

The Competitive Constraints from Private Label Offers on Branded Grocery Pricing

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Abstract: The issue of whether private label and branded goods should be considered in the same market has been debated in competition cases for a long time. Traditionally, competition authorities have considered large price difference between branded and private label products as evidence that branded and private label products are in separate markets. We show that private label products should generally be considered in the same market as branded products in the same product group. For a first assessment, the competitive constraint from a private label product on branded products is well approximated by its market share in the product group. This means that private labels should always be included in the initial assessment of market definition in merger cases and for the purpose of determining critical market share thresholds when applying, for example, the Vertical Block Exemption Regulation.

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*The Competitive Constraints from Private Label Offers on Branded Grocery Pricing**

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1. Introduction

1. We have been asked by Markenverband to assess the competitive impact of private label offerings on branded goods sold in grocery retail. In this report we present an analysis of substitution between branded and private label products based on a selected number of product groups and draw conclusions for competition analysis.
2. We show that private label products should generally be considered in the same market as branded products in the same product group. For a first assessment, the competitive constraint from a private label product on branded products is well approximated by its market share in the product group. This means that private labels should always be included in the initial assessment of market definition in merger cases. More importantly, they should also be included by default when calculating market shares to determine critical market share thresholds when applying, for example, the Vertical Block Exemption Regulation.
3. The issue of whether private label and branded goods should be considered in the same market has been debated in competition cases for a long time. Traditionally, competition authorities have considered large price difference between branded and private label products as evidence that branded and private label products are in separate markets.
4. Today, it is well known that this type of reasoning is economically incorrect. As we know from the industrial organization literature, a product that is perceived to be “lower quality” and sells at a low price can impose very significant competitive constraints on a product that has perceived “higher quality” and higher price.¹ This price differentiation by perceived quality is known as “vertical product differentiation” in the academic literature.

¹ See John Sutton (1986), “Vertical Product Differentiation: Some Basic Themes”, American Economic Review for an overview of the literature on product differentiation along a “quality” dimension (as well as references within). “Quality” in this literature means any characteristic (e.g. advertising) that makes consumers willing to pay more for the product. Product differentiation arises from different willingness of consumers to pay for quality improvements.

5. Private label and branded products in supermarkets are a classic example for such vertical product differentiation. Differentiation occurs primarily because branded products are heavily advertised in public media and thus have developed a brand image.² Private label products typically are not advertised heavily and are sold mostly at a significantly lower price. Price differentials are maintained because consumers have different willingness to pay for products with a strong brand image.³
6. We also know that markets with vertical product differentiation naturally tend towards a concentrated market structure when significant “quality” differences are endogenously created by sunk investments like advertising or R&D.⁴ To assess market power in such markets it is therefore particularly important to understand whether private label brands do constrain the pricing of branded products in practice.
7. Since theory suggests that there are no simple criteria to establish the closeness of competition of private label products to branded products, such an assessment must be based on empirical analysis. We provide such an analysis in this paper for five consumer product categories. We show that private label products do indeed impose very significant competitive constraints on branded products.
8. Central to an analysis of market definition is determining the degree of substitutability between products. Since products are differentiated, some competing products will be closer substitutes than others. “Closeness of substitution” is often argued very loosely in competition cases, but it can be rigorously defined in economics, allowing empirical verification.

² See John Sutton, *Sunk Costs and Market Structure Price Competition, Advertising, and the Evolution of Concentration*, MIT Press, 1991.

³ This is not to say that there are no other quality differences between branded products and private label products. Conversely, some private labels have been advertised and tried to develop their own brand image. However, advertising generally is a dominating differentiating factor between brands and private label products. The exposition chosen here is only for illustrative purposes. Our empirical analysis does not rely on these concepts, and traces only the substitution patterns.

⁴ *Supra* Sutton.

9. The economic concept capturing the idea of “closeness of competition” is the “diversion ratio”. The diversion ratio from product i to product j is defined as the share of customers that switch from buying product i to buying product j in response to a price increase of product i . “Closeness of competition” is measured by the difference between the diversion ratios of product i ’s competitors. If a product j has the highest diversion ratio for product i , then j is the closest competitor to i , because it is the greatest beneficiary of substitution from product i in response to a price increase.
10. A private label product can be viewed as a competitor of a branded product when its diversion ratios is significant relative to the diversion ratios of other competing branded products. When the diversion ratio is higher than those of other branded products, then the private label can even be a closest competitor to a branded product.⁵ Our detailed empirical analysis across several product groups suggests that it is not unusual that a private label product is the closest competitor to all the major brands in a product category. Our analysis shows this to be the case for product groups with large private label market share. These are typically product groups where the vertical dimension of differentiation dominates. When there is additionally horizontal product differentiation this will generally not be the case. However, for *all* product categories included in our analysis, private label products are close enough competitors to impose *substantial* competitive pressure.
11. These findings lead to two important conclusions:
 - (1) Private label products should by default be considered in the same market as the branded products in a product category.
 - (2) Market definition should only exclude private label from the market if there is *other* strong evidence that there is negligible competitive constraint from the private label product.

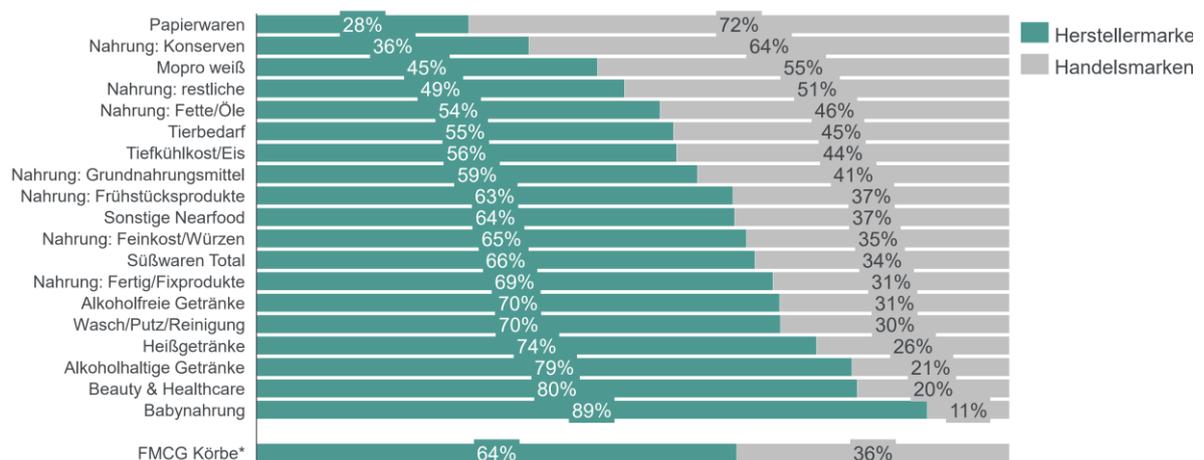
⁵ See Shapiro, C. (1996) "Mergers with differentiated products", Antitrust, Spring, 23-30.

12. There are some further patterns that emerge from our analysis that are helpful for a first assessment of competition in a market with private label and branded products. First, when the price of a private label product is much lower than those of branded products while the measured market share of the private label product is very high, the competitive constraint from private label products is *very strong*. In fact, a very high market share of the private label product does not indicate a dominant position. On the contrary, it indicates a tight competitive constraint on the ability of brands to raise prices.
13. Second, even where the market share of a private label product is much smaller, including the private label product as part of the market is appropriate for an initial analysis. Although in all analysis of competition, market shares are typically not sufficient to ascertain the competitive constraint from a specific product, this would not justify excluding the private label product when calculating market share. Including all branded and private label products in a product category for a first cut analysis appears to be no worse than in other markets, where market shares are routinely used as a filter in competition assessments or for determining whether a product is covered by, for example, the Vertical Block Exemption Regulation.
14. Third, we also show that private label products can be the main competitive constraint on branded products that, at first glance, appear to belong to a different product category altogether. An example analysed in this report is diapers and training pants. These two product categories might be classified as belonging to different markets in a competition investigation that attempts to divine substitutability from introspection. However, our analysis shows that regular private label diapers may exert a considerable competitive constraint on training pants even though there are no private label training pants on offer. If one were to define a market for training pants it would be highly

concentrated, but competitive constraints would be much more significant than such an incorrect market definition would suggest.⁶

15. Our results indicate that, in concrete cases, it may be very important to conduct a detailed empirical analysis, similar to the one conducted in this report, to ascertain the actual competitive interaction in the specific market, because qualitative introspective analysis of closeness of competition will often lead to incorrect results – especially where the competitive role of private label products is concerned.
16. The result that a large market share of private label products typically implies a tight competitive constraint on branded products in the same products group is of considerable importance because of the importance private label products have on supermarket shelves today.
17. Figure 1 gives an overview of the results of a GfK study performed for Markenverband in 2019 that documents the overall relevance of private label products in German supermarket retailing:

Figure 1: Private Label vs. Branded Products in % of Revenue



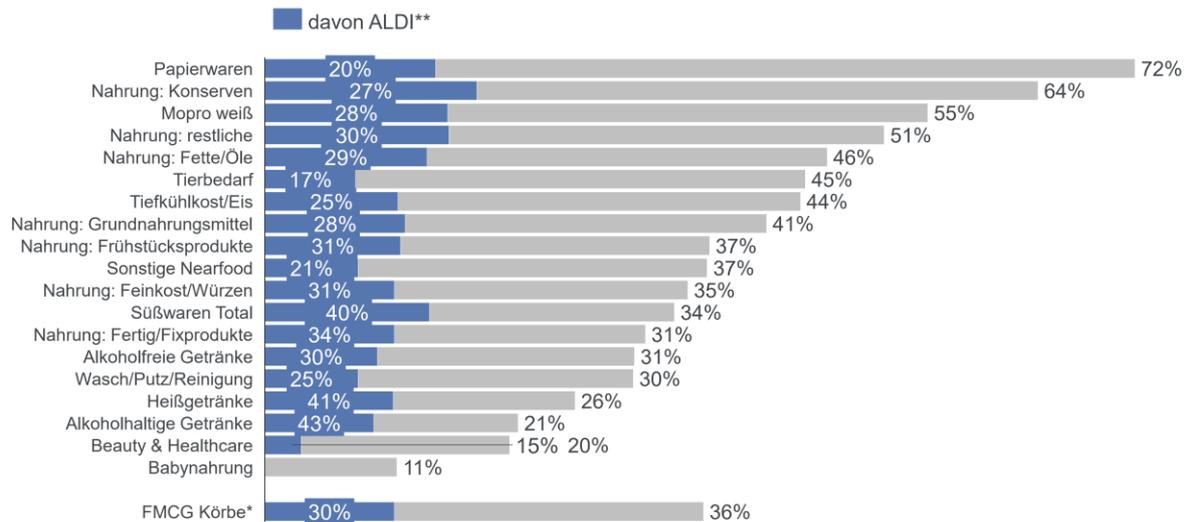
Quelle: DE GfK Consumer Panel FMCG | * FMCG ohne Frische
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⁶ The pattern we find suggests that there are separate markets for diapers sized for babies and diapers sized for toddlers, where regular diapers sized for toddlers and training pants are in the same market.

18. Figure 1 shows the revenue shares of private label (in grey) and branded products (in green) at a considerably aggregated level of product groups in supermarkets and across a broad set of supermarkets. One notices immediately that there are broad categories of high-volume products in which private label products have a large market share of 30% and more. Our analysis suggests that one would expect a significant competitive constraint based on such market shares.
19. However, these numbers include Aldi, which until recently has only sold private label products. This inclusion may distort the market structure encountered by customers when shopping in a particular store within supermarket chains that carry branded products. Figure 2 shows that private label market shares remain very significant even when one separates out the Aldi shares:

Figure 2: Aldi Share among Private Label Product Groups



Quelle: DE GfK Consumer Panel FMCG | * FMCG ohne Frische | ** Aldi Hersteller
 • Marktanteile Herstellermarken vs. Handelsmarken 2019 | Analyse für den Markenverband e.V.

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20. While the set of product groups in which private label products would be expected to have 30% or more market share becomes smaller from excluding Aldi, it still includes all the products with the highest frequency of sales. The implications of our analysis for the assessment of competition between brands and private label products is therefore of considerable importance. For the 5 product groups analysed, private label products appear relatively close competitors to branded products. The competitive constraint appears tightest, where the market share of the private label product is highest.
21. Our technical analysis in the remainder of the report proceeds in several steps. Because in grocery retail we cannot directly observe diversions from one product to another (unlike some contractual markets where the customer switches supplier), we estimate diversion ratios indirectly by using our data to estimate price elasticities. For that purpose, we estimate demand systems for each of the five product categories in our data set. This generates a set of own- and cross- price elasticities of demand that fully characterize the substitution pattern observed.
22. Own-price elasticities of demand measure the percentage quantity loss when the price of a good is increased and prices of all competitors are held constant. The cross-price

elasticity measures the percentage quantity increase when the price of a competing product is increased. These elasticities thus give information both about the degree to which a product loses customers due to a price increase and the degree to which such customers substitute to a specific competitor product. It is shown that by combining the elasticity estimates with the market share of the competitor product one can derive an estimate for the diversion ratio. Our analysis shows that the proportion to which a branded product loses customers to a private label alternative is generally of the same order of magnitude as the relative market share of the private label product among all other products sold in that category at a retailer, making market share a good first guide for the competitive constraint imposed by private label products.

23. A central part of the formal analysis is the estimation of price elasticities, which can only be done through regression analysis for each of the relevant products in each product category. We estimate demand based on a very flexible, but tractable functional form, the LA/AIDS demand system.⁷ The LA/AIDS demand system has been regularly used in demand estimation for supermarket products including attempts to estimate substitution between branded and private label products.⁸ These efforts differ from ours because they are generally performed at a fairly high level of aggregation, either at the level of whole supermarket chains or the whole industry. Sometimes these regression analyses also distinguish by different locations.

⁷ See Deaton, Angus and Muellbauer, John, (1980), An Almost Ideal Demand System, *American Economic Review*, 70, issue 3, p. 312-26. Alston, J. M., Foster, K. A., & Green, R. D. (1994). Estimating elasticities with the linear approximate almost ideal demand system: some Monte Carlo results. *The review of Economics and Statistics*, 76(2), 351-356. Eales, J. S., & Unnevehr, L. J. (1988). Demand for beef and chicken products: separability and structural change. *American Journal of Agricultural Economics*, 70(3), 521-532. Green, R., & Alston, J. M. (1990). Elasticities in AIDS models. *American Journal of Agricultural Economics*, 72(2), 442-445. Green, R., & Alston, J. M. (1991). Elasticities in AIDS models: a clarification and extension. *American Journal of Agricultural Economics*, 73(3), 874-875.

⁸ See for example, R.W. Cotterill, W.P. Putsis, Jr. and R. Dhar (2000), Assessing the Competitive Interaction between Private Labels and National Brands, *The Journal of Business*, 73(1), pp. 109-137. J. A. Hausman, G.K. Leonard (2005), Competitive analysis using a flexible demand specification, *Journal of Competition Law & Economics*, 1(2), Pages 279–301. Min-Hsin Huang, Eugene Jones & David E. Hahn (2007) Determinants of price elasticities for private labels and national brands of cheese, *Applied Economics*, 39:5, 553-563.

24. While there is some evidence that competition between discounters that mostly sell private label products on one hand and full range supermarkets on the other already constrain branded products⁹, we are particularly interested in substitution by the individual end customer *within* a given store. This can be interpreted as measuring direct interbrand competition in the store, while abstracting from competition between different retailers and retail formats. We thus look at substitution at a much more disaggregated level and estimate a demand system for customer choice within a specific store separately for each German retail chain that we consider. Prices are observed as weekly averages over a time horizon of three years, separately for each store of the retailer.
25. In the remaining part of the report, we first describe the data in Section 2. In Section 3 we present the basic steps of the analysis based on one specific supermarket chain. For the remainder of the report, we present tables with the main results in the text. We describe the methodology and further details on the data in the Appendix.

2. The Data

26. We rely on a data set from IRI, which was made available by Markenverband for the purposes of this study. The data is limited to five food categories: milk, cat food, frozen pizza, dishwashing liquid, and diapers. It contains weekly observations of average quantities and prices at the level of individual stores for the years 2016 – 2018. For cat food, we only have data for the year 2016. There are approximately 9000 stores in the data set.
27. The data is limited to three German retailers that we refer to as retailers 1 – 3. The data set has been anonymized with respect to identifying information for the retailer to maintain confidentiality. The data set, nevertheless, allows stores to be linked to the corresponding

⁹ See Rickert, Wey, Haucap, Heimesdorff, and Klein, (2013), Inter-Format Competition among Retailers - The Role of Private Label Products in Market Delineation, DICE Discussion Paper 101.

retailer.¹⁰ Observations from stores which cannot be mapped to a retailer have been removed from the sample. The number of stores affected by this problem is very small.

28. Not all stores in the same chain offer the same product line. This can be a problem when estimating the AIDS demand model, because the model assumes that the set of products remains constant across observations. However, in our data set, product lines vary across stores of a specific retailer only with respect to products with extremely small market shares. Including these products would therefore not affect the estimates generally and may even reduce the precision of the estimates. We therefore drop those products from consideration. The only product group where this is different is milk. For fresh milk, local suppliers tend to have very significant market shares so the product offerings vary regionally across stores within a retailer. To avoid estimation problems for milk, we focus the analysis on UHT-milk, for which the product line for each store within a retailer is the same.
29. We further reduce the number of products by aggregating across different European Article Numbers (EANs) that represent essentially the same products. For example, we aggregate across different “flavours”, i.e. different versions of the product which are usually sold at the same price.¹¹ We also aggregate across different package sizes by estimating a price per given unit of volume or weight. Effectively, we aggregate up to level of brand (like Whiskas and Sheba) thus distinguishing different brands in different price categories for a given manufacturer. This reflects our focus on competition between private label and brands. We estimate the model separately for each product category and retailer.

3. Estimating Diversion Ratios from Store Level Data

30. Often competition authorities have decided that two products are in different markets when their prices are very different. Private label products often exhibit very different (lower) prices. They often are not very differentiated in terms of their physical characteristics but

¹⁰ Retailers generally have multiple, differently branded chains. To preserve the number of observations we have performed estimations at the retailer level. We have checked whether results materially change when estimating at the chain level. While it is more difficult to obtain stable estimates, qualitative results do not appear to be affected.

¹¹ For example, dishwashing liquids of the same brands with different fragrances. Note that this abstracts from certain promotion policies where a specific “flavour” is used for promotions, but the regular price is maintained for other flavours.

differ from branded products primarily by brand recognition and national advertising. We show in this section that the approach of basing market definition on large price differences is fundamentally flawed. In contrast, high market share in the product group *is* a predictor for the competitive constraint that a private label product imposes on branded products - precisely *because* the price is lower than that of competitors.

31. For example, for UHT-Milk, the price for the private label product in our sample is only 50% to 60% of the price of the most expensive brand. Even relative to the cheapest branded product the price of private label UHT-Milk is just 65% to 70% as high. These large price differentials do not mean that these products are not in the same market. In fact, even when customers are willing to pay a premium for the branded product, there may be many customers who are close to indifferent between the high-price branded product and the low-price private label product. In that case, a price increase for the branded product will lead to a large shift of customers to the private label product, so that the private label product becomes an important if not the most important constraint.
32. In fact, which product imposes the tightest constraints on the pricing of a specific branded product is determined by the product that gains the largest share of purchases that the branded product loses from raising the price. This idea is captured in competition economics by the diversion ratio, which is given by the following Formula:

$$DR_{ij} = \text{Diversion Ratio from product } i \text{ to product } j$$

$$= \frac{\text{quantity gained by product } j \text{ from price increase of product } i}{\text{quantity lost by product } i \text{ from price increase of product } i}$$

33. In formal mathematical notation this is generally expressed as the ratio of the change in the quantity demanded for product j , ∂D_j , to the change in the quantity demand for product i , ∂D_i , from a small change in the price of product i , ∂p_i , where “ D ” stands for quantity demanded and “ p ” for price. The symbol “ ∂ ” indicates a small change. With this notation we can rewrite the definition of the diversion ratio between i and j more formally as:

$$DR_{ij} = \frac{\frac{\partial D_j}{\partial p_i}}{-\frac{\partial D_i}{\partial p_i}} = \frac{e_{ji} S_j}{e_{ii} S_i}$$

34. The second term in this expression simply formalizes the verbal definition of the diversion ratio further above. The term $\frac{\partial D_j}{\partial p_i}$ indicates the sales gained by product j when the price of product i is slightly increased. The term $-\frac{\partial D_i}{\partial p_i}$ represents the quantity lost by product i when its price is increased. The ratio of the two is the share of customers that would be captured by product j of all those who would switch from buying product i after a price increase.
35. Diversion ratios are not directly observable in grocery retailing. For that reason, we transform the diversion ratio into terms that we can either estimate or observe directly from the data: price elasticities and market shares at a given store.
36. This transformation of the equation, shown after the second equality sign, achieves this goal. The term e_{ij} gives the percentage change in demand for product j when the price i is changed by one percent. This is called the “cross-price elasticity of demand” between products j and i . It is a standard measure for substitution between two products. The term e_{ii} is the percentage change in demand for product i when the price of product i (*its “own price”*) is changed by 1%. This is the “own-price elasticity of demand” and measures the sensitivity of sales to a price increase of a product (keeping the prices of all competitor products constant). These elasticities can be estimated from the AIDS model through a regression analysis.
37. The competitive constraint a private label product imposes on a branded product is dependent on the cross-elasticity of demand of the private label product in response to a price increase of the branded product, relative to how price sensitive the brand product is to its own price increase. Note that the ratio of cross-price elasticity of demand for the private label product j to the own-price elasticity of demand for the branded product i can be low if the cross-price elasticity is low. We will, in fact, see that the cross-price elasticity of the private label product with respect to a given branded product is often lower than the cross-price elasticity of other branded products

with that product in question. Such an observation does not show, however, that the private label product imposes less of a competitive constraint.

38. The reason is that elasticities only measure percentage demand reactions for a given percentage price increase. However, when a private label product has a large market share the total loss in sales to the private label product from the branded product in question can be much bigger than from any of the other branded products. In other words, when the market share of a private label product is high, it is likely to have a large constraining effect on branded products, even when the cross-elasticity of demand is smaller than those between the branded products.
39. Note that this analysis implies that the observation of much lower prices for private label products is not an indication that they are in a different market. On the contrary, the low price *causes* the large market share, which implies that the private label product imposes a strong competitive constraint. It is precisely the low price that wins over customers and limits the ability of branded products to set higher prices to exploit the willingness of customers to pay a premium on branded products.
40. In the following sections, we show this result for two product groups in which private label products have a particularly high market share in German supermarkets: UHT-milk and cat food.

4. High Market Share of a Private Label Product Implies a Tight Constraint on Branded Products

4.1 Large Market Share of Private Label Implies a Strong Constraint on Brands: The Example of UHT Milk

41. For our example of a market in which there is a very high share of private label, we have selected UHT-milk. We have excluded fresh milk because branded fresh milk supplies are very localized. For this reason, the product line for fresh milk differs for different stores of the same retailer. This pattern would create considerable difficulties for the estimation approach adopted in this report. In contrast, UHT-milk supply is generally national. While the product line may differ between retailers they generally do not vary for different stores of the same retailer. We therefore estimate demand separately for each retailer and thus do

not have to be concerned about varying product lines in our demand estimation for UHT-milk.

42. UHT milk is an example for a market with very little horizontal product differentiation, so that products are primarily differentiated along a vertical dimension of perceived quality. The economic literature suggests that competition in such markets is quite fierce despite the fact that they also appear quite concentrated. We will show that the price constraining role of private label UHT milk is therefore particularly important. This is precisely reflected in its high market share.
43. In addition to the private label product, each of our three retailers list three brands of UHT milk. All of them carry the products of Milchwerke Berchtesgaden and Molkerei Weihenstephan. The third brand is either Schwarzwaldmilch or Hochwald. To allow for full anonymization of retailers we label both brands as “Waldmilch” in the tables below. Both “Waldmilch” brands tend to be at the higher price end for the corresponding retailer at which they are sold.
44. Table 1 below shows the average share of units sold and average retail price per litre of UHT-milk for each of the products with substantial sales for Retailer 2. We observe that the private label product has an average market share of more than 64%. Also note that these shares can vary considerably from store to store. The standard deviation, which measures the dispersion of market shares, is 16.13 percentage points, which must be considered large. To obtain a sense for the degree of variation, assume for the sake of illustration that market shares across stores and time are distributed symmetrically around the mean (which they are not). Then there would be about 5% of stores/week observations for which the private label share is below 32% and about 5% of stores/week observations, where it would be above 96%.
45. A large dispersion relative to the mean market share is also observed for the branded products supplied by Waldmilch, Milchwerke Berchtesgaden, und Molkerei Weihenstephan. Note that the highest price brand is Waldmilch with €1.28 per litre followed by Molkerei Weihenstephan with €1.21, and Milchwerke Berchtesgaden with €1.06. The private label price is much lower and only 53% to 65% of the prices of the branded products.

46. Our empirical analysis shows that the large price differential between the private label and the branded products generates the very large market share we observe. As a result, the private label product imposes a very strong competitive constraints on the pricing of the branded products.

Table 1
UHT-milk
Retailer 2

Sample mean across stores (St.Dev.)

	Share*	Price**
Private Label	75.34 (15.23)	0.69 (0.25)
Waldmilch	5.32 (7.24)	1.28 (0.45)
MW Bercht.	7.24 (11.45)	1.06 (0.10)
MK WS	12.10 (9.12)	1.21 (0.16)

*Share of unit sales
**Price in € for 100ml
MW Bercht.: Milchwerke Berchtesgaden.
WS: Molkerei Weihenstephan.

47. The first step in the analysis is to estimate demand for each branded product and the private label product separately using the AIDS model. From the estimated parameters of the regression equation, we calculate the implied own-price and cross-price elasticities for each of the products. These elasticities are presented in Table 2 below.

Table 2
UHT-milk
Price Elasticities (Retailer 2)

Q/P	Private	Waldmilch	MW Bercht.	MK WS
Private	-1.262***	0.116***	0.292***	0.442***
Waldmilch	0.013	-2.542***	0.043	0.345***
MW Bercht.	0.656***	-0.062***	-3.370***	0.625***
MK WS	0.513***	0.094***	0.312***	-2.920***

Elasticities represent the change in quantity in the product-manufacturer in rows due to a price change of the product-manufacturer in columns.
 *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors of the elasticity estimates in parentheses .
 MW Bercht: Milchwerke Berchtesgaden. MK WS: MK Weihenstephan.

48. Each entry in Table 2 shows the percentage quantity change of the product indicated in a row from a percentage price increase by the product indicated in a column. Stars behind the estimates indicate that the estimate is statistically distinguishable from zero. When this is not the case, we treat the coefficient as zero and ignore it in further calculations because we cannot reject the hypothesis that it is, in fact, zero.
49. The numbers on the diagonal correspond to the own-price elasticities of the products. Note that product maximization implies that these coefficients must each be strictly smaller than -1, which is the case here. For branded products they are between -2.5 and -3.4, which is of the order of magnitude expected from other studies of groceries products (if a little less elastic). The own-price elasticity of the private label product is notably less elastic but still within a range that can be rationalized by theory.
50. Cross-price elasticities are almost all strictly positive and statistically significantly different from zero. There are two exceptions. First, Waldmilch's quantity does not appear to react to price increases of the lowest priced products, namely the private label product and the product of Milchwerke Berchtesgaden. This is not very surprising. Waldmilch is the most

expensive brand and the private label product is far less expensive than any branded product. This holds to a slightly lesser degree for Milchwerke Berchtesgaden.

51. When the price of a low-priced product is raised, substitution will typically go with a larger proportion to another lower priced product or to the next higher priced product (unless consumption is reduced overall). Substitution from a low-priced product to the highest priced product will be much rarer – especially for products that are mainly differentiated by perceived quality. Our results are consistent with these predictions. Substitution for the private label product goes primarily to the two next highest priced products but not to Waldmilch. Substitution from MW Berchtesgaden goes either to the lower priced private label product or the next higher priced branded product, but not to Waldmilch. The estimate of the cross-elasticity for MW Berchtesgaden is slightly higher than that of the private label product, although both are statistically indistinguishable from zero.
52. However, the negative cross-price elasticity of Milchwerke Berchtesgaden with respect to the Waldmilch price is not consistent with theory. It is statistically significantly negative, indicating that the demand for the Milchwerke Berchtesgaden product falls when Hochland increases its price. This makes little sense. However, such unreasonable estimates sometimes arise in demand estimation. Since such a regression result is suspect, we eliminate these results for further analysis. This is particularly unproblematic in this case since Waldmilch has a very small share of the market in any case, which may be the reason that it is difficult to estimate reasonable cross-price elasticities for this brand.
53. Combining the information from demand elasticities and market shares we obtain estimates for diversion ratios between products, which can be interpreted as measures of closeness of competition for different brands. This is shown in Table 3.

Table 3
UHT-milk
Unit Diversion Ratios
Retailer 2

	Private	Waldmilch	MW Bercht.	MK WS
Private		64.3***	91.0***	94.4***
Waldmilch	0.1		0.9	5.2***

MW Bercht.	5.0***	-3.3***	12.7***
MK WS	6.5***	8.4***	15.5***

Diversion of quantities of the row product due to a price change by the column product. Stars indicate degree of significance. *** p<0.01, ** p<0.05, * p<0.1. The coefficients without stars cannot be distinguished from zero and therefore essentially have to be interpreted as zero
 MW Bercht: Milchwerke Berchtesgaden. MK WS: MK Weihenstephan.

54. We see from these diversion ratios that the large bulk of quantity shifts from an increase in the brand product prices arises from substitution to the private label product. When the private label product raises the price, there is some substitution to higher priced products, but not to the highest priced product.
55. The much lower diversions from the private label product to brands arises because an increase in the private label product price primarily leads to private label customers stopping their purchasing of UHT-milk. There is some evidence for this because the own-price elasticity of the private label product is very strongly affected by the income effect. This means that customers with a smaller budget will substitute out of UHT-milk consumption when the cheapest product gets more expensive in order to retain income for buying other products.
56. It is also possible that private label milk is not priced at the profit maximizing price for private label sales. This could be the case because the price of private label products is often priced to attract customers to visit the store. Store advertising (in contrast to national advertising by brands) often targets products like milk that are bought by many customers for regular use. The level of prices of frequently purchased branded products as well as private label offerings are often driven by competition between stores. Stores price a core set of products at low prices to attract business to the store and gain margins on other products that customers do not use for a price comparison between stores. The low price of the private label product is then driven less by competition between brands

of the same product category, but the increase in the quantity of sales of other products that customers buy who were attracted to the store by the low price for the private label product. For that reason, estimates of demand for private label products can be distorted, because our regressions cannot include all of the factors that would capture competition between retailers through store specific advertised prices.

57. Consistent with this role of retail competition, we see a particularly high incidence of non-sensical own-price elasticity estimates and cross-price elasticities for changes in the private label price in our data set. On one hand, the price of the private label would be set lower than its own-price elasticity would suggest, because pricing takes into account the margin of other products that are bought. This would explain own-price elasticities below the ones implied by theory. At the same time, a price increase of the private label product does not increase the quantity of competitor branded products as much because a relatively larger part of substitution is absorbed by substitution to another retailer. As a result, the cross-elasticity can even become negative.
58. Since our interest in this paper concerns the constraint that private label products impose on branded products, our analysis on diversion ratios will focus primarily on the impact of price increases of the branded products on the quantities sold of other products in the product group. This analysis uncovers the diversion ratios from branded to private label products, which gives us the relevant information on the pricing constraint that private label products impose on branded products.
59. There is one further issue that becomes apparent when considering Table 3. Note that diversion ratios generally should add up to something smaller than 1 because substitution in reaction to a price increase does not only go to competitor products but also to non-consumption. However, some of the diversion ratios above add up to more than 100%. There are two reasons for these estimation results. First, the diversion ratios depend on estimates of the underlying parameters that themselves are estimated with

error. If the diversion ratios add up to more than 100% this will, at least partially, reflect estimation error.

60. Second, it appears to be difficult to identify the volume reduction from lower consumption of UHT-milk (or other products). This is determined primarily by the own-price elasticity. For this reason, the relative size of the diversion ratios from a brand to its competing product appear to be much more informative than the absolute value of diversion ratios. The explanation is that such relative measures do not depend on the own-price elasticity of demand, which determines the degree of substitution out of the product group.
61. We therefore calculate in Table 4 the share of each product of the total diversions that go to other products of the same product category *in the same store*, when the price of another products is increased. This measure only depends on the (market share weighted) cross-price elasticities of the competitors of a product that raises its price. In simple terms, this is the store market share a competitor gains among customers that switch from a product that raises its price.
62. An advantage of this measure is that it can easily be compared to the relative market shares of the competing products in the store. Suppose there are two competitors of the firm that raises the price. One has a market share of 40% and the other a market share of 20% in the store. This means their relative market shares are 66.6% and 33.3% respectively of the total joint market share of 60%. A rule of thumb often used for firms in the same market is that it is assumed that competitors would gain customers from another firm raising prices in the proportion of their relative market shares. When that is true, relative market shares can proxy for diversion ratios and thus also proxy for the relative constraints that companies impose on any specific competitor. In Table 4 we show that this correspondence between relative market shares and diversion ratios is approximately true for the private label product for UHT-milk at Retailer 2.

Table 4
UHT-milk
Relative Diversion Ratios in Store (in %) vs.
Relative Market Shares
Retailer 2

	Private	MW Bercht.	MK WS
Private		85	84.1
		81.2	85.7
Waldmilch	0.9	0.8	4.6
	21.6	5.7	6.1
MW Bercht.	43.1		11.3
	29.4		8.2
MK WS	56	14.4	
	49.1	13.0	

Diversion of standardised quantity-units of the row product-manufacturer due to a price change on the column product-manufacturer. *** p<0.01, ** p<0.05, * p<0.1

MW Bercht: Milchwerke Berchtesgaden. MK
WS: MK Weihenstephan.

63. In Table 4 the bold numbers give the relative diversion ratios, i.e. the share of sales lost by the product in the vertical column to all competitors in the store that is captured by the product on the horizontal row. The smaller, unbolded numbers are the relative shares of the products in each row excluding the sales quantity of the product in the vertical column.

64. To understand the table, consider Milchwerke Berchtesgaden increasing the price. This puts us into the second column. The bold numbers in the table are the relative diversion ratios. The number 85 in the first row indicates that 85% of the sales that Milchwerke Berchtesgaden loses from a price increase to competitors in the same store (when all other products stick to the same price) are captured by the private label product. The second highest relative diversion goes to Molkerei Weihenstephan with 14.4%. The

remaining business (0.8%) goes to Waldmilch. These numbers do not add up to 100% due to rounding error.

65. We see that the relative diversion to the private label product, which has the lowest price, is higher than its relative market share. This can be read off in the row for private label, where the relative diversion ratio of 85% is higher than the smaller number below, which indicates the relative market share of 81.2%. However, the estimation error on the relative diversion ratios means that these numbers are effectively not distinguishable. This means that the constraint imposed by the private label product on the price of Milchwerke Berchtesgaden and Molkerei Weihestephan is a little larger than the relative market share suggests but qualitatively the two correspond almost exactly.
66. In contrast, the competitive constraint from the firm with the highest price, Waldmilch, is significantly lower than its relative market share of 5.7% would suggest. Also note that the relative diversion ratio of Waldmilch is only of significant impact for Molkerei Weihestephan, the product with the highest price after Waldmilch. For price increases of the private label product, the relative diversions from Molkerei Weihestephan is higher than that of Milchwerke Berchtesgaden despite the fact that Molkerei Weihestephan has the higher price. However, this is a reflection of the higher popularity of the Molkerei Weihestephan product. When compared to the relative market share, Milchwerke Berchtesgaden does impose a stronger constraint on the private label despite being a less popular product.
67. These patterns reflect the insights from our earlier discussion. Products are primarily vertically differentiated in the UHT-milk market, i.e. perceived “quality” differences based on brand reputation will determine relative prices. Substitution in response to a higher price will then go asymmetrically more to lower priced products than to higher priced products. This means that in such vertically differentiated markets the lowest price firm will impose a disproportionate competitive constraint on all other products

and gain large market share. Hence, the private label product is the most important competitive constraint on *all* branded products. The high market share reflects that constraint.

68. We have shown these results first for just one retailer, which allowed us to illustrate some of the challenges with estimation and interpretation of the results. However, not all retailers are the same. They may cater to different types of customers with higher and lower incomes. Their private label products may have different reputation for quality. For this reason, we would expect the estimation results to somewhat differ from retailer to retailer. In the remainder of this section, we show that the qualitative results of our discussion on UHT-milk carry over to other retailers but that there are some differences due to different roles of products at different retailers.

69. Table 5 first shows the descriptive statistics for retailers 1 and 3 in our data set.

Table 5
UHT-milk, Sample descriptive statistics.

Retailer 1			Retailer 3		
Q/P	Share	Price(€)*	Q/P	Share (%)	Price(€)*
Private Label	74.02 (13.61)	0.73 (0.10)	Private Label	67.77 (16.00)	0.72 (0.09)
MW Bercht.	5.74 (7.77)	1.13 (0.10)	MW Bercht.	2.96 (3.98)	1.02 (0.09)
MK WS	10.66 (7.11)	1.20 (0.17)	MK WS	13.54 (13.28)	1.19 (0.15)
Waldmilch	9.58 (10.30)	1.49 (0.10)	Waldmilch	15.73 (8.97)	1.12 (0.12)

* Average Share of unit sales

** Average price per litre in €

MW Bercht: Milchwerke Berchtesgaden. MK WS: MK Weihenstephan.

Schwarz: Schwarzwaldmilch

70. Note that for Retailer 1 and 3 the relative price positioning between Private Label, Milchwerke Berchtesgaden, and Molkerei Weihenstephan are almost identical with

those for Retailer 2. However, for Retailer 1 Waldmilch, as the most expensive brand, is priced significantly higher than Waldmilch at Retailer 2. Nevertheless Waldmilch, has about twice the market share at Retailer 1 than it has at Retailer 2. In contrast, Waldmilch has a significantly lower price at Retailer 3 and at the same time very low market share.

71. These results indicate significant differences between the retailers in their ability to sell high priced brands in their stores. We would expect this to also have impact on the diversion ratios. For simplicity of exposition, we directly present the comparison between relative diversion ratios and relative market shares at the retailer to illustrate these differences.

72. Table 6 summarizes these results for Retailer 1 and 3.

Table 6
UHT-milk: Relative Diversion Ratios vs. Relative Market Shares

	Retailer 1			Retailer 3			
	MW Bercht.	MK WS	Waldmilch	Private Label	Waldmilch	MW Bercht.	MK WS
Private Label	80.5 78.5	79.5 82.9	78.8 81.9	Private Label	37.7 69.8	64.7 78.4	63.6 80.4
MW Bercht.		13.5 6.4	21.2 6.3	Waldmilch		15.0 3.4	12.8 3.5
MK WS	0.0 11.3		0.0 11.8	MW Bercht.	10.5 14.0		23.6 16.1
Waldmilch	19.5 10.2	6.9 10.7		MK WS	51.8 16.2	20.3 18.2	

Relative Diversion ratio of standardised quantities to the row product due to a price change for the column product in larger **bold** numbers. Corresponding relative market shares in smaller unbolded numbers below the relative diversion ratio.

MW Bercht: Milchwerke Berchtesgaden. MK WS: Molkerei Weihenstephan.

73. Note that for retailer 1 the relative diversion ratio to the private label products is around 80%. This is again very close to the relative market share of the private label product.

This is different for the second lowest priced product (Milchwerke Berchtesgaden), which receives a higher relative diversion of sales relative to its relative market shares. This reflects that substitution from higher priced products to lower priced products is stronger in vertically differentiated markets than substitution the other way around.

74. It is somewhat surprising that a price increase of Milchwerke Berchtesgaden has a disproportionate quantity effect on Waldmilch compared to its relative market share, while it has virtually no effect on Molkerei Weihenstephan. This may be related to difficulties of estimating quantity responses in Molkerei Weihenstephan. When Molkerei Weihenstephan, the second highest price product, raises the price the quantity share gained by Waldmilch is lower than its relative market share. In fact, we then have the same asymmetry of stronger substitution to lower priced products we saw for Retailer 1 and the private label product providing the critical constraint.
75. Retailer 3 provides a counterexample to this pattern in the reaction of consumers to a price increase at Waldmilch, which appears to be a high quality image product with low market share at Retailer 3. It appears that in this case substitution to a similarly positioned product, namely Molkerei Weihenstephan, dominates the relative diversions, which far exceed those of the relative market share of Weihenstephan. When other products increase their prices the by far dominant relative diversion is again to the private label product. However, this diversion is in this case somewhat lower than the relative market share. The reason appears to be the pricing behaviour of Waldmilch, which appears to be perceived as a higher quality product, but positioned at a significantly lower price than at Retailer 2. Hence, the price-quality combination appears particularly attractive generating relative diversions far above relative market share.
76. Generally, it appears that the basic patterns are stable across retailers. Market share including sales of the private label product is a reliable guide to closeness of competition (i.e. the source of relative price constraints of branded products). The private label

product is the closest competitor of all other UHT-milk producers in the market. Where results vary somewhat this is usually caused by a producer with smaller market share or a product placed at the upper end of the pricing range, namely Waldmilch. But even these high-priced products appear strongly constrained by private label competition in their ability to raise prices.

5. The Interplay of Vertical and Horizontal Product Differentiation

77. Our example of UHT milk is a limit case where products are homogeneous except for a vertical dimension of perceived quality. This meant that substitution was particularly strong between products with a high and low perceived quality level. So far, we have looked at private label products with very high market shares. In this section we show that for private label products with lower market shares there is more variance in the relationship between market share and competitive impact than at high market shares. Nevertheless, the market share remains a good guide for a first assessment of the competitive impact of private label products on branded products.
78. Private label products tend to have lower market shares when the branded products are more strongly horizontally differentiated, so that quality differences between products do not dominate the degree of product differentiation for all products. Vertical product differentiation still has a similar role to play as in the previous section because the low perceived quality good will still impose a particularly strong constraint with respect to the branded product that is least differentiated on the horizontal dimension. But that also means that some branded products that are differentiated from the private label product may sometimes be priced more aggressively than the private label product of some retailer because they are closer on the horizontal dimension with another branded product.
79. Horizontal differentiation then means – as in all markets - that the mapping from

market shares to competitive constraints becomes less reliable. This insight does not imply that private label products should not be considered in the same market as branded products. Instead it reflects the general observation that with horizontally differentiated products market shares do not fully reflect the relevant competitive constraints and thus a more careful analysis is generally necessary to fully understand competitive constraints.

80. In the remainder of this section, we look at four examples for product groups ranging from a very fragmented market like the market for dishwashing liquids to a very concentrated market like frozen pizza and baby diapers, where we show the different way how horizontal and vertical product differentiation interplay.

5.1 Cat Food: Large Market Share of Private Label still Captures the Competitive Constraints when Manufacturers offer different Quality Levels

81. Our second example with high private label market shares is cat food. Market shares do not quite reach the levels we observe in UHT-milk. This is unsurprising since UHT-milk would, most likely, be perceived as a less (horizontally) differentiated product. Brand image is then primarily a vertical attribute and the pricing constraint from the low brand image private label tends to be particularly strong.

82. Brands in cat food are also differentiated horizontally, i.e. customers differ at equal prices in their preferences over products. In addition, we also have branded producers put several brands on the market.

83. Furthermore, brands differ to the extent to which they are important for wet or dry food. While it is possible to separate wet and dry food products, this leads to a very unwieldy set of results. Here we aggregate to the brand level since the qualitative results are unchanged when we focus simply on vertical and horizontal differentiation by brand.

84. An additional complication is introduced because that the main manufacturers of cat food offer both a basic and a higher quality brand to target different customer groups. Private label products are only active at the basic level and are priced in the lowest price bracket – although in cat food the private label products do not have the lowest price. Still, the question arises whether the private label product is a significant constraint only for the basic brands or also for the brands offered explicitly as higher quality products at higher prices. Table 7 shows the basic structure of this market for the three retailers in our sample.

Table 7
Cat Food: Average Shares and Average Prices

	Retailer 1		Retailer 2		Retailer 3	
	Share*	Price**	Share*	Price**	Share*	Price**
Felix (Nestle)	11.75 (7.09)	0.30 (0.07)	19.06 (11.12)	0.34 (0.06)	14.06 (7.00)	0.34 (0.06)
Gourmet (Nestle)	3.71 (4.55)	0.60 (0.14)	8.68 (7.32)	0.61 (0.11)	6.74 (5.80)	0.61 (0.10)
Private Label	53.92 (15.65)	0.23 (0.07)	31.04 (24.92)	0.22 (0.05)	44.37 (13.38)	0.25 (0.04)
Kitekat (Mars)	11.65 (7.85)	0.19 (0.02)	13.93 (9.31)	0.20 (0.04)	10.16 (5.89)	0.20 (0.03)
One (Nestle)	3.52 (2.65)	0.44 (0.10)	5.77 (3.65)	0.45 (0.07)	4.57 (3.11)	0.43 (0.07)
Sheba (Mars)	6.64 (6.38)	0.62 (0.11)	9.14 (6.27)	0.65 (0.11)	9.17 (6.84)	0.65 (0.12)
Whiskas (Mars)	8.80 (5.22)	0.34 (0.06)	12.37 (7.31)	0.33 (0.07)	10.93 (5.33)	0.35 (0.05)

*Share in units (standardised at 100g)

**Price in € per 100gr

85. There are two brand manufacturers at all retailers, Mars and Nestle, which each producing a brand in a lower price segment (Whiskas and Felix respectively) and in a high-priced segment (Sheba and Gourmet). In addition Nestle produces an intermediate level brand (One) and Mars a very low price alternative (Kitekat). The higher-end brand for Mars is priced on average at 88% above the basic brand, Whiskas, while Nestle's

high priced brand Gourmet is priced between 70% and 80% higher than Felix. The private label product is priced at a discount of 25% to 30% of the basic brands Whiskas and Felix. But Mars' Kitekat brand is consistently priced even below the private label product.

86. Interestingly the private label brand has by far the largest market share, ranging from 31% for retailer 2 to 54% of retailer 1. But the lowest price brand does not achieve much more than 10% market share. Clearly the quality perception of customers is higher for the private label products than for Kitekat, since they sell at a higher price and achieve larger market share. We now show that market share is not always a good guide for where customers substitute to because reactions to price increases may not be proportional to market shares when the trade-off between price and quality varies between customers.

87. Estimating an LA/AIDS demand system allows us to determine by estimation whether the basic brands and the high-priced brands both compete with the private label product. We show in Table 8 that this is generally the case.

Table 8					
Cat Food: Relative Diversion Ratios vs. Relative Market Shares					
Retailer 1					
	Felix (Nestle)	Gourmet (Nestle)	Kitekat (Mars)	Sheba (Mars)	Whiskas (Mars)
Felix (Nestle)		20.6 12.2	20.3 13.3	23.7 12.6	24.5 12.9
Gourmet (Nestle)	4.3 4.2		7.9 4.2	9.3 4.0	1.8 4.1
Private Label	29.6 61.1	35.5 56.0	53.5 61.0	36.8 57.8	31.3 59.1
Kitekat (Mars)	33.0 13.2	18.8 12.1		12.8 12.5	28.5 12.8
One (Nestle)	5.0 4.0	2.5 3.7	1.4 4.0	2.0 3.8	5.1 3.9
Sheba (Mars)	14.0 7.5	17.7 6.9	9.0 7.5		8.8 7.3

Whiskas (Mars)	14.0	5.0	7.9	15.5
	10.0	9.1	10.0	9.4

Retailer 2

Q/P	Felix (Nestle)	Gourmet (Nestle)	Kitekat (Mars)	Sheba (Mars)	Whiskas (Mars)
Felix (Nestle)		35.5	27.3	21.7	48.1
		20.9	22.1	21.0	21.8
Gourmet (Nestle)	11.0		7.1	25.3	2.6
	10.7		10.1	9.6	9.9
Private Label	16.6	14.4	41.9	19.5	12.4
	38.4	34.0	36.1	34.2	35.4
Kitekat (Mars)	34.7	6.7		19.0	26.4
	17.2	15.3		15.3	15.9
One (Nestle)	2.9	4.8	-1.6	7.6	6.6
	7.1	6.3	6.7	6.4	6.6
Sheba (Mars)	11.2	20.8	10.3		3.9
	11.3	10.0	10.6		10.4
Whiskas (Mars)	23.6	17.8	15.0	6.8	
	15.3	13.6	14.4	13.6	

Retailer 3

Q/P	Felix (Nestle)	Gourmet (Nestle)	Kitekat (Mars)	Sheba (Mars)	Whiskas (Mars)
Felix (Nestle)		19.2		21.9	35.1
		15.1		15.5	15.8
Gourmet (Nestle)	9.5			17.6	19.5
	7.8			7.4	7.6
Private Label	57.7	40.5		35.6	48.9
	51.6	47.6		48.9	49.8
Kitekat (Mars)	18.9	11.1		23.1	-2.6
	11.8	10.9		11.2	11.4
One (Nestle)	-2.9	-2.7		-1.3	0.6
	5.3	4.9		5.0	5.1
Sheba (Mars)	3.2	14.4			-1.6
	10.7	9.8			10.3
Whiskas (Mars)	13.7	17.4		3.0	
	12.7	11.7		12.0	

Relative diversion ratio of standardised quantities to the row product due to a price change for the column product in larger bold numbers. Corresponding relative market shares in smaller unbolded numbers below the relative diversion ratio.

88. There is considerable variation in substitution behavior to private label brands. Only for retailer 3 is the relative diversion ratio close to the relative market share of the private label product. For the other two retailers relative diversion ratios tend to be significantly below the relative market shares. But in those cases diversion ratios to the even lower priced Kitekat are significantly above the relative market share of Kitekat. The largest joint relative diversion ratios from Gourmet and Sheba is always to the low priced brands Kitekat and private label. For retailers 1 and 3 this exceeds 50%. This shows that low price brands including private label account for the strongest price constraint on the highest price products.
89. Generally substitution is broadly spread between all brands with private label always taking a very substantial proportion of the relative diversion. It is therefore again appropriate to include private label and brands in a single market. We also again have the phenomenon that very large market shares of private label indicate that prices are low and that the competitive constraint imposed on brands is large. The idea of a firm with market share having particular market power is therefore incorrect. Private label products have large market share precisely because they are constraining brands through low prices at acceptable quality levels.
90. This insight might seem surprising at first, but upon reflection it is quite intuitive. While customers might want to buy a higher quality product for a higher price, they may revert to a basic product when the high-quality product becomes too expensive. But when they buy a basic product anyway, they might just save a bit more money and go for the private label. Since the private label product is very popular conditional on buying the basic product, most of the substitution away from the high-price products is to the private label product.
91. Note that these conclusions may depend on the quality of the private label product. To see this note that for Retailer 2 the relative diversion ratios from any branded product

(except for the even lower priced Kitekat) to the private label product is relatively small and far below the relative market share. In this case substitution is much more strongly towards the base product of the other brand or to the lowest priced brand.

92. These examples show that the market share is not always the best guide to determining the closest competitor. But generally high market shares combined with low prices relative to branded products imply that the private label product imposes a tight competitive constraint not only on products at the same quality level but also at higher quality levels and in very significantly higher price brackets.

5.2. Dishwashing Liquid: The Impact of Private Label Products in a Fragmented Market

93. Dishwashing liquid is the most fragmented market in our sample. There is a private label product at each retailer. In addition, there are 5 brands with substantial market shares. Henkel is the leading brand, achieving more than 30% average market share at two of the retailers. But even the market shares of Henkel are volatile across different stores and retailers. The average market share of Henkel at Retailer 2 is only 21.3%. Prices also vary significantly across retailers and stores. Table 9 gives an overview of the distribution of average market shares and average prices across the three retailers considered in this study.

Table 9
Dishwashing Liquid: Average Shares and Average Prices

	Retailer 1		Retailer 2		Retailer 3	
	Share (%)	Price(€)*	Share (%)	Price(€)*	Share (%)	Price(€)*
Colgate	13.53 (10.55)	1.15 (0.24)	6.23 (7.03)	0.84 (0.19)	9.96 (8.00)	1.02 (0.21)
Fit	11.41 (12.78)	0.95 (0.20)	8.05 (8.57)	1.36 (0.50)	9.77 (12.46)	0.93 (0.16)
Private Label	20.90 (9.34)	0.67 (0.08)	29.56 (12.06)	0.76 (0.13)	22.01 (8.75)	0.63 (0.06)
Henkel	33.08	1.25	21.32	1.18	31.50	1.30

	(15.31)	(0.21)	(11.19)	(0.15)	(13.23)	(0.18)
Procter	9.51	1.50	10.28	1.29	13.14	1.43
	(8.79)	(0.27)	(7.46)	(0.20)	(9.64)	(0.22)
Werner	11.57	1.26	24.56	1.66	13.62	1.29
	(8.24)	(0.26)	(10.28)	(0.35)	(8.11)	(0.29)

*Price per 500ML

94. Note that the market share of Henkel at Retailer 1 and Retailer 3 is given by 33% and 31.5% respectively, while the market share of the Private Label product is at 21% and 22% respectively. At Retailer 2 this relationship is reversed. Henkel has a market share slightly exceeding 21% and the Private Label product has a market share just under 30%. Note also that the Private Label product has a higher average price and Henkel a lower average price at Retailer 2. This is an indication that the perceived quality of Private Label products appears to vary between different retailers.
95. Other brands have market shares in the order of magnitude of 10%. But the positioning also varies between the retailers. While Werner prices are on average at about the level of Henkel at Retailer 1 and 3, it has a much higher price at Retailer 2. At the same time, Werner also commands about twice the market share in comparison to Retailer 1 and 3. In contrast, Procter has the highest price at Retailer 1 and Retailer 3, but prices like Henkel at a significantly lower level at Retailer 2. Similarly, the pricing strategies of Colgate and Fit appear to differ between Retailers 1 and 3 on one hand and Retailer 2 on the other. At Retailer 1 and 3 Fit has the second lowest price, below €1, but prices above Procter at Retailer 2. Colgate, in contrast, prices above €1 at Retailers 1 and 2, but drops its average price to close to that of the Private Label product at Retailer 3. We therefore expect to see patterns of diversion ratios that are much more similar for Retailer 1 and 3 than for Retailer 2.
96. While the price positioning of some brands differs by retailer, we see stable patterns for the distribution of price levels. One brand prices at least at €1.40, a second tier of brands prices between €1.20 and €1.30, and a third tier of prices is much closer to the Private

Label price at around 1€. We, therefore, expect similar patterns of diversion depending on the price band at which brands are positioned independently of retailer.

97. Table 10 provides an overview of the relative diversion ratios and compares them to the relative market shares for price increases for each of the brands for which a meaningful regression result could be derived.
98. Table 10 reveals that there is a basic structure of competition in the market that relates to the different price levels we identified above. Henkel prices in the upper middle price tier and has diversions from price increases both to higher priced products and lower priced products. The diversion ratio to Colgate is consistently large with 33% to 35% although Colgate has much smaller market share. But even where the Colgate market share is only slightly above 6%, as for Retailer 2, Colgate is the closest competitor to Henkel measured in terms of diversion generated from a price increase.
99. The reason for this result is that the cross-price elasticity between those products is persistently large across different retailers. The two products are therefore perceived as very close substitutes. However, it is also notable that the price of Colgate is higher, the higher its market share, indicating that Colgate compensates with a lower price at a retailer like Retailer 2, where Colgate demand is low. The impact on substitution to Colgate from Henkel is fairly consistent across the three retailers as a result.
100. The second regularity is that the (generally) highest priced product in the market is Procter. It loses the greatest share of demand to Henkel when raising prices. This again reflects the typical vertical differentiation strategy (possibly supported through advertising)¹², where the highest priced firm will lose customers with high willingness to pay for perceived higher quality to the next pricing tier, when it raises the price.

¹² See John Sutton, "Sunk Costs and Market Structure: Price Competition, Advertising, and the Evolution of Concentration" MIT Press, 1991.

Table 10
Dishwashing Liquid: Relative Diversion Ratios vs. Relative Market Shares

Retailer 1					
	Colgate	Fit	Henkel	Procter	
Colgate		26.0	35.0	27.7	
		15.3	20.2	15.0	
Fit	10.8		14.1	14.2	
	13.2		17.1	12.6	
Private Label	19.4	21.9	21.1	6.2	
	24.2	23.6	31.23	23.1	
Henkel	41.8	20.7		42.6	
	38.3	37.3		36.6	
Procter	15.4	16.0	18.4		
	11.1	10.7	14.2		
Werner	12.6	15.4	11.3	9.2	
	13.4	13.1	17.3	12.8	
Retailer 2					
	Colgate	Fit	Henkel	Procter	
Colgate		0	34.8	5.4	
		6.8	7.9	6.9	
Fit	10.4		6.5	8.7	
	8.6		10.2	9.0	
Private Label	9.0	45.6	15.5	9.8	
	31.5	32.1	37.6	32.9	
Henkel	59.3	6.1		66.2	
	22.7	23.2		23.8	
Procter	7.4	48.3	33.2		
	11.0	11.2	13.1		
Werner	13.9	0	10.0	9.9	
	26.2	26.7	30.5	27.4	
Retailer 3					
	Colgate	Fit	Henkel	Procter	
Colgate		n/a	33.5	25.3	
			14.5	11.5	
Fit	0.8		6.4	5.9	
	10.9		14.2	11.2	

Private Label	44.7	n/a	35.8	24.9
	24.4		32.2	25.3
Henkel	43.0	n/a		39.7
	35.0			36.3
Procter	11.5	n/a	15.9	
	14.6		19.2	
Werner	0	n/a	5.1	4.1
	15.1		19.9	15.7

Relative Diversion of units to the row product due to a price change by the column product and relative market share when the product that changes the price is not considered.

101. The pricing constraint from the private label product varies considerably between the different retailers. At Retailer 1, the relative diversion ratio is somewhat below the relative market share, but with a substantial impact at about 20% for all brands except for Procter.
102. However, at Retailer 2, where the private label product has almost 30% market share, the impact of diversion to the private label product is much lower (except with respect to Fit, which primarily loses customers from price increases to the private label product and Procter). In fact, it appears that the private label product has a relatively high price and a higher market share relative to branded products than at other retailers.
103. The low diversions to the private label product at Retailer 2 appears to be explained by Colgate, which is priced only slightly above the private label product at this retailer. It thus absorbs a much greater share of substitution away from the other branded products. This makes sense because it is estimated to be a closer substitute to Henkel than the private label product, which must partially arise from low horizontal product differentiation. When Colgate prices at a price close to the private label product it will absorb a much greater proportion of the diversions from Henkel relative to the private label product when Colgate prices at a higher price point.
104. Where Colgate is priced above €1, and the private label product at a significantly

lower price, market shares of the private label product may be smaller overall, but the diversions from price increases at branded products are across the board higher. For example, at retailer 3, where the private label price is particularly low, its relative diversion ratio from Colgate, Henkel, and Procter is far greater than its actual market share. These differences may arise not only from differences in the private label perceived quality but also from the product placement strategy of the retailer facing a fairly fragmented market of branded competitors.

105. These observations are a warning that market shares do not always fully capture the competitive interaction in the market. But this does not suggest that private label products should not be considered as part of the same market from the start of the analysis. The deviation between market share and actual impact on competition is far larger for the branded products than for the private brands. As a rule of thumb, high-priced brands impose less of a competitive constraint on the market than private label brands, which tend to constrain the prices of branded products at all price levels.

5.3. Frozen Pizza: The Role of Private Labels when two Brands Compete Head-to-Head

106. The frozen pizza market is among the two very concentrated markets presented in this study. There are only two significant brands in the market: Dr. Oetker and Wagner. As can be seen in Table 11, the prices of Dr. Oetker and Wagner frozen pizza are almost identical with Wagner pricing a fraction below Dr. Oetker on average. The private label product is sold on average at a discount of at least 46% from the average Dr. Oetker price. Dr Oetker has between 41% to 46% market share and Wagner achieves between 26% to 35%. The remainder goes to the private label product of the retailer, which means that the market share of the private label product is greater than that of Wagner by a little under 5 percentage points at Retailer 1 and 3 and smaller by 13.5 percentage points at Retailer 2.

107. The large discount on the prices of the branded products therefore does not result in a very large market share for the private label product in contrast to the case of UHT-milk. This observation may suggest that the private label products are less close a substitute for frozen pizza of branded products than is the case for UHT-milk. Nevertheless, the private label product does command a higher market share than Wagner at Retailers 1 and 3.

Table 11
Frozen Pizza: Average Shares and Average Prices

	Retailer 1		Retailer 2		Retailer 3	
	Share	Price	Share	Price	Share	Price
Dr. Oetker	41.33 (19.27)	0.69 (0.07)	45.44 (19.88)	0.70 (0.07)	42.17 (18.36)	0.71 (0.07)
Private Label	32.62 (22.51)	0.36 (0.08)	20.99 (15.94)	0.38 (0.08)	31.31 (18.73)	0.38 (0.05)
Wagner	27.29 (17.65)	0.68 (0.10)	34.49 (18.99)	0.70 (0.10)	26.63 (14.74)	0.68 (0.09)

*Share in % of quantity sold, **Price in € per 100g

108. However, in contrast to the markets studied earlier, differentiation between Dr. Oetker and Wagner does not appear to be vertical. The perceived quality of the products appears to be similar. This results in almost equal pricing. This implies that one would expect Dr. Oetker and Wagner to be closer competitors than the private label product at a much lower price but with similar market share to Wagner.

109. This intuition is reflected in the relative diversion ratios in Table 12. The relative diversion ratios between Dr. Oetker and Wagner are fairly symmetric (except, possibly, for Retailer 3) and much higher than the relative diversion ratios of Dr. Oetker and Wagner to the private label product. However, on average the relative diversion ratios to the private label product range from about 30% at retailer 1 to above 40% at retailer 2.

Table 12
Frozen Pizza: Relative Diversion Ratios vs. Relative Market Shares

Retailer 1		
	Dr. Oetker	Wagner
Dr. Oetker		68.7 55.9
Private Label	28.9 54.4	31.3 44.1
Wagner	71.1 45.6	
Retailer 2		
	Dr. Oetker	Wagner
Dr. Oetker		58.9 68.4
Private Label	41.2 37.8	41.1 31.6
Wagner	58.8 62.2	
Retailer 3		
	Dr. Oetker	Wagner
Dr. Oetker		68.3 57.4
Private Label	38.6 54.0	31.7 42.6
Wagner	61.4 46.0	

Relative Diversion of units to the row product due to a price change by the column product and relative market share when the product that changes the price is not considered.

110. While substantially smaller than the diversions among the higher priced firms, these diversion ratios are so substantial that they must lead to a considerable constraint on the ability of Dr. Oetker and Wagner to raise prices. In fact, at retailer 2 this competitive constraint is even stronger than the relative market shares would suggest. Again, there is no question that the private label product is in the same market and starting the assessment based on market shares is appropriate. As in any differentiated products market such an assessment is not sufficient to determine, which goods are the closest substitutes.

111. Note also that this example gives further insight into how to assess the relative closeness of competition between brands and private label products. Where a low price of the private label product is related to significantly higher market shares than the branded products as with UHT-milk and cat food, it is likely that the private label product is a very close substitute of the branded product. Where despite the low price of the private label the branded products have similar or higher market share (as in the case of frozen pizza), it is more likely that the branded products are the closer competitors. However, this does not mean that the constraint from private label products is not significant.

5.4. Diapers: Private Label Products Impose Pricing Constraints not just on Functionally Equivalent Products

112. The market for diapers in German supermarkets is heavily concentrated. Procter with its brand Pampers dominates the market, while there are many brands, most of these brands have negligible market share at the three retailers covered in this study. At these retailers, the main competition to Procter comes from the private label products.

113. However, for our study it is of interest to consider whether the competitive effect of private label standard baby diapers only constrain pricing of Procter baby diapers or whether a related Procter product, namely training pants, also constrained by the private label product.

114. Training pants are used for potty training and are essentially diapers in pant format that a toddler can pull down when going to the potty. They are physically quite different products from a standard baby diaper and private label versions are not available.

115. However, there is potentially substitution between regular baby diapers and training pants. One can do potty training without training pants. But training pants

make potty training easier for the parents. If training pants get more expensive a parent may thus just forego the convenience training pants give to the parent. Since training pants are used for a much shorter time period than regular diapers, even price sensitive buyers who purchase the regular baby diapers, might buy them for a short period time. In that case we might see a competitive constraint from regular private label diapers on Procter training pants.

116. As Table 13 shows training pants have, as expected, a small share of the overall market between 5% and 14% depending on the retailer. At Retailer 2, where training pants have small market share, the market share of the private label brand is particularly high. In Retailer 1 and 3 Procter's regular diaper has almost three times the market share as the private label product.

Table 13
Diapers: Average Shares and Average Prices

Products	Retailer 1		Retailer 2		Retailer 3	
	Share (%)	Price(€)*	Share (%)	Price(€)*	Share (%)	Price(€)*
Private Label	22.35 (18.60)	0.15 (0.01)	54.66 (19.26)	0.16 (0.01)	22.53 (15.19)	0.16 (0.01)
Procter Normal	66.47 (19.66)	0.24 (0.03)	40.39 (16.17)	0.24 (0.02)	63.32 (16.88)	0.25 (0.04)
Procter Sport	11.18 (9.24)	0.32 (0.05)	4.95 (5.84)	0.31 (0.03)	14.14 (10.16)	0.32 (0.05)

*Price per unit

117. Since the private label product is the only product that can constrain pricing of Procter products, it is of particular interest in this case to see how strongly the private label product constrains both Procter Normal (regular diaper) and Procter Sport (training diaper) relative to the option of buying less, i.e. the diversion to the no purchase option. We therefore first consider the absolute diversion ratios in this case.

118. Unfortunately, demand for Procter Normal can only be estimated for Retailer 2 because for the other retailers there is too little variation in price to make that feasible.

For that reason, we only show the diversion ratios for Retailer 2 in Table 14.

119. As Table 14 shows, about half of the sales Procter Normal loses from a price increase are diverted to the private label product, but only 5% to the training pants. The diversion to the private label product is therefore large. The small diversion to training pants is, in contrast, obvious. Training pants can only be used in a fairly short time window. On the other hand, the diversion ratios for a price increase for Procter Sport shows that there is hardly any diversion to non-consumption when the price of this product goes up. Parents and toddlers still need diapers. However, this substitution splits evenly between Procter Regular and the Private Label (there is statistically no difference between the two diversion ratios).
120. This result arises because the private label product has bigger market share than Procter Regular at a significantly lower price. For Retailer 2 the constraint on Procter Sport due to the private label is therefore as large as that on Procter Regular, implying a very significant constraint.

Table 14
Diversion Ratios Diapers
Retailer 2

	Procter normal	Procter sport
Handels	48.0	47.4
Procter normal		48.2
Procter sport	5.0	

Diversion of quantities to the row product due to a price change on the column product

121. However, the constraint on training pants from the private label product differs considerably between the retailers. For Retailer 1 only a quarter of sales divert to the private label after a price increase for Procter sport. For Retailer 3 this rises to a third.

For retailer 2 it is a half.

Table 15

Proctor Sport: Relative Diversion Ratios vs. Relative Market Shares

Product	Retailer 1	Retailer 2	Retailer 3
Private Label	75.8 25.2	49.6 57.5	35.5 26.2
Procter normal	24.2 74.8	50.4 42.5	64.5 73.8

Relative Diversion of units to the row product due to a price change by the column product and relative market share when the product that changes the price is not considered.

122. The important insight gained from this example is that the market share together with the price differential does not only imply the degree to which the private label product imposes a constraint in the same product type, namely a normal diaper, but also on a product for which normal diapers are a substitute if it becomes too expensive. It would therefore also be incorrect to consider the private label normal diaper as being in a different market from the Procter training diaper – at least for sizes that correspond to the toddler age group. In fact, analysis of this type suggests that market definition might have to be done on the basis of age/size group for diapers, where training pants are only a relevant substitute for the older age/larger size diapers.

6. Conclusion

123. In this report we have demonstrated that private label products in supermarket retailing are generally in the same market as branded products and must be considered to assess competition in the market overall. Where private label products do not just have large price discounts but also large market shares as in markets with fairly homogeneous goods, the competitive constraints on prices arising from private label products are so strong that the private label tends to be the closest competitor of all branded products.

124. With smaller market shares, private label products tend to be a less severe constraint on branded product pricing, but the constraints remain significant even when branded products are the closest competitors in the market. The analysis of our examples from a broad range of fragmented and concentrated markets suggest that any analysis must start from the presumption that private label products are a competitor in the market and counting private label production fully for market analysis when performing an initial market screen based on market shares.
125. These results have important implications for competition policy assessment in mergers and antitrust cases. In antitrust cases, critical market share benchmarks should be applied to all products in a product group including the private label product. For example, the private label sales should be included when applying the market share thresholds for the Vertical Block Exemption Regulation.
126. In the review of mergers between brands, private label sales should also be included in the measurement of market shares for the purposes of a first assessment.
127. However, our analysis also points out, that there is no market definition short cut to the assessment of the competitive effects of mergers in markets with product differentiation. Products can seem superficially quite different - like diapers and training pants – but the private label generalist product may nevertheless be a close substitute to a more specialized product like training pants. Only careful analysis reveals that, for example, market definition for diapers should be done along different age groups, where, for toddlers, regular diapers and training pants may be in the same market.
128. Such results stress that market definition based on listing similar characteristics of products, as is still a common practice at many competition authorities, is simply not an appropriate approach to market definition. Some of the substitution patterns we have unveiled in this study can *only* be verified by careful empirical analysis.

7. Appendix

A.1 The Data

Our sample contains five products group: milk, cat food, dishwashing liquid, frozen pizza, and diapers. Each product in a product group is identified by a unique product code (EAN). For each product we observe average weekly prices and quantities at the product/store level. We simplify the data set in two ways. First, we drop products that generally have very small market share because there are too few observations to identify quantity responses to price changes from the data. Second, we aggregate products to the brand level. Thus, we abstract from various product characteristics like different “flavours” and package sizes, but we retain separate products, where manufacturers sell several brands as in cat food. In particular, we aggregate the data in the following way for each product group.

1. **Milk:** We consider only UHT milk. This segment of the milk market represents roughly half of the sales in the overall sample and is sufficiently differentiated from fresh milk to be treated as a separate product group. While fresh milk is supplied by many local brands, making it impossible to estimate across regions, UHT-milk is produced by national manufacturers under national brand names.
2. **Cat Food:** For cat food, our dataset includes the following characteristics:

Table A1. Cat food. Sales (%) by product segment and characteristic.

package / type	General	Supplement	Cat Grass	Cat's milk	Snack	Grand Total
Bag-(Dry)	71%	0%	0%	0%	3%	74%
Bowl-(Wet)	11%	0%	0%	0%	0%	11%
Others	7%	1%	0%	3%	3%	15%
Total	89%	2%	0%	3%	6%	100%

We use data for both dry and wet cat food and aggregate to the brand level, which covers 85% of the sales in the sample.

3. **Dishwashing:** All products are kept in the sample. Product characteristics contained in our data set are “type” of dishwashing liquid (Normal, Skin-care, perfumed) and “fragrance” (lemon, normal, etc.). We aggregate across these products since they are largely priced the same with the exception of promotions, where sometimes only one type or fragrance of a brand is discounted while others are not.

4. **Frozen Pizza:** Types of pizza include “Flammkuchen”, “Minipizza”, “Pizzataschen” and “Pizza”. We analyze only “Pizza”, which accounts for 87.5% of total sales. We aggregate overall varieties sold.
5. **Diapers:** There are two main types of diapers, normal diapers and sport/training diapers. These represent 85% and 13% of sales, respectively. We keep both of them as separate products that are potential substitutes. The rest of the sample consists of adult and swimming products, which we discard.

A.2 The Brands in the Data Set

One feature of the AIDS model is that estimation requires product line to be the same for all geographic markets considered. In our sample, the “geographic market” is the store. This requirement restricts us from including smaller brands in our analysis, since smaller brands are not present in all stores of a given retailer. We therefore select the main brands in each product category and discarded brands that have on average less than 3% market share across the three retailers. With such small market shares, sales are too infrequent to generate meaningful estimates for the demand parameters.

Except for cat food, where the two main manufacturers, Mars and Nestle Purina, sell several brands (e.g. Nestle Purina produces Gourmet and Felix, among others), each manufacturer has a single brand in each product category. In cat food we aggregate to the brand level to simplify the exposition. The results are not fundamentally different when one disaggregates to the product level, but they get more unwieldy to present. For each of the product categories except for H-Milk, the selected main manufacturers are the same across all retailers (see table A2). For H-Milk we call two brands produced by two different manufacturers (Schwarzwaldmilch und Hochwald) jointly “Waldmilch”. Waldmilch therefore refers to different manufacturers when estimating for different retailers. This is done to preserve anonymity of the retailers.

A.3. Aggregation of Products to the Brand Level

The products retained in the data set still vary by characteristics like flavour and package size. We have normalized prices across different sized package to a standardized unit, presented in Table A7 below. We then calculate the weighted average price across all variants (e.g. flavours) of the product.

Table A7. Selected brands in each product category

Product category	Brand	Normalised Price-Quantity
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H-Milk	Handelsmarke Waldmilch Milchwerke Berchtesgaden MK Weihenstephan	100ml
Cat Food	Felix (Nestle) Gourmet (Nestle) One (Nestle) Handelsmarke Sheba (Mars) Whiskas (Mars) Kitekat (Mars)	100g
Frozen Pizza	Dr. Oetker Handelsmarke Wagner	100g
Dishwashing liquid	Colgate Palmolive Fit Handelsmarke Henkel Procter & Gamble Werner & Mertz	500ml
Diapers	Handelsmarke - Normal Diapers Procter & Gamble - Normal Diapers Procter& Gamble - Sport Diapers	Unit (diaper)

A.4 Demand estimation

We estimate an Almost Ideal Demand System (AIDS) as first suggested by Deaton and Muellbauer (1980). This econometric model of demand allows us to compute own- and cross-price elasticities from the estimated parameters. The model is convenient for such estimation because it is consistent with economic theory and can be estimated without data on product characteristics. It is relatively easy to estimate and interpret.

Instead of directly estimating demand, i.e. the relationship between quantity sold and prices set in the market, the AIDS model estimates the relationship between expenditure on a product i as a function of the prices of all products in the product category and the expenditure share of that product group at a given store:

$$w_{imt} = \alpha_i + \sum_j \gamma_{ij} \log(p_{jmt}) + \beta_i \log\left\{\frac{Y_{mt}}{P_{mt}}\right\}, \quad (1)$$

where w_{imt} is the share of sales of brand i in store m in week t . Or:

$$w_{imt} = \sum_{im} \frac{p_{imt} * q_{imt}}{Y_{mt}} \quad (2)$$

p and q are price and quantity, as defined in the previous section. Y_{mt} is the total expenditure on the product category, and P is a price index. For simplicity, we use a linear Stone Price Index, resulting in the so-called LA/AIDS model. It has been showed that this linear approximation compares well with the translog version (Altson, Foster, and Green 1994). However, one issue with the Stone Price index is that it results in the expenditure share appearing in both right- and left-hand side of the equation, generating simultaneity. To correct for it we use lag of the share, as suggested by Eales and Unnevehr (1988):

$$\log P_{mt} = \sum_i w_{imt-1} \ln p_{imt} \quad (3)$$

Therefore, the share of each product i is a function of prices and real expenditure. By construction, shares add up to one in each store-week, yielding the following additivity properties:

$$\sum_{i=1}^n w_i = 1, \sum_{i=1}^n \alpha_i = 1, \sum_{i=1}^n \beta_i = 0, \sum_{i=1}^n \gamma_i = 0$$

Homogeneity $\sum_j \gamma_{ij} = 0$ and symmetry $\gamma_{ij} = \gamma_{ji}$ can be imposed if desired. For household level data, these conditions need to hold in order to be consistent with consumer theory, but for aggregate data, as in our case, these do not need to be imposed. We estimate an unrestricted model, therefore not imposing any restrictions on competition among brands. We also include store (φ_m) and week (δ_t) fixed effects to control for any common shocks. Hence the share equations to be estimated are:

$$w_{imt} = \alpha_i + \sum_j \gamma_{ij} \log(p_{jmt}) + \beta_i \log\left\{\frac{Y_{mt}}{P_{mt}}\right\} + \varphi_m + \delta_t + \varepsilon_{imt}$$

Once the system has been estimated we can recover uncompensated (Marshallian) cross and own price elasticities from the model parameters (see Green and Alston, 1990, 1991):

$$e_{ij}^u = -\delta_{ij} + \frac{\gamma_{ij} - \beta_i \bar{w}_j}{\bar{w}_i}$$

Where δ_{ij} is the Kronecker delta (1 if $i = j$, 0 otherwise), and \bar{w}_i is the average share.

And unit diversion ratios can be computed as, where \bar{q}_j, \bar{q}_i are average quantities.

$$DR_{ji} = \frac{e_{ji}^u \bar{q}_j}{e_{ii}^u \bar{q}_i}$$

The estimation has been carried out using Stata. Week fixed effects are included as week dummies. Store fixed effects have been added by transforming the original data, for computational reasons. Last, right before estimation, we have discarded stores that are contained in our sample for less than 20 weeks. Recall that by the nature of the model, we can only use observations in which all the selected manufacturers have sales. E.g. if a store never sells sport/training diapers, it will not be considered in our estimation. The minimum of 20 weeks criteria ensures that we are not using stores in which some of our selected brands are only sold rarely. Nevertheless, changing this threshold upwards or taking it away all together does not substantially change our results.