J different products defined by the cartesian product of brand and retailer sets. Let there be R retailers, and S_r is the set of products sold by retailer r. There are F manufacturers and let G_f be the set of products produced by manufacturer f. F_j is the fixed fee paid by the retailer for selling product j, w_j is the according wholesale price and p_j is the final retail price. Let $s_j(p)$

[3]Following the argument of Bonnet and Dubois (2010), this assumption is justified by the non-discrimination laws of comparable services. They argue that in the case of resale price maintenance only the offered retail prices are essential for the decision-making of the retailers.

be the market share of product j, M is the total market size, and μ_j and c_j are the constant marginal costs of production and distribution of the product j, respectively.

The profit of the retailer r is given by:

$$\Pi^r = \sum_{j \in S_r} [M(p_j - w_j - c_j) s_j(p) - F_j], \tag{9}$$

and the profit of the manufacturer f is:

$$\Pi^f = \sum_{k \in G_f} [M(w_k - \mu_k) s_k(p) + F_k], \tag{10}$$

subject to the retailers' participation constraints: $\forall\ r = 1, ..., R,\ \Pi^r \geq \overline{\Pi}^r$. As already explained, manufacturers make take-it or leave-it offers to retailers. However, they have to respect the participation constraint of the retailers. Let the outside option $\overline{\Pi}^r$ of the retailer be a constant that can be normalized to zero, such that we have for the participation constraint $\Pi^r \geq 0$. As Rey and Verge (2010) show, this participation constraint is binding and can be substituted in (10) which gives the following expression:

$$\Pi^f = \sum_{k \in G_f} [M(p_k - \mu_k - c_k) s_k(p)] + \sum_{k \notin G_f} [M(p_k - w_k - c_k) s_k(p)] - \sum_{j \notin G_f} F_j. \tag{11}$$

Rey and Verge (2010) point out that a manufacturer internalizes the margin of the whole vertical chain of its own products, but also internalizes the retail margin of its competitors. We see that this profit expression does not depend on the franchise fees of the manufacturer f. As the manufacturers simultaneously propose the contracts to the retailers, the wholesale prices and the fixed franchise fees of the other manufacturers do not affect the terms of the contracts offered by the manufacturer f. Moreover, when resale price maintenance is introduced, the wholesale prices do not affect the profit of the manufacturer as it can conquer the retail profits via the franchise fee. However, it does influence the behavior of its competitors. The optimization problem of f then becomes:

$$\max_{p_k \in G_f} \sum_{k \in G_f} [M (p_k - \mu_k - c_k) s_k (p)] + \sum_{k \notin G_f} [M (p_k^* - w_k^* - c_k) s_k (p)]. \tag{12}$$

In the absence of any additional restrictions, we are not able to separately identify the wholesale margins $w_k - \mu_k$ and the retail margins $p_k - w_k - c_k$. As suggested by Bonnet et al. (2015), we will assume that retail margins are equal to zero in the French dairy dessert market. The first order conditions for the manufacturer f under this condition are given by:

$$s_j (p) + \sum_{k \in G_f} (p_k - \mu_k - c_k) \frac{\partial s_k (p)}{\partial p_j} = 0 \quad \forall j \in G_f. \tag{13}$$

The first order conditions allow us to recover marginal costs mc_{jt} as the sum of costs of production and distribution. Note that the identified margin $p_k - \mu_k - c_k$ is equal to $w_k - \mu_k$ under the assumption of zero retail margins. It is useful to denote the identified margins in matrix notation as follows:

$$\hat{\Gamma}_f + \hat{\gamma}_f = - (I_f S_p I_f)^{-1} I_f s (p) \quad \forall f \in F. \tag{14}$$

The left-hand side is the sum of wholesale ($\hat{\Gamma}_f$) and retail ($\hat{\gamma}_f$) margins.[4] The margins are identified as a function of estimated demand parameters that are included in S_p, that is, the matrix of first derivatives of market shares with respect to price. I_f is the diagonal ownership matrix of firm f which takes the value 1 if the product belongs to the firm f and 0 otherwise. $s(p)$ is the vector of estimated market shares.

Using observed prices and estimated margins, we are able to recover marginal costs which are then used to estimate inputs in the next step.

3.2 Merger simulation

When assessing the implications of a merger, two main factors are in opposition. First, the change in industry implies an upward pressure on price, as the market power of the merged firm increases. Competitors also benefit from the decreased competitive pressure by increasing their prices. The second factor is the change of the cost structure of the merged firms. Synergies may reduce marginal production costs that firms can partially or completely transmit to final retail prices. Competitors have to follow and cut prices to prevent their customers from switching. The question is, what is the net effect on the price of these two opposing forces?

In this section, we present the methodology used to estimate cost savings from a potential merger, on the one hand, and the methodology used to evaluate the price effect of a merger — taking into account the estimated cost saving and the change of the industry — on the other hand. Section 3.2.1 describes

[4] Note that in our selected equilibrium, the latter one is equal to zero.

the source of potential cost savings. In Sections 3.2.2 and 3.2.3, we present the methodology on how we estimate the potential savings of production inputs. The method presented in Section 3.2.3 requires data on the inputs and the outputs of manufacturers. In Section 3.2.2, we show how we obtain these quantities from our data. Section 3.2.4 shows how we translate the input savings into marginal cost reductions, and finally, Section 3.2.5 describes how we simulate the new price equilibrium post merger and how we assess the effect on consumer surplus.

3.2.1 Synergies

Cost efficiencies are a major argument used by firms to justify a proposed merger in front of the regulatory authorities. Gugler et al. (2003) showed that synergies are present in about one third of the mergers. In this section, we discuss where synergies stem from in general, the relevant merger gains to focus on and we examine their suitability in the French dairy dessert industry.

Farrell and Shapiro (1990) describe three sources of merger gains. First, the merged firms can distribute their output across the participating firms, moving production to the more efficient production sites. This would not change the firms' knowledge or capital intensity. The changes in marginal costs and the associated gains are due to a reallocation to the production site with lower marginal costs pre-merger. Second, firms can shift capital from one firm to another in order to operate at a higher scale. Farrell and Shapiro (2001) argue that merger benefits that are due to economies of scale cannot be used to justify a merger in most cases. This is because if firms can reach a higher scale of production, and thus benefit from lower production costs without a merger, the benefits of a merger can be realized without an increase in market concentration which would be potentially harmful for consumers. They further explain that in the general case, market pressure should force firms to produce at a higher scale if possible, making a merger unnecessary. Third, firms can learn from each other. This involves the sharing of knowledge and management skills, or taking advantage of complementary patents. This could lead to a change in marginal cost after a merger. In this case, the marginal cost reduction is derived from economies of scope or harmony effects (Bogetoft and Wang (2005)).

An important question in this paper is identifying the source of synergies which is most likely to occur in the French dairy dessert industry. The main input ingredient of any yoghurt or other dairy desserts is raw milk. In the production process, there are multiple highly-automated steps that the raw milk goes through in order to transform it into an input that can be used in the final product. The first steps (clarification and standardization) in the production process usually involve multiple rounds in centrifuges and cooling and heating phases in order to ensure a homogeneous input that meets certain requirements, such as fat content. Depending on the final product, different steps then follow which are automated and firm specific. Each company is likely to be efficient in some of the steps in the production process that are crucial for their specific products. Certain products require certain procedures in order to obtain the desired consistency and water content, which makes each firm an expert in the method it uses in the production process. After a merger, this firm-specific expertise is shared among the merging firms, such that we expect that in this industry, technological transfer and management skills are the main source of merger gains (Brush et al. (2011)).

Another important factor is the number of people involved in the production process. A firms' technical sophistication should also be reflected in the number of workers required for production. A more technically-advanced firm requires fewer workers to produce a certain amount of output; that is, better management can make use of a workforce more efficiently. After a merger, technical transfer and introduced management skills should also carry over to the less efficient firm in terms of manpower efficiency.

3.2.2 Inputs and outputs

After obtaining marginal costs mc_{jt} from the equilibrium model, in order to calculate synergy gains, we need definitions for inputs $k \in K$ and outputs. As we have to make outputs of arbitrary firms comparable, it is convenient to define a product by its category $c \in C$. We then distinguish the outputs between the three different categories: yoghurts, fromage frais and petit suisse, plus other dairy desserts. This means that each firm $f \in F$ can produce three different kinds of products. The total output of firm f of product category c is given by its total quantity of products $y_{fc} = Ms_{fc}$ in this category, where s_{fc} is the market share of firm f in the product category c and M is the total market size. We assume that production technologies in each category across firms differ in efficiency. We estimate inputs by regressing marginal costs on input prices g_{kt} and we assume that the marginal cost of product j in period t has the following specification:

$$mc_{jt} = \sum_{f \in F} \beta_{f(j)c(j)} + \sum_{r \in R} \beta_{r(j)} + \sum_{f \in F} \sum_{c \in C} \sum_{k \in K} \gamma_{f(j)c(j)k} g_{kt} + \epsilon_{jt}. \tag{15}$$

As marginal costs are the costs of producing one unit,[5] the estimated coefficients $\gamma_{f(j)c(j)k}$ can be interpreted as the amount of input k needed to produce one unit. $\beta_{f(j)c(j)}$ are fixed effects for each firm and category that capture unobserved cost shifters that vary across firms and product categories. $\beta_{r(j)}$ are retailer fixed effects and capture retailer specific costs, such as costs of warehousing and distribution. The total amount of input k for product category c of firm f is given by $x_{fck} = Ms_{fc}\hat{\gamma}_{fck}$. A firm f is characterized by its input and output vector x^f and y^f, respectively.

3.2.3 Estimating potential merger gains with DEA

We now introduce the method that allows us to estimate the potential gains ex ante using Data Envelopment Analysis (DEA).[6] Following Bogetoft and Wang

[5] We assume a constant return to scale production technology. Under this assumption, we can use the marginal costs as average costs. (cf Footnote 11 in Subsection 3.2.3 for a justification of this assumption)

[6] DEA is a non-parametric method for production frontier estimation and is used to measure the efficiency of a single firm within an industry. The basic idea of the efficiency measure is linked to Farrell (1957) who argues that the efficiency of a firm is assessed by its distance to the production possibility set of the industry. The method wraps a tight fitting hull around the input/output data of the entire industry, such that it satisfies certain assumptions that vary, depending on the specification of the technology. The efficiency of a firm is then measured by its distance to this hull, also called frontier. For a more fundamental introduction, see for example, "Introduction to Data Envelopment Analysis and Its Uses" by Cooper et al. (2005).

(2005), the production possibility set $T(x, y)$ is defined as:

$$T = \left\{ (x, y) \in \mathbb{R}_{+}^{K+C} | \text{x can produce y} \right\}. \tag{16}$$

In the following, we introduce how synergy gains are estimated in this framework. First, we introduce the "potential overall gains" of merging, which is a maximal benchmark of potential savings. Then, in order to receive more realistic potential savings, "adjusted overall gains" are introduced, which control for the individual inefficiency of the merging firms. In the third step, the concept of "input slacks" is introduced, allowing us to calculate additional savings that are not captured in the previous step. At the end of this section, we provide three examples to illustrate the importance of the assessment of adjusted overall gains and input slacks.

Potential overall gains

In order to measure the potential synergy gains of a merger, the inputs and outputs of the merged entity are pooled together, pretending that it is in fact one firm, and then the distance of this artificial firm to the frontier is measured. There are several ways to conduct this projection. We use the input-oriented view, as this can be converted to cost savings. With this approach, the efficiency of firm f is measured by how much we can reduce the inputs of this firm and produce the same amount of outputs in comparison to the industry frontier. Let us define the set of firms that merge as U. Pooling the inputs and outputs of all

$f \in U$ and projecting it on the frontier gives the "potential overall gains" from merging, and is described by the following program:

$$E^U = Min\left\{E \in \mathbb{R} \middle| \left(E * \sum_{f\in U} x^f, \sum_{f\in U} y^f\right) \in T\right\}. \tag{17}$$

This translates into the following optimization problem:

$$\begin{array}{rcl} & \min\limits_{E,\lambda} E & s.t. \\ E * \left[\sum\limits_{f\in U} x^f\right] & \geq & \sum\limits_{f\in F} \lambda^f x^f \\ \sum\limits_{f\in U} y^f & \leq & \sum\limits_{f\in F} \lambda^f y^f \\ \lambda & \geq & 0 \end{array} \tag{18}$$

As E is a scalar, it reflects the proportional reduction of inputs that is possible compared to the efficient industry frontier. The condition $\lambda \geq 0$ comes from the constant return to scale assumption.[7] The measure E^U simply represents the inefficiency of the combined inputs and outputs of the merging firms U. It allows

[7]DEA can be performed under different assumptions in terms of the underlying production technology T of the considered sector. The returns to scale property plays a crucial role as the shape of the estimated frontier depends on this property. Potential merger gains are calculated using the distance of the combined firm's inputs and outputs to the frontier. This means the merger gains are dependent on the shape of the frontier. Thus, it is crucial to provide a good justification for the chosen technology. As explained in Section 3.2.1, the source of merger gains we focus on is learning and technology sharing. Following the argument of Farrell and Shapiro (2001), we rule out increasing returns to scale. Furthermore, following Bogetoft and Wang (2005), we assume that after a merger, firms could further operate as two single firms and simply coordinate prices without further integration. This rules out decreasing returns to scale. In order to capture synergies derived from economies of scope, we will then use a constant returns to scale (CRS) production technology.

us to compute the amount of reduction (1-E^U) in percentage of the inputs used by the merged firms to reach the industry frontier. Note that E^U captures more than the synergy effects that are due to economies of scope as it also contains the individual inefficiency of the individual merging firms (Bogetoft and Wang (2005)).

Adjusted Overall Gains

As we aim to extract the effects that are due to learning from amongst the merging firms, we have to remove the effect due to the technical inefficiency of the individual firms. Following Bogetoft and Wang (2005), we decompose the "potential overall gains from merging" E^U into the "adjusted overall gains" E^{U^*} and individual inefficiency T^U in such a way that we have:

$$E^U = E^{U^*} * T^U. \tag{19}$$

Bogetoft and Wang (2005) propose to first project the inputs of the individual firms on the frontier and then use these adjusted inputs in the merger analysis. This way individual inefficiency is taken care of, and the resulting efficiency measure of the pooled adjusted inputs only reflect the synergy effects due to learning or economies of scope. E^{U^*} is given by:

$$E^{U^*} = Min \left\{ E \in \mathbb{R} \middle| \left(E * \sum_{f \in U} E^f x^f, \sum_{f \in U} y^f \right) \in T \right\}. \tag{20}$$

We see that the only difference between E^{U^*} and E^U is that we multiply the input vector of the individual firm f, that is part of the merger U, by its efficiency score E^f obtained from a first step where we projected the single firms on the frontier.[8]

Input slacks

Thus far, we have been considering a linear reduction in inputs, which is a proportional decrease of all inputs by $\left(1 - E^{U^*}\right) * 100\%$. However, it is likely that after this proportional reduction, there is still the possibility of input specific reductions. Ji and Lee (2010) refer to this as "input slacks". Bogetoft and Wang (2005) mention this possibility but do not implement it. Here, we make use of this option and add the input slacks to allow for nonlinear reductions in inputs. Intuitively, the achieved savings in this case are at least as high as in the linear case, because the input slacks are on top of the linear part.

We define the input slack for input k of the merged entity U as S_k^U. Let x_k^U be the pooled total amount of input k for the entity U. Then the reduced input k post merger is given by:

$$E^{U^*} x_k^U - S_k^U. \tag{21}$$

We want to express the savings of input k of U in a single score E_k^U similar to

[8]This first step is a standard DEA with a CRS technology using all initial firms. From this, the efficiency scores E^f are obtained and are then used to adjust the inputs of the merging firms.

the efficiency scores obtained from the DEA but input specific. Following Cooper et al. (2005), this is given by:

$$E_k^U * x_k^U = E^{U^*} * x_k^U - S_k^U. \tag{22}$$

The first term of the right-hand side $E^{U^*} x_k^U$ is the linear part of the reduction. In addition to this, we subtract the input specific reduction S_k^U. We want to express the total reduction of each input as an input specific score E_k^U. We have all information such that we can solve for E_k^U, as follows:

$$E_k^U = \frac{E^{U^*} * x_k^U - S_k^U}{x_k^U}. \tag{23}$$

Examples

To illustrate the three different parts that have been formally introduced, consider the following examples. There are two firms, A and B, neither of which are located on the frontier, and that produce both one product y with two inputs x_1 and x_2. Let us assume that at the efficient industry frontier, in order to produce $y = 10$ outputs, $x_1 = 4$ and $x_2 = 4$ inputs are required. Let us distinguish three different settings of this market to illustrate the three parts shown before: a) firms use the same technology; b) firms use different technology symmetrically; and c) firms use different technology asymmetrically.[9] In a), both firms are equally efficient. This means that they need the same number of inputs to produce the same number of outputs, that is, $y = 5$, $x_1^A = 5$ and $x_2^A = 5$ and $x_1^B = 5$ and

[9] Table 7 in the Appendix summarizes the results of the three examples.

$x_2^B = 5$. In this setting, both firms use the same production technology, and we would not expect any merger gains that are due to economies of scope or learning, as the firms are equal. However, in this setting, the measure E^U would predict merger gains as follows. When inputs and outputs are pooled, we have $y = 10$, $x_1^U = 10$ and $x_2^U = 10$. We can reduce both inputs by 60% compared to the frontier because we then hit the frontier in both input dimensions. This now means that we have $E^U = 0.4$ because $0.4 * x_1^U = 4$. This example shows that two equal firms would produce synergy gains using E^U. These synergies are due to both firms' individual inefficiency pre-merger, as the example illustrates.

Consider now the example in setting b) where neither firm is located on the frontier but use different production technologies. Let us now assume that firm A uses $x_1^A = 4$ and $x_2^A = 6$ and firm B uses $x_1^B = 6$ and $x_2^B = 4$ to produce $y = 5$ outputs each. Let the efficient frontier be $y = 5$ and $x_1 = 2$ and $x_2 = 2$. We see that both firms are inefficient compared to the frontier, but firm A has an advantage in input 1 compared to firm B and firm B has an advantage in input 2 compared to firm A. The program E^U (without removing individual inefficiency) would produce the following savings. Combining both firms' inputs and outputs we have $y = 10$, $x_1^U = 10$ and $x_2^U = 10$. We can reduce both inputs by 60% because we then hit the frontier in both dimensions. This implies that $E^U = 0.4$. This again contains individual inefficiency plus the gains that are due to learning. If we now project the individual inputs (without pooling) on the frontier we get $E^A = 0.5$, $E^A * x_1^A = 2$ and $E^A * x_2^A = 3$ for firm A and $E^B = 0.5$, $E^B * x_1^B = 3$

and $E^B * x_2^B = 2$ for firm B.[10] Next, if we pool these adjusted inputs and outputs we have $y = 10$, $x_1^U = 5$ and $x_2^U = 5$. After adjusting and pooling the individual inputs, we again look at the amount by which we can proportionally reduce these inputs compared to the industry frontier. In this example, this delivers $E^{U^*} = 0.8$ as $E^{U^*} * x_1^U = 4$ and $E^{U^*} * x_2^U = 4$. This implies the following decomposition: $E^U = 0.4$, $E^{U^*} = 0.8$ and $T^U = 0.5$. Here we see that the relatively large savings that are due to E^U can be deceiving, and once individual inefficiency is controlled for the potential savings that are due to economies of scope are much smaller. The individual inefficiency scores $E^f = 0.5$ are reflected in the decomposition with $T^U = 0.5$.[11] The difference between a) and b) is that in a) the adjusted overall gains are zero, whereas in b) they are 20%, and this shows how the mechanics of generating synergies of this method works. Specifically, this demonstrates how firms can benefit from each other when they have comparative advantages in different inputs.

The asymmetric case c) is similar to case b) except that now firm B requires $x_1^B = 8$. Conducting the same exercise as in b) delivers $E^{U^*} = 0.8$. However, note that after multiplying the pooled and adjusted input $x_1^U = 6$ with $E^{U^*} = 0.8$ we obtain 4.8 which does not reach the frontier which is located at $x_1 = 4$. So there is further room for additional reductions of 0.8 in this input dimension. This further reduction is captured by the input slacks, which appear when the

[10] E^f represents the individual inefficiency score. Here we have $E^A = E^B$ because of a symmetric example. However, in general, this is not the case.

[11] In this example, individual inefficiency scores E^f coincide with T^U. This is due to the constructed symmetric example and does not hold in general.

merging firms do reach the frontier in all input dimensions, after adjusting for individual inefficiency and proportionally reducing the inputs by E^{U^*}

3.2.4 Marginal cost reduction

As E_k^U represents the input specific synergy gains from merger U, we can reduce the output k of the merged entity by $(1 - E_k^U) * 100\%$. The new marginal cost of the merged entity U is given by:

$$\bar{mc}_{jt} = \begin{cases} mc_{jt} - \left(\sum_{k \in K} \left(1 - E_k^U\right) \hat{\gamma}_{f(j)c(j)k} g_{kt}\right) & for\ j \in U, \\ mc_{jt} \quad otherwise, \end{cases} \tag{24}$$

where $\hat{\gamma}_{f(j)c(j)k}$ is the estimated input k from the cost estimation that is used by firm f to produce output c. This estimated input is multiplied by the possible reduction $\left(1 - E_k^U\right)$, and the input price g_{kt}, as we want to subtract only the savings in Euros from the initial marginal costs mc_{jt}.

3.2.5 Price effects

In this section, we present the general methodology used to assess the effects of the change in the industry structure and cost savings on prices. The simulation is performed using the following program:

$$\min_{\left\{p_{jt}^*\right\}_{j=1,\ldots,J}} \left\| p_t^* - \Gamma\left(p_t^*, I_1^*, ..., I_{F-1}^*\right) - \gamma\left(p_t^*, I_1^*, ..., I_{F-1}^*\right) - \bar{mc}_t \right\|, \tag{25}$$

where $\Gamma\left(p_t^*, I_1^*, ..., I_{F-1}^*\right)$ and $\gamma\left(p_t^*, I_1^*, ..., I_{F-1}^*\right)$ are, respectively, the margins of manufacturers and retailers as a function of new equilibrium prices and new the ownership structure. The first three terms represent the marginal costs derived from the new price equilibrium, which should be equal to the new marginal costs $\bar{mc}_t$ in (24).

As we aim to isolate the price variation for the two opposite forces, we also simulate the price effects for two benchmark cases. On the one hand, we use the change in the industry structure only, then $\bar{mc}_{jt} = mc_{jt}$, and on the other hand, we use marginal cost savings only, then $\left(I_1^*, ..., I_{F-1}^*\right) = (I_1, ..., I_F)$.

We also compare our results to the common practice of reducing all marginal costs by 5% post merger. In this case, the new marginal costs post merger $\bar{mc}_{jt}$ are equal to $0.95 * mc_{jt}$ for merging firms and mc_{jt} for non-merging firms.

Furthermore, it is interesting to compare the impact on consumer surplus and the profit of the industry with and without synergies. Following Bonnet and Dubois (2010), consumer surplus is given by:

$$CS_t\left(p_t\right) = \frac{1}{|\alpha_i|} ln\left(\sum_{j=1}^{J} exp\left[V_{ijt}\left(p_t\right)\right]\right). \tag{26}$$

4 Empirical results

First, we discuss the results of the demand estimation, implied price-cost margins and the marginal costs. Then we present the results of the Data Envelopment Analysis and the effects of the four proposed mergers.

4.1 Demand estimates, price elasticities and margins

We estimated a random coefficient logit model over a random subsample of 100,000 observations using a simulated maximum likelihood method, and these results are reported in Table 3. The price coefficients have the expected negative sign. We distinguished between national brands and private labels. The mean disutility of prices is higher for national brands with -3.05 and -2.33 for private labels, which means that consumers react more to price variations when they buy national brands than store brands. The standard deviation is estimated to be 0.93, such that only an infinitesimal part of α_i is positive. The error term of the price equation is positive and significant, meaning that the unobserved variables that explain the prices are positively correlated with the utility of buying a product. This is consistent with display and advertising costs, for example.[12]

Table 3: Demand Estimates

Parameter	Coefficient	StD
Price		
Average for NB products	-3.0511	0.0009
Average for PL products	-2.3376	0.0009
Standard deviation	0.9363	0.0001
Error term of the price equation	1.2820	0.0008
Brand fixed effects	Yes	
Retailer fixed effects	Yes	

The demand estimation allows us to compute own- and cross-price elasticities. Table 4 presents the average own-price elasticities across manufacturers and categories. Mean own-price elasticities range from -2.98 to -5.89. Private label

[12]The estimation results of the price equation are in the Appendix Table 8. We chose milk, diesel oil and plastic prices as instrumental variables. They are all significant.

products have the most elastic demand in all product categories. In the yoghurt category, manufacturers 1 and 3 have the least elastic demand. The second column suggests that no national brand producer has more market power than the others in the other dairy desserts category. In the third category, manufacturer 5 enjoys the most market power. Similar own-price elasticities were found by Draganska and Jain (2006) and Bonanno (2012) that ranged between -2.45, -6.25 and -1.4, -6.86, respectively.

Table 4: Own Price Elasticities

	Yoghurts	Other Dairy Desserts	Fromage Blanc and Petit Suisse
Manufacturer 1	-3.67 (0.48)	-4.12 (0.09)	-3.94 (0.10)
Manufacturer 2	-4.05 (0.17)		-4.10 (0.13)
Manufacturer 3	-3.67 (0.26)	-4.06 (0.12)	
Manufacturer 4	-4.14 (0.07)	-4.11 (0.03)	-3.59 (0.18)
Manufacturer 5	-4.05 (0.14)	-4.17 (0.05)	-2.98 (0.18)
Manufacturer 6	-4.18 (0.04)		
PL products	-4.19 (0.29)	-4.98 (0.24)	-5.89 (0.34)

Standard deviations are in parenthesis and represent variation across brands, retailers and periods.

The average implied price cost margins are reported in the Appendix in Table 9 across categories and manufacturers. On average, the total margin is 37% for yoghurt products, 32% for other dairy desserts and 29% for fromage frais and petit suisse products. Manufacturer 1 has the strongest market power given that the average margin of its products are the highest for the three categories, 49%, 40% and 44%, respectively. Manufacturer 3 exhibits the second largest margins with respect to the other firms. The lowest margins are for the private label products in each category. In total, the margins range between 17% and 49%. Other authors find similar margins: Bonanno (2012) recovers margins that range between 16% and 68%; and Villas-Boas (2007) finds margins that range between 12.8% and 45.8% in the preferred supply model. Regarding the results on marginal costs in the Appendix in Table 10, they seem to be consistent. In total, manufacturer 1 has the lowest marginal costs closely followed by manufacturer 3 and PL products. These three manufacturers have very similar low marginal costs for yoghurts and other dairy desserts. In the yogurt category, the marginal cost is higher for manufacturers 5 and 6 as they also use other milks that are more expensive than cow milk, such as soy milk or sheep and goat milks. As expected, the marginal costs of producing fromage frais and petit suisse and other dairy desserts are higher.

4.2 Cost function and DEA

For the estimation of the cost function, we use input prices from the French National Statistic Office (INSEE). We remain consistent with economic theory, as in Gasmi et al. (1992), we impose the positivity of the parameters δ_{fck}, and therefore, we use a non-linear least square method. We have chosen to use milk and salary as inputs, as they are the main inputs required to produce dairy products.

We present the results of the DEA in Table 5. In total, the DEA is performed with 13 initial firms that are shown in the upper part of Table 5 and 78 constructed mergers of which we show three selected mergers at the bottom part of Table 5.

In total, we have 91 decision-making units with two inputs and maximal three outputs.

For the initial firms, we show the first stage efficiency scores E^f that are used to adjust the inputs before they are pooled to construct the mergers. A value of 1 means that this firm is part of the industry frontier, which is the case for five out of 13 firms.

At the bottom part in columns 2-4, the merger specific efficiency measures are given.[13] The first E^{U^*} in column 2 shows the linear efficiency scores from the DEA. For the mergers, this score is already adjusted for individual inefficiency. Thus, all inputs of a given firm that is part of the merger can be reduced by multiplying the inputs with the respective efficiency score and keeping the output constant. The implied input specific efficiency scores are given in columns 3 and 4 for milk and salary, respectively. These are also the scores that are used to calculate the savings in marginal costs in column 5. In the three mergers we consider, the input specific efficiency scores are equal to the linear efficiency score in column 2. This means that there is no further input specific reduction in inputs possible.

The last column shows the average adjusted potential savings in marginal costs in percent, and the standard deviation across products, and time periods within the merged entity are shown in parenthesis. Even though the input savings are the same for a given product category and firm, the percentages vary as the original marginal costs are different. The savings of the selected mergers range

[13] We use the bootstrap estimator presented in Kneip et al. (2008). In each bootstrap sample, we use 50% of the original sample size as the naïve approach leads to inconsistent results, as pointed out by Kneip et al. (2008)

between 1.88% and 7.84%.[14]

Table 5: DEA - Constant Returns to Scale

Manufacturers	E^f	Manufacturers	E^f
Manufacturer 1	0.57	Manufacturer 8	0.92
Manufacturer 2	0.97	Manufacturer 9	0.75
Manufacturer 3	0.85	Manufacturer 10	1
Manufacturer 4	0.91	Manufacturer 11	0.78
Manufacturer 5	1	Manufacturer 12	0.77
Manufacturer 6	1	Manufacturer 13	1
Manufacturer 7	1		

Mergers	E^{U^*}	E^{Um}	E^{Us}	Average MC Savings
M1 - M3	0.86	0.86	0.86	7.84% (3.78)
M1 - M11	0.97	0.97	0.97	1.88% (0.97)
M8 - M9	0.92	0.92	0.92	3.37 % (2.03)

Standard deviation across products and periods in parenthesis.

4.3 Merger simulation and welfare

We consider three potential mergers. The initial HHI in the French dairy dessert industry is 1,160.[15] The M1-M3 merger combines the pre-merger market shares of 24% and 8%, respectively. The change of the HHI is more than 250 and

[14]Table 14 in the Appendix summarizes mean savings of all 78 possible bilateral mergers. First note that only about 56% of the possible mergers are predicted to produce any efficiency savings at all. If we neglect the mergers that produce relatively small efficiencies and only consider mergers with at least 3% savings, then only about 35% of the mergers produce synergy gains. This means that about 44% of the mergers do not produce efficiency gains and are likely to harm consumers. Other authors find similar results. Our results are consistent with Gugler et al. (2003) who make use of a large panel data set to analyze merger effects of companies world-wide that occured during the 15 years prior to 2003. They find that approximately 29% of the mergers produced efficiency gains.

[15]Note for the calculation of the HHI and the changes post-merger, we assume that each private label manufacturer is treated as a single firm.

the initial HHI is above 1,000, such that this merger would be of concern for the Competition Authority according to the merger guidelines. This merger is expected to produce 7.84% savings in marginal costs. The M1-M11 combines pre-merger market shares of 24% and 4%, respectively, and is expected to produce savings of 1.88%. The change in HHI is 195. Manufacturers 8 and 9 both have 6% pre-merger market shares. Efficiency gains are expected to be 3.37% with a relatively low change in HHI of 67.

We simulate the new price equilibria and derive effects on prices, firm profits and consumer surplus for the three different mergers. For each case, we perform four different simulations. We derive the new equilibrium with the new industry structure only, second, with the new industry structure and the reduced marginal costs, and third, with the reduced marginal costs only. In this way, we aim to disentangle the opposing forces on prices. We compare the results to the usual approach of ad hoc savings of 5%.

We also calculate the pass-through rate, market share variation and examine in detail the profit changes for each firm.

Note that the effects of mergers on the economy are highly dependent on the substitution pattern between the products of the merging firms. For example, if the products are close substitutes, we would expect that a lot of competitive pressure is taken away by merging, and thus firms can increase prices relatively more compared to a case of weak substitutes. On the other hand, we could have the case where two firms merge with relatively high market shares but the offered brands are only weak substitutes. In this case, a merger may have a low impact on the level of competition as both firms compete more with the firms outside the merger. This is also recognized by the Competition Authority in the merger guidelines.

Table 6 summarizes the results of the four simulations for the three merger cases. Columns 2-4 represent the three different mergers. For each of the mergers, we analyze the effects on prices and profits of the industry, and the prices and profits of the merged and outside firms separately.[16] As we are interested in the effects of mergers on consumers, we also present the changes in consumer surplus.

Benchmark

When we take into account the change of the industry structure only and the reduced marginal costs only, these results can be viewed as benchmark results. The former is a worst case and the latter a best case scenario from the consumers' perspective. We see that without cost savings, all figures behave as expected in all three mergers. Industry prices[17] and industry profits increase and consumer surplus decreases as expected. The merged firms benefit more than the average outside firm. Also price reactions are larger for the merged firm than the average industry price changes.

The other benchmark case — when we do not take into account the change in industry structure and look at the effects of the reduced marginal costs only — also show consistent results. As in this setup, there is only the downward

[16]Note that we cannot identify the fixed fees; in which case we are then only able to compute industry profit, that is, the sum of retail and manufacturer profit

[17]Industry price changes are computed as the weighted average (by market share) of price changes over all products in the industry.

pressure on prices, we see that all prices of the merged entity and the outside firms decrease in all cases. Note that we would expect that only the firms that experience the reduced cost would benefit in this new market equilibrium and the effect on total industry profit is therefore ambiguous. Indeed, we see that indeed only firms that have lower marginal costs increase their profits. The higher the marginal cost savings, the more they benefit. The firms with cost reductions now have a larger margin and thus have an incentive to decrease prices in order sell to more consumers. All the outside firms lose in the new equilibrium. As a reaction to the price cuts by the firms with lower marginal costs, outside firms cut prices as well and lose, as they do not enjoy any cost reductions to compensate for the lower prices. Industry profits increase in all three cases. Consumer surplus always increases, which is consistent with economic intuition, as reduced costs should always benefit the consumers without changes in the industry structure.

Net effect

In this section, we discuss the results of the scenario when we take into account both the change in industry structure and the reduction of marginal costs.

The M1-M3 merger produces the highest efficiency gains of the three mergers we consider, and also represents the largest increase in market concentration. Table 11 shows that the merging parties are also the main competitors of each other according to the substitution patterns. We see that industry prices actually decrease by 0.33%. Merged firms decrease prices to a larger extent by 1.81%. Here, the upward pressure on prices can be outweighed by the marginal cost reductions. Industry profits increase by almost 6%. This large increase is driven by the increase in the merging parties profits. Table 17 shows profit changes for each firm. Manufacturers 1 and 3 gain 17.39% and 19.10%, respectively. Outside firms lose between 1.20% and 1.83%. Interestingly, the post-merger strategy for both merging firms appears to be different. Table 15 shows that manufacturer 1 decreases and manufacturer 3 increases its prices post merger.[18] The merging parties seem to shift consumers from manufacturer 3 to manufacturer 1 by this pricing policy post merger. Table 9 shows that manufacturer 1 has the higher margin and also the higher market share pre-merger giving the merged entity incentives for this kind of strategy. Consumer surplus in this scenario increases by 0.92%, which is a large difference to the merger scenarios without efficiency gains and the ad hoc 5% rule, which predicts a decrease in consumer surplus of 1.1% and a very slight increase of 0.17%, respectively.

The M1-M11 merger results in a medium change of industry concentration of more than 195 of the HHI and low savings of less than 2%. The reductions in marginal costs are just enough to compensate for the increase in concentration, which means that industry prices show minimal change, and rise only slightly by 0.06%. Merging firms increase prices by 0.37%. Industry profits increase by 1.63%. Merging firms benefit more than outside firms. Table 17 shows that manufacturers 1 and 11 gain 4.63% and 2%, respectively. Outside firms gain around 0.3% each. The strategy employed is similar as in the merger between manufacturers 1 and 3. As shown in Table 15, the extremely negative pass-through rate of manufacturer 11 indicates a relatively large price increase post merger. At the same time, manufacturer 1 decreases its prices slightly. Again,

[18] A negative pass-through rate means that prices have increased after a cost reduction.

this suggests that the merging parties make consumers switch from manufacturer 11 to 1. Manufacturer 1 has a much higher margin and a higher market share. Consumer surplus decreases by 0.16%, making the merger anti-competitive. The 5% ad hoc rule delivers completely different results. It overstates the pro-competitive effects and predicts an increase of 0.66% in consumer surplus.

The merger between manufacturers 8 and 9 increases concentration by only 67 in HHI. The merger produces medium cost savings of 3.37%. We expect this merger to increase consumer surplus, as the downward pricing pressure is likely to outweigh the upward pricing pressure, as the increase in concentration is relatively small. Industry prices decrease by 0.14%. Merging firms decrease prices by 1.87%. Industry profits increase by 0.60%. The merging parties largely benefit from this merger as they increase profits by 12.83%. Outside firms lose 0.70% on average. Table 15 shows that both firms decrease prices post merger. As expected, consumer surplus increases post merger by 0.38%. The 5% ad hoc rule overstates the pro-competitive effects.

A notable detail of the presented results is that marginal cost savings and concentration effects seem to have an equal weight for the market outcome post merger for all effects, except for the profits of the merged entities. This can be seen in Table 6, where for most effects the net effect is approximately an average of the two benchmark cases. However, the changes in profits of the merged entities are almost only driven by cost savings. The benchmark results show that profit changes, when we only take into account synergy gains, are almost the same as profit changes, when we take into account both forces. Even in the case of M1-M3 with a relatively large increase in concentration, the changes in profits are almost only driven by synergy gains. This is an important result, as the main incentive to merge is the expected profit change. Our results suggest that managers are more likely to neglect the positive effect of concentration, and instead focus on possible synergy gains as the main driver for profit changes. Furthermore, post-merger pricing can be complex and may involve asymmetric pricing in order to encourage consumers to switch from one firm to the other.

Table 6: Merger Effects

Effects\Merger	Manufacturers M1 - M3	M1 - M11	M8 - M9
Cost Savings	7.84% (3.78)	1.88% (0.97)	3.37% (2.03)
HHI (ΔHHI)	1550 (390)	1355 (195)	1227 (67)
Prices			
Industry			
Only Merger	0.56% (0.22)	0.25% (0.01)	0.07% (<0.01)
Merger+Sav	-0.33% (0.03)	0.06% (0.01)	-0.14% (0.01)
Only Sav	-0.97% (0.02)	-0.20% (0.01)	-0.22% (0.01)
5 Percent	-0.04% (0.02)	-0.28% (0.01)	-0.22 (<0.01)
Merged firms			
Only Merger	3.08% (0.07)	1.58% (0.05)	0.95% (0.2)
Merger+Sav	-1.81% (0.18)	0.37% (0.04)	-1.87% (0.05)
Only Sav	-5.34% (0.15)	-1.26% (0.04)	-2.93% (0.07)
5 Percent	-0.22% (0.09)	-1.77% (0.06)	-2.90% (0.04)
Profits			
Industry			
Only Merger	1.51%	0.87%	0.33%
Merger+Sav	5.80%	1.63%	0.59%
Only Sav	3.82%	0.69%	0.17%
5 Percent	4.15%	3.06%	0.67%
Merged firms			
Only Merger	0.59%	0.39%	0.11%
Merger+Sav	17.80%	4.36%	12.83%
Sav	16.88%	3.93%	12.68%
5 Percent	11.27%	11.93%	19.59%
Outside firms			
Only Merger	2.08%	1.10%	0.36%
Merger+Sav	-1.73%	0.30%	-0.70%
Sav	-4.38%	-0.88%	-1.15%
5 Percent	-0.33%	-1.25%	-1.33%
Cons. Surplus			
Only Merger	-1.1%	-0.58%	-0.19%
Merger+Sav	0.92%	-0.16%	0.38%
Only Sav	2.40%	0.47%	0.62%
5 Percent	0.17%	0.66%	0.71%

5 Conclusion

Evaluating mergers is one of the key tasks of competition authorities. Empirical tools have become more sophisticated, taking into account strategic effects as well as vertical structure and contracts used within the vertical structure. However, one of the main aspects in mergers are the potential synergy gains that can arise post merger. So far, merger simulation models rely on ad hoc assumptions about cost reductions, or the models are used to find the required cost reductions to make a merger worthwhile. Other research aims at quantifying synergy effects due to fixed costs savings by reducing the product space.

In this article, we present an integrated approach to estimate efficiency gains and incorporate them into the merger simulation. We estimate a structural demand and supply model taking into account the vertical structure of the market. The contribution of this article is to use Data Envelopment Analysis in a next step, in order to derive synergy gains of potential mergers, and incorporate them into the structural model. We implement this methodology in the French dairy dessert market, and we simulate the impact of some bilateral mergers, taking into account the new ownership configuration and marginal cost savings. We find that only about 56% of the mergers produce any synergy gains, meaning that roughly half of the mergers do not produce any synergy gains and are therefore considered to be anti-competitive. The average marginal cost reductions are 2.55%, which implies that the ad hoc rule of 5% savings overstates the pro-competitive effects of mergers in the French dairy dessert industry. Depending on the marginal cost savings, the effects on prices, profits and consumer surplus differ. We find that the upward pressure on prices after a merger can be outweighed by the downward pressure, due to reduced marginal costs if savings are large enough. By isolating the concentration and efficiency effects on profits, prices and consumer welfare, we show that potential savings are just as important as market concentration. However, incentives to merge are fully driven by cost savings. Concentration effects on profits of the merging firms are relatively small compared to the effects that are due to cost savings. This suggests that policy makers require more reliant tools in order to screen mergers for their potential efficiency gains. Furthermore, our results suggests that firms may want to shift consumers from one firm to the other by asymmetric pricing strategies post merger.

Note that the predicted efficiency gains represent a maximal benchmark and should be regarded as potential cost savings. A natural next step for research would be to test the predictions and market outcome of our approach with real world mergers.

The limit of this analysis is that we cannot simulate long run effects of cost savings. As we have demonstrated, large savings are beneficial for consumers. However, this is only true in the short run. Large efficiency savings could prevent potential future market entry and may further reduce competition in the long run. Another limit of this analysis is that we do not account for product repositioning after a merger. As Mazzeo et al. (2014) find, merging firms may have incentives to reduce the number of products if the products are close substitutes. Another factor we do not take into account is the possibility of imposed remedies for the merging parties that are supposed to weaken the anti-competitive effects.

6 Appendix

Table 7: Merger Gains Examples CRS

Entity	In and Outputs y	x_1	x_2	Linear Reduction E^f	E^U	E^{U*}	T^U	Input Slacks S_1^U	S_2^U	E_1^U	E_2^U
Frontier	10	4	4								
	5	2	2								
a)											
Firm A	5	5	5	0.4							
Firm B	5	5	5	0.4							
Merger	10	10	10		0.4	1	0.4	0	0	1	1
b)											
Firm A	5	4	6	0.5							
Firm B	5	6	4	0.5							
Merger	10	10	10		0.4	0.8	0.5	0	0	0.8	0.8
c)											
Firm A	5	4	6	0.5							
Firm B	5	8	4	0.5							
Merger	10	12	10		0.4	0.8	0.5	0.8	0	0.66	0.8

Table 8: Estimates of the price equation

Parameter	Coefficient	Standard Error
Plastic price	0.011	0.005
Diesel oil price	0.006	0.002
Milk price	0.030	0.001
Brand fixed effects	Yes	
Retailer fixed effects	Yes	
F test of instrumental variables (p value)	1648.89	0.00

Table 9: Margins in Percent

Producer	Yoghurts	Other Dairy Desserts	Fromage blanc and Petit Suisse
Manufacturer 1	49.26 (9.58)	40.40 (2.30)	44.63 (1.86)
Manufacturer 2	25.32 (1.24)		25.04 (0.78)
Manufacturer 3	39.39 (2.22)	35.25 (1.78)	
Manufacturer 4	24.34 (0.42)	24.51 (0.20)	28.19 (1.42)
Manufacturer 5	24.81 (0.92)	24.12 (0.32)	33.90 (1.83)
Manufacturer 6	23.99 (0.22)		
PL products	24.19 (1.48)	20.15 (1.05)	17.16 (0.91)
Total	36.78 (12.90)	32.34 (8.04)	28.99 (8.94)

Standard deviation across brands, retailers and periods are in parenthesis.

Table 10: Marginal costs in Euros per liter

Producer	Yoghurts	Other Dairy Desserts	Fromage blanc and Petit Suisse
Manufacturer 1	1.02 (0.48)	1.46 (0.21)	1.11 (0.10)
Manufacturer 2	1.64 (0.34)		2.26 (0.36)
Manufacturer 3	1.06 (0.13)	1.43 (0.16)	
Manufacturer 4	1.86 (0.21)	1.70 (0.04)	3.17 (0.23)
Manufacturer 5	2.48 (0.27)	2.15 (0.22)	4.14 (0.36)
Manufacturer 6	2.22 (0.12)		
PL products	1.02 (0.12)	1.41 (0.14)	2.07 (0.36)
Total	1.36 (0.59)	1.55 (0.31)	2.45 (0.99)

Standard deviations across brands, retailers and periods are in parenthesis.

Table 11: Cross Price Elasticities NB

\	Man 1	Man 2	Man 3	Man 4	Man 5	Man 6	PL Man
Man 1		0.023	0.027	0.019	0.016	0.021	0.028
Man 2	0.004		0.004	0.004	0.004	0.004	0.003
Man 3	0.043	0.037		0.031	0.026	0.035	0.044
Man 4	0.002	0.003	0.002		0.003	0.003	0.002
Man 5	0.001	0.001	0.001	0.001		0.001	0.001
Man 6	0.001	0.001	0.001	0.002	0.002		0.001
PL Man	0.016	0.015	0.016	0.014	0.012	0.014	

Table 12: Cross Price Elasticities PL

\	Man 7	Man 8	Man 9	Man 10	Man 11	Man 12	Man 13	NB Man
Man 7		0.002	0.002	0.002	0.002	0.001	0.002	0.001
Man 8	0.016		0.016	0.016	0.016	0.015	0.016	0.015
Man 9	0.001	0.001		0.001	0.001	0.001	0.002	0.001
Man 10	0.005	0.005	0.005		0.005	0.004	0.005	0.005
Man 11	0.010	0.010	0.010	0.010		0.009	0.010	0.009
Man 12	0.072	0.072	0.072	0.071	0.072		0.072	0.068
Man 13	0.005	0.005	0.005	0.005	0.005	0.004		0.005
NB Man	0.014	0.014	0.013	0.013	0.014	0.012	0.014	

Table 13: Estimated Inputs

Category	Yoghurts		Dairy Desserts		FB and PS	
Producer	Milk	Salary	Milk	Salary	Milk	Salary
1	0.78	0.01	1.48	0.10	1.35	0.06
2	0.27	0.08			1.15	0.03
3	0.78	0.02	1.63	0.07		
4	1.46	0.05	1.00	0.04	0.34	0.06
5	0.83	0.01	0.71	0.03	1.12	0.15
6	0.45	0.03				
PL Producer						
7	0.03	0.01	0.50	0.01	0.50	0.07
8	0.52	0.04	0.48	0.01	0.68	0.04
9	0.71	0.05	0.37	<0.01	1.04	0.04
10	0.40	0.01	0.92	0.02	0.61	0.02
11	0.41	0.06	0.71	0.01	0.89	0.03
12	0.36	0.02	1.42	0.07	0.73	0.01
13	0.41	0.03	1.57	0.04	0.32	<0.01

Table 14: Summary Savings

	Fraction of Mergers	Av. MC Savings
All	100%	2.55%
Savings>0	56.41%	4.51%
Savings>1%	51.28%	4.90%
Savings> 3%	34.62%	6.16%
Savings> 5%	17.95%	8.27%

Table 15: Pass Through

	Scenario		
Merger\	Merger+DEA	Only DEA	Merger+ 5%
M1 - M3 (7.84%)			
M1	0.35 (0.41)	0.95 (0.12)	0.36 (0.23)
M3	-0.36 (0.73)	1.09 (0.05)	-0.75 (0.20)
Average	0.11 (0.63)	1 (0.12)	-0.01 (0.57)
M1 - M11 (1.88%)			
M1	0.17 (0.49)	0.96 (0.12)	0.75 (0.14)
M11	-5.53 (2.99)	1.04 (0.01)	-0.68 (0.29)
Average	-0.14 (1.53)	0.97 (0.12)	0.67 (0.36)
M8 - M9 (3.37%)			
M8	0.53 (0.97)	1.02 (0.02)	0.73 (0.07)
M9	0.18 (0.24)	0.99 (0.08)	0.75 (0.08)
Average	0.35 (0.13)	1.01 (0.06)	0.74 (0.07)

Table 16: Market Share Variation

Merger\	Scenario			
	Only Merger	Merger+DEA	Only DEA	Merger+ 5%
M1 - M3 (7.84%)				
Outside	2.15% (0.23)	-1.78% (0.20)	-4.55 (0.42)	-0.32 (0.07)
Inside	-9.12% (6.19)	6.93% (16.37)	19.37 (17.16)	0.14 (7.26)
Average	-3.35% (7.10)	2.48% (12.24)	7.13 (16.94)	-0.1 (5.08)
M1 - M11 (1.88%)				
Outside	1.11% (0.09)	0.29% (0.04)	-0.89% (0.07)	-1.26% (0.11)
Inside	-2.65% (5.05)	1.28% (6.34)	4.13% (3.61)	7.71% (5.95)
Average	-0.19% (3.47)	0.63% (3.76)	0.85% (3.20)	1.85% (5.52)
M8 - M9 (3.37%)				
Outside	0.33% (0.04)	-0.66 (0.08)	-1.07 (0.13)	-1.20 (0.16)
Inside	-4.04% (0.17)	6.90 (6.37)	11.92 (6.59)	14.16 (5.12)
Average	0.17% (0.83)	-0.38 (1.88)	-0.59 (2.76)	-0.63 (3.07)

Table 17: Profits by Firm

Manufacturers\Merger	M1 - M3	M1 - M11	M8 - M9
Cost Savings	7.84% (0.36)	1.88% (0.18)	1.62 % (1.3)
Manufacturer 1	17.39%	4.63%	-0.71%
Manufacturer 2	-1.72%	0.30%	-0.69%
Manufacturer 3	19.10%	0.31%	-0.74%
Manufacturer 4	-1.39%	0.27%	-0.58%
Manufacturer 5	-1.20%	0.25%	-0.53%
Manufacturer 6	-1.78%	0.30%	-0.70%
Manufacturer 7	-1.81%	0.30%	-0.73%
Manufacturer 8	-1.83%	0.30%	12.86%
Manufacturer 9	-1.82%	0.30%	12.80%
Manufacturer 10	-1.79%	0.30%	-0.72%
Manufacturer 11	-1.83%	2.00%	-0.74%
Manufacturer 12	-1.79%	0.30%	-0.72%
Manufacturer 13	-1.79%	0.30%	-0.73%

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