Private Label Entry as a Competitive Force?[*]

An analysis of price responses in the Norwegian food sector

Tommy Staahl Gabrielsen
Department of Economics, University of Bergen
Fosswinckelsgt. 6, N-5007 Bergen, Norway
email: tommy.gabrielsen@econ.uib.no

Frode Steen
Department of Economics, Norw. School of Economics and Bus. Administration
Helleveien 30, N-5045 Bergen, Norway
email: frode.steen@nhh.no

Lars Sørgard
Department of Economics, Norw. School of Economics and Bus. Administration
Helleveien 30, N-5045 Bergen, Norway
email: lars.sorgard@nhh.no

June 2001
(a preliminary version, do not circulate without permission)

Abstract:
According to existing theory, the introduction of a private label has an ambiguous effect on the prices of competing national brands. We undertake an empirical analysis of the effects of private label entry on national brand prices in the Norwegian food sector. We first estimate a set of 83 dynamic price regressions. The results suggest that introduction of a private label typically leads to higher prices on national brands. However, we observe a large heterogeneity in price responses. When we apply a dynamic panel data approach, the same picture emerges. We find heterogeneity with both negative and positive significant price responses. However, we also establish that highly distributed and ranked products are typically more influenced by private label entry than less distributed and ranked products ("weaker" national brands). We also find some support in our data that more successful PL entry – as measured by the PL market share – have typically a larger impact on the national brand prices.

* The authors are particularly grateful to Turid Marie Espeseth for her research assistance and to ACNielsen, Norway, for providing the dataset. We would also like to thank Øyvind Anti Nilsen and seminar participants at ACNielsen, NHH and the University of Bergen for valuable comments and suggestions. This research is partly financed by the Norwegian Research Council through SNF (The Foundation for Research in Economics and Business Administration).

1. Introduction

Retailer-owned brands, often denoted by private labels (or simply store-brands), have had an enormous growth in the last decades in many countries and many product categories (Dobson, 1998; Connor *et al*, 1996). Most of the academic literature on private labels, a rather new literature, is primarily empirical studies trying to explain the variation in private labels penetration across product categories (e.g. Sethuraman, 1992; Hoch and Banerji, 1993; Dhar and Hoch, 1997). Others are concerned about whether introduction might shift the relative channel power from the national brand manufacturer to the retailer (Chintagunta *et al*, 2000; Kadiyali *et al*, 2000; Messinger and Narasimhan, 1995). Although the predominant public opinion seems to be that the growth of private labels have had a pro-competitive effect (see Harris *et al*, 2000), there are rather few theoretical as well as empirical studies actually investigating the competitive effect from private label introduction. The purpose of this article is to test empirically what effect private label introduction has on the prices of competing national brands in the Norwegian grocery sector.

According to existing theory, private labels have an ambiguous effect on prices on national brands. On the one hand, it is argued that the introduction of a private label may lead to lower retail prices of the competing national brands. The argument is simply that the introduction of a private label would lead to intense price rivalry between the national brand and the private label (see Mills, 1995). On the other hand, if consumers' demand elasticity is heterogeneous, private label introduction may result in higher retail prices on the national brands. One reason is that the introduction of a private label leads to intense rivalry for the price sensitive consumers. The national brand producer may then give up fighting for the price sensitive consumers and instead concentrate on consumers with low demand elasticity, and then at a higher price than before entry of a private label (see Perloff *et al*, 1996). Another reason to expect a price increase on national labels following private label introduction is that the national brand producer may initially have met the challenge of private labels by offering the retailer an exclusivity contract. In this contract the retailer is offered a low wholesale price contingent on that no private label is introduced in the relevant product category. However, if the retailer at some point in time refuses such a contract, and introduces a private label, the response from the national brand may be to increase his price (see Gabrielsen and Sørgard, 2000).

As discussed above the theoretical predictions of the price effects of private label introduction are mixed, and so are also the results from the empirical literature. Putsis (1997) analyse the price response from national brands on private label introduction, and finds that private label introduction on average lowers the prices of national brands. Cotterill *et al* (2000) investigate the effect from private label market coverage (distribution) on the price of the national brand. These authors find that in some product categories an increase in private label market coverage will increase the prices of national brands, while the opposite is true in other product categories. Finally, Harris *et al* (2000) find that increases in the market share of private labels leads to a rise in the price of national brands in some product categories, whereas the opposite is true in other product categories.

We argue that according to theory it is important to focus on the price effect of the private label *introduction*. The reason is that private label introduction at a particular point of time may identify a termination of an exclusive dealing relationship with the national brand producer, and may as such be a genuine reason for a price increase on the national brand. We have therefore, in contrast to Cotterlill *et al* (2000) and Harris *et al* (2000), chosen to focus on the price response from national brands to the introduction of a private label. Putsis (1997) also looks at price responses to private label introduction, but that study reports the average price effect of a private label introduction. According to theory, the price of national brands may increase in some product categories and fall in other product categories. It is therefore natural to focus on individual product categories. In addition it is of interest to trace any systematic regularities between product categories. In accordance with this, we report the price effect on national brands of individual private label introduction and whether there are some characteristics across product categories that explains why the prices of some national brands go up and others go down.

The dataset is provided by ACNielsen Norway. It consists of 83 private label entries over a period of 4 years. We estimate a set of 83 dynamic price regressions. We find that an introduction of a private label typically leads to higher prices on national brands. However, a large heterogeneity in price responses is observed. A closer examination indicates that the degree of product differentiation and the number of loyal customers might matter for the results. Therefore, we extend the model and apply a dynamic panel data approach using the full dataset. The same picture as before emerges. We find heterogeneity with both negative and positive significant price responses. However, we also establish that highly distributed and ranked products are typically more influenced by private label entry than less distributed and ranked products ("weaker" national brands). We also find some support in our data that more successful PL entry – as measured by the PL market share – have a larger impact on the national brand prices.

One important lesson from our study is that it is too simple to argue that more private label products leads to more intense price rivalry. The main result is that product "strength" matters. That is, the prices of the largest national brand products in terms of ranking or distribution are more influenced by private label entry than number 2 and 3 products, or less distributed products.

2. Theory

Recent theoretical work on private labels include Mills (1995), Narasimhan and Wilcox (1998), Raju *et al* (1995), Perloff *et al* (1996) and Gabrielsen and Sørgard (2000). All these authors focus on the effects on wholesale and retail prices on national brands from private label introduction. In Mills (1995) private label introduction is always beneficial for the retailer as national brand producers are forced to price concessions. Private label introduction is also beneficial to society because their introduction alleviates problems due to double marginalization and therefore excessively high consumer prices. Much in the same vein is Narasimhan and Wilcox (1998). In their model some consumers incur switching costs when starting to buy the private label. Again private label introduction triggers a battle over market shares which leads to price concessions from the national brand producer. Due to a rectangular demand assumption, consumer prices are unaffected by private label introduction, but introduction is always beneficial for the retailer due to lower wholesale prices from the national brand producer.

In Raju *et al* (1995) the main focus is on how the introduction of a private label affects a retailer's profits and which factors determine the private label's market share. Comparative statics concerning how the introduction of a private label affects prices on national brands is not reported. Perloff *et al* (1996) apply a Hotelling model and find that the introduction of a private label may even increase the price of the national brand. After entry of a private label each producer of a national brand may find it attractive to sell only to the consumers located close to its product in the characteristic space. This may lead to an increase in the price of the national brand, since it before entry sets a low price to attract consumers located far away from its location.

Finally, Gabrielsen and Sørgard (2000) add to the strategy set of national brand producers by allowing them to react to a threat of private label introduction not only by lowering wholesale prices, but to do so in exchange for national brand exclusivity. This option implies that the mere threat of private label introduction may affect the equilibrium outcome. The model distinguishes between loyal and switching consumers. Loyal consumers never consider buying a private label, switching consumers may switch if the price differential is sufficiently large. When private label entry is feasible, one of three situations may emerge. First, national brand exclusivity (no introduction of a private label) may still arise as an equilibrium outcome. If so, the price of the national brand will go down compared to a situation without private labels (the monopoly outcome). The reason is that the producer of the national brand may lower its exclusive dealing wholesale price so as to make it unattractive for the retailer to introduce a private label. Second, if the private label is introduced the producer of the national brand may increase its wholesale price compared to monopoly and thereby induce an increase in the retail price of the national brand as well. The reason is that the competition for the switching consumers is harsh after private label introduction, and the national brand producer chooses to concentrate on his loyal consumers and increases his price. Third, the private label may be introduced leaving the price of the national brand unaffected. This happens when the national producer serves only the loyal consumers before entry, and thus sets a high wholesale price both before and after the introduction of a private label.

In addition to these theories there are also more general theories that can explain why national brand producer may respond to private label introduction by increasing their prices. One strategy that national brand producers may use when faced with private label entry is to increase the quality of the goods they produce, or alternatively intensify advertising. These strategies will increase costs and may also increase brand loyalty, which both will tend to increase prices. Second, Salop (1977) have shown that a firm can be better able to exploit ignorant consumers by increasing consumer uncertainty. A national brand producer can create noise by selling the same product under different labels (brand proliferation). It is well known that many national brand producers also supply a virtually identical product to grocery stores under a private label. Provided that the cost of brand proliferation is small it may be profitable to sell the branded product at a high price and the private label at a low price compared to selling only the branded product at an intermediate price.

3. Empirical predictions

It should be clear from the previous sections that the predictions on how prices on national brands respond to private label introduction are ambiguous. If private label introduction alleviates problems due to double marginalisation on branded products, we should expect lower prices on national brands. However, two other effects may overturn this effect. First, if the national and private labels are differentiated one might observe a price increase or no price change at all. Second, if a brand has loyal consumers in the sense that these consumers will never consider purchasing the private label, the number of loyal consumers may be important. The more loyal customers, the more likely one is to observe price increases on national brand. For more homogenous products with few loyal consumers a price increase is less likely, and with few loyal consumers prices on national brands might depreciate after entry of a private label (henceforth PL entry). Finally, we do expect that the price change of the national brand is more significant in product categories where the private label has a high market share than in product categories where it has a limited market share. The intuition is simply that a large market share by the private label triggers a large price response by the national brand.

The discussion can be summarised in three central predictions:

Prediction 1: We expect price increases in some product categories, and price reduction in others after PL entry. Heterogeneity should be present.

Prediction 2: "Strong" national brands should on average increase their prices more often than "weak" products after PL entry.

Prediction 3: If PL entry is successful in terms of market shares, we expect a larger impact on the national brand price than when PL entry is less successful.

Note, though, that we should be careful with the last prediction. This prediction does not follow directly from the models discussed above. In particular, also alternative interpretations apply. For instance, a private label with a large market share has a large impact on a national brand price, suggesting a causality from private label market share to the price of national brands. However, we could have the opposite causality. A large price increase on the national brand can result in a large market share for the private label. Moreover, we could have a substantial price reduction on a national brand to prevent a private label from capturing a large market share. If so, we could observe that a significant price reduction on the private label in a product category where the private label did not succeed. That would not be in line with prediction 3.

4. The market in question

We analyse the Norwegian food market. During the last ten years we have seen a structural change at the retail level, where four large chains; "*Hakon gruppen* (HG)", "*Reitan gruppen* (RG)", "*Forbukersamvirket* (FS)" and "*Norges gruppen* (NG)" have increased from representing less than 50% of the market to nearly 100%.[1] Table 1 shows the development in market shares in the Norwegian food sector.

[1] FS was renamed in October 2000, and its name is now CooP.

However, most of the takeovers and mergers took place before 1995. The last five years the chains have had relatively stable market shares. We use a data set from ACNielsen Norway. The dataset is a weekly panel with 197 weeks of information on prices, markets shares, distribution on both private labels and national brands for the period January 1997 to October 2000. The dataset is described in more detail in Appendix A.

Table 1 : The development in market shares of the Norwegian food chains.

År	***HG***	***RG***	***FS***	***NG***	***Others***
1990	10,2	5,7	22,8	7,1	54,2
1992	16,8	11,0	23,0	16,5	32,7
1994	24,0	11,3	24,4	37,1	3,2
1995	27,7	11,8	24,9	32,7	2,9
1996	28,6	11,8	25,2	32,1	2,3
1997	28,3	12,5	25,2	32,6	1,4
1998	28,0	13,2	24,9	32,7	1,0
1999	27,7	13,7	25,2	33,2	0,2

Source: *Notes from the Norwegian competition authority* 1/2000

This market may serve as a particular good case, since the private label "invasion" still is relatively "new", but at the same time increases rapidly. The national brands have been exposed to the threat from PL entry for only a relatively short time period, and have during our data period been forced to react to the private label "invasion".

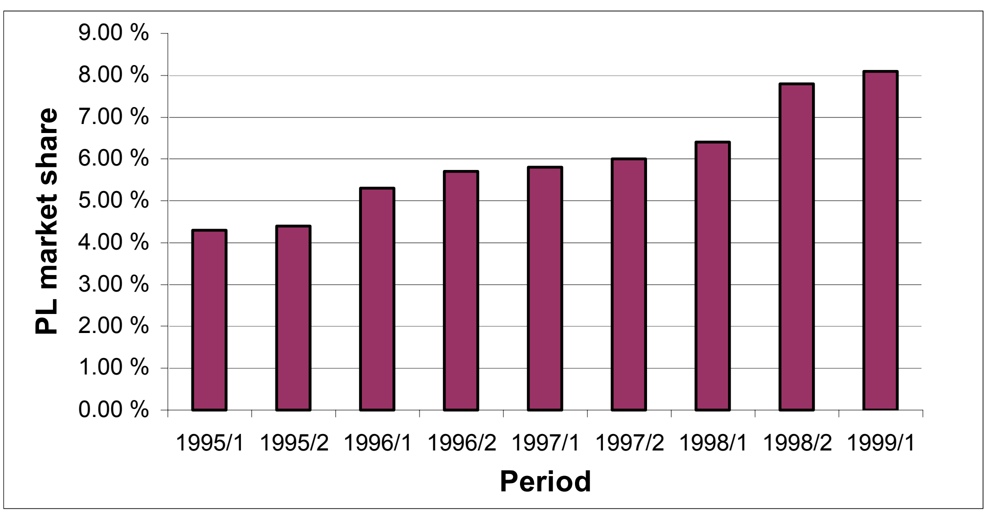

Figure 1 The development in private label shares from January 1995 to January1999, Source: ACNielsen 1999 (excluding RG).

In Figure 1 the development in market shares of private labels are shown; in less than four years the market share is nearly doubled. Newer figures including also the RG-chain suggest a private label market share above 10% by the end of 2000. We expect that this trend will continue.[2] The increase in private label share has been a common strategy for all chains. In Figure 2 we decompose the private label shares for each of the chains, and as we see the same growth pattern is present for all four chains.

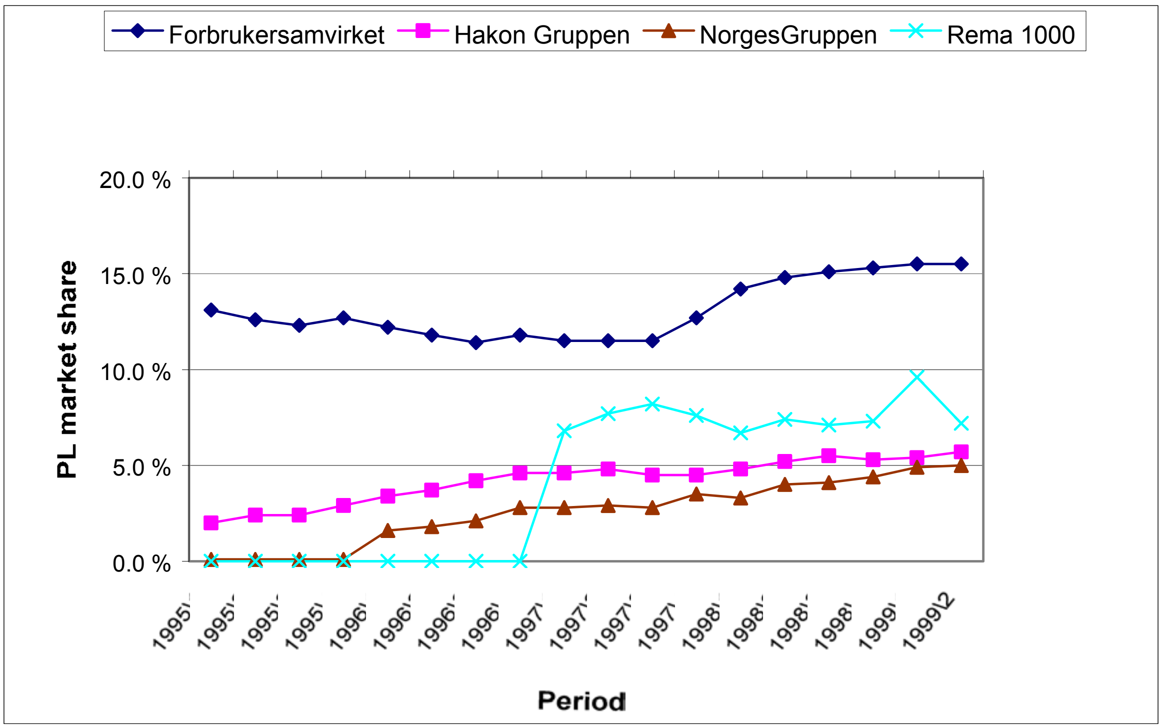

Figure 2 Development in private label market shares for the four Norwegian chains (Source ACNielsen 1999)

To be able to obtain a tractable dataset we have restricted our analysis to 83 private label introductions. These introductions are chosen according to several criteria. First, we have only

[2] The chains have a declared strategy to increase the number of private labels. An FS chain representative said in March 2000:"*All unprofitable products will be removed from our shelves*" (source: Dagens Næringsliv 01.03.2000). One month later the HG-Chain representative Svante Nilsson said: "*We will make more room for our own private labels in our stores. Private labels are more profitable to the chain than national brands, and*

considered private labels introduced in the period January 1998 to January 2000 and that reached a national market share within its product group above 2% by May 2000. This is to obtain a long enough *pre*- and *post* entry period, and to include only "significant" entrants. Second, product groups where a lot of noise is anticipated due to other factors as seasonal products (e.g., "Easter soft drinks"), "price signal products", "structural changes" etc. were excluded. Finally, we excluded groups where it was difficult to identify who the rival or rivals were. The remaining group is both representative for the Norwegian food sector, includes 41 different market segments, and covers the most important private label introductions in our data period.[3]

As discussed in the previous section, theory suggests some heterogeneity with regards to price responses to PL entry. By looking at our data we can get a first impression of this heterogeneity.

In figures 3 and 4 we show the price development for some of the analysed products. In Figure 3 the prices of ready-made frozen French fries are shown. We observe an upward shift in the price of the national brand after PL entry. FRIONOR is a large producer with relatively strong products in a differentiated product segment. This suggests that a possible explanation for the increase can be loyal consumers, increased quality or spatial competition. The market share of the private label was 23.5% in May 2000.

In Figure 4 the prices of a more typical homogenous product are shown – spaghetti. The price effect of the PL entry differs from one national brand to another. One national brand (Sopps) seems to increase its price, the other national brand (Maretti) reduces its price after entry. The two national brands have each approximately 30% of the market in this chain, but in the aggregated Norwegian spaghetti market, Sopps (47%) is nearly twice as big as Maretti

---

are also important in distinguishing our chain from our competitors. Today the private label share is only 5%, we hope to increase it to 10%."(Dagens Næringsliv 27/4-2000).

[3] The data period is restricted to four years since this is the longest period ACNielsen was able to provide data for directly from their database. Furthermore, earlier data is of a lower quality.

(27%). Hence, the market leader increases its price and the closest rival reduces its price. The PL entry was quite successful in this chain, usurping a market share of 30% by may 2000.

Finally, in Figure 5 we have shown the price development for a very homogenous product – flour. Here the entry leads to a large price decrease of the national brand (Mølleren). Still, the entry was extremely successful. The private label dominates this segment by May 2000, with a market share of 73%.

[Figure 3 to 5 approximately here]

The three Figures suggest that we will find both price increases and reductions following PL entry. More interesting though, is to see whether we can detect systematic patterns in the national brand price shifts. This is what we turn to next.

5. Econometric model

To our knowledge, our study is the first to use micro data to test directly the price response of the introduction of private labels. However, within a very parallel literature on generics in the market for pharmaceuticals, several prise response studies have been conducted. Grabowski and Vernon (1992) studied the effect of generic entry on prices for 18 high sales volume pharmaceutical products that were first exposed to generics during the years 1983 to 1987. For each drug the authors examined prices prior to entry and prices one year subsequent to generic entry. Using a relatively simple regression model they estimated the impact of the number of generic suppliers in a market on the ratio of the generic price to the name brand price.[4] Their result suggested that name brand prices rose relative to generic prices subsequent to generic entry.

[4] The model included two covariates along with the number of generics; the total dollar sales in a market in a given year and a time dummy.

Caves *et al* (1991) suggest that simple pre-entry versus post-entry brand name price comparisons or regressions of price on numbers of generic entrants may understate negative entry effects on prices because other omitted factors have caused brand-name prices to rise over time. One such variable is producer price index for pharmaceuticals. They argue that empirical price regression models must be specified so as to minimize bias from these unobservable time-varying factors. Caves *et al* (1991) include fifty different intercepts to represent category-year groups average changes, in addition to several other time related dummy-variables, linear time trends and quadratic time trends. They found evidence that suggested that entry led to reductions in name brand prices.

In this paper, we pursue two econometric test strategies. First, we formulate a basic dynamic price model that will be used to undertake an exploratory analysis of our dataset. This will enable us to uncover heterogeneity in the outcome for the different product types, and get a first grip on possible systematic patterns. Second, Section 5.2 extends our dynamic price model to take advantage of the panel properties in our dataset. Here we are able to test statistically some of the more suggestive results from the exploratory tests in the first subsection. The models will be in line with those of Caves *et al* (1991). However, we include a dynamic element by explicitly modelling the autoregressive element of the price process as an AR(1) model.

5.1 The basic dynamic price model

The most commonly used statistical model to describe price development is the autoregressive first order model (AR(1)). Last period's price is the main predictor for this period's price. We assume that the development in a price series x_t is described by; $x_t = \rho \cdot x_{t-1} + \varepsilon_t$, where $\varepsilon_t \sim iid\,(0,\sigma)$. This model has been widely applied within the literature on market integration and efficient markets, and offers several advantages.[5] First-order serial correlation is captured within the model, and when extended with more variables it allows us to distinguish between short and long run effects. The AR(1) model is therefore a better statistical price model than the ones used in the earlier empirical studies discussed above. It has a sound statistical foundation, and has also been widely used as a common way of describing price processes in the economic literature.[6] In our case we would like to include other factors as well. In particular, prices may rise over time due to a general price increase on food. To account for this, a linear trend (t) and the consumer price index (CPI) are included (see Caves *et al*, 1991). Furthermore, the different product prices will have different means which is accounted for with a constant term (α): [7]

(1) $$P_t^{NB} = \alpha + \rho \cdot P_{t-1}^{NB} + \lambda t_t + \gamma CPI_t + \varepsilon_t .$$

where P_t^{NB} is the national brand price. To measure any possible shift in the national brand price after PL entry we also include a dummy variable ($D\,\mathrm{int}^{PL}$). This variable takes the value "1" if entry of a private label in the same market segment as the national brand.

(2) $$P_t^{NB} = \alpha + \rho \cdot P_{t-1}^{NB} + \lambda t_t + \gamma CPI_t + \beta D\,\mathrm{int}_{\mathrm{t}}^{PL} + \varepsilon_t$$

[5] See e.g., Isard, (1977); Richardson, (1978); Beck, (1994); Ardeni (1989); Goodwin and Schroeder (1991); Doane and Spulber (1994), Sauer, (1994); Schwarz and Szakmary, (1996); Asche, Salvanes and Steen (1997); Asche, Bremnes and Wessels (1999).

[6] Caves *et al* (1991) apply a GLS model that accounts for first order serial correlation. However, our AR(1) specification is a better way of dealing with serial correlation, since instead of "removing" the autoregressive component (as in GLS) we use it to obtain a better price model.

[7] For all the coffee products we also include an international coffee price, expressed in NOK. This is to prevent any noise from fluctuating international coffee prices.

Equation (2) is our basic price model, which we will use throughout the analysis. A β significantly different from zero will indicate that the national brand price is significantly influenced by the PL-entry. A positive β suggests a price increase, and a negative β indicates a price reduction. The price variable P_t^{NB}, and the CPI index are measured in logarithm.

We estimate (2) for the 83 product matches we have in our dataset, providing us with 83 OLS regressions. This will give us a first idea about the effect of PL entries; have the PL entries any significant price effects on the national brands, and if so, which products experience a price increase and for which products has the price gone down? For most of the 83 product matches we have 197 weeks of price observations, for some of them we have fewer observations. The key results from these 83 regressions are presented in Table 2.

Several things can be learned from these results. First, prediction 1 is confirmed; we observe a large heterogeneity, with both significantly positive and negative βs. Second, most of our βs are positive, 51 of 83 estimated parameters (or more than 60%) are positive. This pattern is even stronger when we consider the significant parameters. Using a two-tailed test, 15 parameters are significantly positive on a 5% level, whereas only *two* is found to be significantly negative. This is in line with the findings in Harris *et al* (2000).[8] Hence, it seems that the introduction of a private label typically leads to higher prices on national brands.

Third, looking at the product categories we get the impression that the degree of product differentiation and the number of loyal customers might matter. The most significant and largest price reduction for national brands was found for *flour*, probably one of the most homogeneous product group in our sample (see Figure 5). When looking at product groups with positive shifts in national brand prices, we find several "strong" products. For instance, for the six product matches of coffee in our sample, four PL entries are found to increase national brand prices significantly. We also find several soft drink matches where the same thing applies. Also Frionor significantly increased its price on French fries in response to PL entry (see Figure 3). This supports prediction no. 2.

Turning to market shares, Table 2 reports the private label market share in each product group and chain. The average private label market share for all 83 products is 33.7%. For the 15 significant positive βs the average is considerably higher, 41.7%. For the two negative βs the market share is above 73% for both products.

Note also that no significantly negative βs is found for products with small market shares; private labels need to be large to induce a decrease in national brand prices. The average PL market share in Table 2 over all negative βs is 40%, whereas the average PL market share for the positive βs is 30%. Finally, none of the PL entries that lead to a significant price increase had less then 7% PL market share. In the group of non-significant βs we have as many as 15 products with PL market shares less than 7% (28%), and as many as 10 below 3%.

To sum up, if PL market share can be interpreted as a success criterion, our findings give support to prediction 3; significant changes in national brand prices are typically observed in product categories with successful entry of a private label. Moreover, no national brands reduce their price as a response to an unsuccessful (small) introduction, whereas some increase their price. The latter result is important, since the alternative to prediction 3 – significant price reduction on a national brand in a product category where a private label is not successful – found no support. In such a case an unsuccessful entry should be linked to a reduced national brand price. We would anticipate negative significant βs in these cases,

[8] These authors state: "*We have a remarkable result. Despite the large number of estimated coefficients (288) every statistically significant coefficient is positive.*" Actually they found one fourth of their coefficients to be positive on a 5% level, in our case the number is close to this; one fifth.

since a significant reduction in the national brand price would reduce the room for potential private label success. However, this is not what we can observe in the regression results.

So far we have found some support for our predictions. However, we need to go a step further to statistically validate our conclusions. In order to try to single out what is a strong product we might condition our test on variables that can serve as instruments for the "strength" of a product, alternatively, the number of "loyal" customers. In addition to market shares we therefore use two more variables, the actual distribution ratio of each product in all Norwegian stores, and a ranking of the products according to size. The distribution ratio is a number between 0 and 100, where 100 means that the product is distributed in all stores. The only national brand in our dataset that covers 100% of the stores is Coca-Cola. The rank variable tells whether the national brand is a number 1, a number 2, or a number 3 product in terms of market share. Table 3 presents correlation between the estimated βs, distribution ratio, rank and market shares, and may give us a first impression of relationships.

[Table 3 approximately here]

Several interesting things can be seen from these simple correlations. The higher the PL market share, the more likely we are to observe reduced national brand price; the higher the national brand market share, the more likely we are to observe a price increase. Rank and distribution ratios are, however, variables that seem nearly uncorrelated with the βs. When we consider only the "significant" product matches, we find a negative correlation between rank and β at -.22. However, the correlation is insignificant. The sign suggests that a number 3 national brand is more likely to reduce its price than a number 1 ranked national brand. The most interesting result in Table 3 is that for the "significant" product matches, all correlations are substantially stronger and significant.

The next section extends model (2) to take advantages of the panel properties to see whether these "suggestions" also are valid in an econometric model based on the full data set of 15 761 observations.

5.2. A dynamic panel price model

We now extend the dynamic price model to exploit the panel properties of our dataset. Furthermore, we condition our dummy variable $D\text{int}^{PL}$ on our information on market shares, distribution and rank. Our basic panel model is:

$$(3) \qquad P_{i,t}^{NB} = M_r + \rho \cdot P_{i,t-1}^{NB} + \lambda t + \gamma CPI_t + \beta D\text{int}_{\text{i,t}}^{PL} + \varepsilon_{i,t}$$

where M_r is a set of dummy variables that vary according to market segment. For example, market segment number 14 is coffee and includes three different coffee-product matches within one chain. There are a total of 41 different market segments with 1 to 7 product matches; r=1-41. The market segment dummies are included to account for different price levels in each market segment. Hence, the model we use includes both a dynamic AR(1) component for each product match, and a "fixed effects" element through the 41 market segment dummies.[9]

Now we extend the dynamic panel model in two levels. First, we estimate three models where we condition $D\text{int}^{PL}$ on private label market share, and the national brands' rank and distribution level:

[9] Since we here include a lagged endogenous variable problems might arise since the lagged endogenous variable can be correlate with the error term in a dynamic fixed effect model (Anderson and Hsiao, 1982; Nickell, 1981). However, this problem is present if (as is most common) the cross section element dominates the time dimensional element, i.e., the number of cross sectional observations exceeds usually by far the number of

$$P_{i,t}^{NB} = M_r + \rho \cdot P_{i,t-1}^{NB} + \lambda t + \gamma CPI_t +$$

$$(4.1) \qquad \beta_1 D\text{int}_{i,\text{t}}^{PL} \cdot DISTR_1^{NB} + \beta_2 D\text{int}_{i,\text{t}}^{PL} \cdot DISTR_2^{NB} + \beta_3 D\text{int}_{i,\text{t}}^{PL} \cdot DISTR_3^{NB} + \varepsilon_{i,t}$$

$$P_{i,t}^{NB} = M_r + \rho \cdot P_{i,t-1}^{NB} + \lambda t + \gamma CPI_t +$$

$$(4.2) \qquad \beta_1 D\text{int}_{i,\text{t}}^{PL} \cdot RANK_1^{NB} + \beta_2 D\text{int}_{i,\text{t}}^{PL} \cdot RANK_2^{NB} + \beta_3 D\text{int}_{i,\text{t}}^{PL} \cdot RANK_3^{NB} + \varepsilon_{i,t}$$

$$P_{i,t}^{NB} = M_r + \rho \cdot P_{i,t-1}^{NB} + \lambda t + \gamma CPI_t +$$

$$(4.3) \qquad \beta_1 D\text{int}_{i,\text{t}}^{PL} \cdot MS_1^{PL} + \beta_2 D\text{int}_{i,\text{t}}^{PL} \cdot MS_2^{PL} + \beta_3 D\text{int}_{i,\text{t}}^{PL} \cdot MS_3^{PL} + \varepsilon_{i,t}$$

The distribution, rank and PL-market share variables are all dummies and have the same structure; "1" denotes high (distribution, rank or PL-market share), "2" medium and "3" low. For instance, MS_3^{PL} refers to a low private label market share and will accordingly take the value 'one' when this is the case, and 'zero' otherwise. $RANK_2^{NB}$ represents a national brand that is ranked as number two etc. The exact definitions of these variables are given in Appendix A. By estimating these three models we will be able to uncover whether differences in distribution, rank or PL-market share are important for the price response of the national brands.

Finally, we extend the model even further. The third step is to look at two combinations of models 4.1 to 4.3, where we condition $D\text{int}^{PL}$ on rank and PL-market share, and distribution and PL-market share. The model that combines distribution and private label market share is:

years included in a dataset. In our case, the opposite is true, the time dimension is weekly with 197 observations,

$$
\begin{aligned}
P^{NB}_{i,t} &= M_r + \rho \cdot P^{NB}_{i,t-1} + \lambda t + \gamma CPI_t + \\
(5.1) \qquad & \sum_{j=1}^{3} \sum_{k=1}^{3} \beta_{jk} D\mathrm{int}^{PL}_{i,\mathrm{t}} \cdot DISTR^{NB}_{j} \cdot MS^{PL}_{k} + \varepsilon_{i,t}
\end{aligned}
$$

where *j* refers to distribution level and *k* to PL market share size. Hence, the parameter β_{11} measures the price response of the national brand for those national products that have a large distribution and where the private label has acquired a large market share. Correspondingly, β_{33} measures the price response for those products that have a relatively small distribution and where the private label only has gained a small market share. In the next model, we condition on rank rather than distribution:

$$
\begin{aligned}
P^{NB}_{i,t} &= M_r + \rho \cdot P^{NB}_{i,t-1} + \lambda t + \gamma CPI_t + \\
(5.2) \qquad & \sum_{j=1}^{3} \sum_{k=1}^{3} \beta_{jk} D\mathrm{int}^{PL}_{i,\mathrm{t}} \cdot RANK^{NB}_{j} \cdot MS^{PL}_{k} + \varepsilon_{i,t}
\end{aligned}
$$

Now the parameter β_{11} measures the price response of the national brand for those national products that are ranked as number 1 and where the private label has acquired a large market share, etc.

These five extended models allow us to test whether differences in rank, distribution or the private label market share, or combinations of these can explain the heterogeneity in price responses uncovered in the previous section. In particular, this panel data framework

---

which is considerably more than the 83 product matches.

allows us to use all information simultaneously, and also permits various statistical tests of the validity of our results.

The models 3 to 5 are presented in Table 4. The statistical properties are good, with a high explanation power, and a clearly significant AR(1) parameter; ρ is estimated close to 0.80 in all six models, suggesting a stationary process.[10] The trend and CPI variables are both non-significant and have different signs. However, these two variables are strongly positive correlated (with correlation > 0.90), and therefore multicollinearity applies with large standard errors. The trend parameter picks up the positive price trend, and the CPI variable any possible negative deviation from this trend. The coffee price variable is significant and positive in all models.

[Table 4 here]

Turning now to the parameter β, several interesting things can be observed. In model 3, β is non-significant, suggesting no change in national brand price. This result, which is more like an average effect, disregards the underlying heterogeneity. In the extended models, we try to decompose the heterogeneity. The first extension – model 4 – suggests some more action. In models 4.1 to 4.3 one of the βs is significant, indicating a negative shift in national brand price for products that is ranked as number one – but only at a 10% level. A joint F-test (bottom Table 3) of the effect of conditioning the price response on rank, distribution and PL-market share; $H^0: \beta_1 = \beta_2 = \beta_3 = 0$, cannot be rejected for distribution and PL market share, but is clearly rejected for rank. Hence, rank seems to pick up some of the observed heterogeneity. We extend the model even further in models 5.1 and 5.2. It is evident that more of the heterogeneity is then accounted for. Out of 18 different βs, 9 are significant. The majority of these suggest a positive price response. On a 5% level, all significant βs are positive in the distribution vs. PL market share model (5.1). The results are summarised with signs in Table 5.

[Table 5 here]

When we look at the significant β s, we observe some regularities. In particular, β_{11}, β_{12} and β_{13} are significant in all models. The products that either are ranked as number one or have the highest distribution are thus most influenced by private label entry. These are those products where we would anticipate most loyal customers and "strong" products (see prediction 2). Furthermore, β_{11} in both models are significant on a 1% level and positive. Hence, a large PL market share, or a successful entry, leads to a price increase on the highest ranked and distributed products. Correspondingly, β_{13} is significant and negative in both models, suggesting that the national brands are more likely to reduce price after less successful PL entry (low PL market share).

Of the remaining 12 parameters (medium and low rank or distribution) only 3 parameters are significant. β_{21} is negative, suggesting that number 2 products are more likely to compete with successful PL entrants, whereas number 2 products that face "smaller" PL entrants increase their price (β_{23}>0). The last significant parameter β_{33} in model 5.1 is harder to interpret at first glance. It suggests that the national brands that have the lowest distribution increase their prices when faced with a "small" PL entrant. However, within this group we typical find "niche" products that might have very loyal customers within more narrowly defined market segment.

We perform different joint F-test in models 5.1 and 5.2. First, we jointly test the importance of the degree of distribution and rank. We impose a joint zero restriction on the

[10] Even though we know that the AR(1) parameter will have a negative biased variance, a test of ρ =1 is

three parameters that correspond to each distribution/rank level. For instance, $H_0^1 : \beta_{11} = \beta_{12} = \beta_{13} = 0$ implies that there is no national brand price response in the high distribution or number one product group. The different hypotheses are summarised and test statistics provided in Table 5 and 6. The same pattern as was seen in the individual parameters can be traced also here. The null of no price response in the high distribution/rank one group (H_0^1) is clearer rejected than the medium and low hypotheses (H_0^2 and H_0^3). When we test whether differences in PL market share have different effects in terms of price response, we find that the null hypothesis of no national brand price response is rejected in five out of six tests. Most clearly for the high PL market share group ($H_0^4 : \beta_{11} = \beta_{21} = \beta_{31} = 0$), and the low PL market share group ($H_0^6 : \beta_{13} = \beta_{23} = \beta_{33} = 0$). In the distribution/PL market share model (5.1) all three PL market share hypotheses were rejected. The PL market share test results are interesting, since these give support to our third empirical prediction: the degree of success of the PL entry – the size of the PL market share - matters for the national brand price response.

[Table 6 here]

Our predictions from theory thus seem to have found statistical support. We do find heterogeneity also in the panel data models, with both negative and positive significant price responses; prediction 1. There is also a pattern where highly distributed and ranked products are more influenced by PL entry than less distributed and ranked products ("weaker" national brands); prediction 2. This is seen in both the individual parameters and the joint tests. Finally, prediction 3 that more successful PL entry – as measured by the PL market share –

---

rejected with t-values in the range of 39 to 49, clearly indicating a stationary process.

should have a larger impact on the national brands find some support. The joint null of no price response of national brands on the most successful PL entrants ($H_0^4 : \beta_{11} = \beta_{21} = \beta_{31} = 0$) is most clearly rejected in Table 5. However, as opposed to what we concluded in the previous section, we find some weak support for the alternative to prediction 3. We now find two out of six cases where national brand prices are reduced significantly in market segments where the PL market share is low. The empirical evidence is mixed, though, since out of the remaining four cases we find two significant positive estimates.

6. Some concluding remarks

In our single regression approach we observed a large heterogeneity, with both significantly positive and negative βs. Most of our βs were positive: out of 83 estimated parameters, more than 60%. This tendency is even stronger when we consider the significant parameters. 15 parameters are significantly positive on a 5% level, whereas only *two* is found to be significantly negative. Hence, it seems that an introduction of a private label typically leads to higher prices on national brands. A closer examination indicates that the degree of product differentiation and the number of loyal customers might matter in each product category. The most significant and largest price reduction found for national brands was in the product category *flour*, probably the most homogenous product group in our sample. When we looked at the product groups where we found positive shifts in national brand prices, we found several "strong" products.

In the dynamic panel data approach the same picture emerged. We found heterogeneity with both negative and positive significant price responses supporting our first empirical prediction. We also found that highly distributed and ranked products are typically more influenced by PL entry than less distributed and ranked products ("weaker" national brands), supporting our second prediction. Finally, even though we are more careful here, we also find some support in our data for prediction 3. More successful PL entry – as measured by the PL market share – have typically a larger impact on the national brands.

We have thus to a large extent been able to condition the heterogeneity observed in section 5.1 on differences in distribution, rank and PL market share. However, there is still some heterogeneity that is not accounted for. One candidate is marketing activity by the national brands, and another candidate could be product quality characteristics.

One important lesson from our study is that it is too simple to argue that more private label products leads to more intense price rivalry. What we have found, though, is that product "strength" matters. That is, the prices of the largest national brand products in terms of ranking or distribution are more influenced by PL entry than number 2 and 3 products, or less distributed products. We also found that the prices of national brands typically increase after an introduction of a private label.

References

Anderson T. W., and C. Hsiao (1982) “Formulation of dynamic models with error components” *Journal of the American Statistical Association* 73:371-8

Ardeni, P. G. (1989): "Does the Law of One Price Really Hold for Commodity prices?", *American Journal of Agricultural Economics*, 71: 661-69.

Asche F. & H. Bremnes and C.R. Wessels (1999): “Aggregation, Market Integration and Relationships between prices: an application to world salmon markets” *American Journal of Agricultural Economics*, 81: 568-81.

Asche, F., K. G. Salvanes and F. Steen (1997): "Market Delineation and Demand Structure," *American Journal of Agricultural Economics*, 79:

Beck, S. E. (1994), "Cointegration and Market Efficiency in Commodities Futures Markets," *Applied Economics*, 26: 249-257.

Caves R. E., M.D. Whinston and M.A. Hurwitz (1991): “Patent expiration, Entry, and Competition in the U.S. Pharmaceutical Industry” *Brookings Papers: Microeconomics*, 1-48.

Chintagunta P.K., A. Bonfrer and I. Song (2000): “Studying the impact of Store Brand Entry: An Application of a Random Coefficients Logit Model with Aggregate Data. Mimeo, Graduate School of Business, University of Chicago.

Connor, J. M., R. T. Rogers and V. Bhagavan (1996): "Concentration Change and Counterwailing Power in the U.S. Food Manufacturing Industry", *Review of Industrial Organization*, 11: 473-492.

Cotterill, R. W., W. P. Putsis and R. Dahr (2000): "Assessing the Competitive Interaction between Private Labels and National Brands", *Journal of Business*, 73(1): 109-138.

Dhar, S. K. and S. J. Hoch (1997): “Why store brand penetration varies by retailer, “ *Marketing Science*, 16(3): 208-227.

Doane, M. J. and D. F. Spulber (1994), "Open Access and the Evolution of the U.S. Spot Market for Natural Gas," *Journal of Law and Economics*, 37: 477-517.

Dobson, P. (1998): "The Economic Welfare Implications of Own Label Goods," mimeo, School of Management and Finance, University of Nottingham.

Dobson, P. and M. Waterson (1997): "Counterwailing Power and Consumer Prices", *Economic Journal*, 107: 418-430.

Dobson, P. and M. Waterson (1999): "Retailer Power: Recent Developments and Policy", *Economic Policy*, 0(28): 133-156.

Gabrielsen, T.S. and L. Sørgard (2000): ”Private Labels, Price Rivalry, and Public Policy,” Working Paper No. 41/00, Foundation for Research in Economics and Business Administration, Bergen.

Goodwin, B. K. and T. C. Schroeder (1991), "Cointegration Tests and Spatial Price Linkages in Regional Cattle markets", *American Journal of Agricultural Economics*, 73: 453-64.

Grabowski H. G. and J. Vernon (1992): “Brand loyalty, entry, and price competition in pharmaceuticals after the 1984 Drug act,” *Journal of Law and Economics*, 35: 331-350.

Harris, J.M., Perloff, J.M., Shimshack, J.P. and M.B. Ward (2000): ”Effects of the Private-Label Invasion in Food Industries,” mimeo, Department of Agricultural and Resource Economics, University of California, Berkeley.

Hoch, S. J. and S. Banerji (1993): "When do Private Labels Succeed?", *Sloan Management Review*, Summer 1993, 57-67.

Isard, P. (1977) “How far can we push the law of one price?”, *American Economic Review,* 67: 942-948.

Kadiyali, V., Chintagunta, P. And N. Vilcassim (2000): “Manufacturer-retailer channel interactions and implications for channel power: An empirical investigation of pricing in a local market,” *Marketing Science*, 19(2): 127-148.

Messinger, P. R. And C. Narasimhan (1995): “ Has power shifted in the grocery channel?” *Marketing Science*, 14(2): 189-223.

Mills, D. E. (1995): "Why Retailers Sell Private Labels," *Journal of Economics & Management Strategy*, 4: 509-528.

Narasimhan, C. and R. T. Wilcox (1998): "Private Labels and the Channel Relationship: A Cross-Category Analysis", *Journal of Business*, 71: 573-600.

Nickell, S. (1981) “Biases in dynamic models with fixed effects” *Econometrica*, 49:1399-416.

Perloff, J.M., Suslow, V.Y. and P.J. Seguin (1996): ”Higher Prices from Entry: Pricing of Brand-Name Drugs,” mimeo, University of California, Berkeley.

Putsis, W. P. (1997): "An Empirical Study of the Effect of Brand Proliferation on Private Label - National Brand Pricing Behaviour", *Review of Industrial Organization*, 12: 355-371.

Putsis, W. P. and R. W. Cotterill (1999): "Share, Price and Category Expenditure - Geographic Market Effects and Private Labels", *Managerial and Decision Economics*, 20: 175-187.

Raju, S. J., R. Sethuraman and S. K. Dahr (1995): "The Introduction and Performance of Store Brands", *Management Science*, 61: 957-978.

Richardson, D.J., (1978) “Some empirical evidence on commodity arbitrage and the Law of one price”, *Journal of International Economics*, 8: 341-51

Salop, S. C. (1977): ”The Noisy Monopolist: Imperfect Information, Price Dispersion, and Price Discrimination,” *Review of Economic Studies*, 44(3): 393-406.

Sauer, D. G. (1994), "Measuring Economic Markets for Imported Crude Oil," *Energy Journal*, 15: 107-123.

Sethuraman, R. (1992): "The Effect of Marketplace Factors on Private Label Penetration in Grocery Products", Working Paper no. 92-128, Marketing Science Institute.

Schwarz T. V. and A. C. Szakmary (1994) "Price Discovery in Petroleum Markets: Arbitrage, Cointegration, and the Time Interval of Analysis," *Journal of Futures Markets*, 14: 147-167.

Appendix A – Data and variable description

The data set is from ACNielsen Norway, and contains weekly prices on national brands and private labels for the period 01.01.1997 to 01.10.2000. In addition we have data on market shares, distribution level of the national brands and the ranking of these in May 2000. Totally we have 83 product matches in 41 different market segments. Totally this give us a panel of 15761 observations. The consumer price index is from the Statistics Norway (SSB).

The dummy variables used in models 4 and 5 are defined as:

$\mathbf{MS^{PL}_1}$ = 1 if the PL market share is $\geq 20\%$
$\mathbf{MS^{PL}_2}$ = 1 if the PL market share is between 8% and 20%
$\mathbf{MS^{PL}_3}$ = 1 if the PL market share is $\leq 8\%$

$\mathbf{Rank^{NB}_1}$ = 1 if the national brand is ranked as number 1
$\mathbf{Rank^{NB}_2}$ = 1 if the national brand is ranked as number 2
$\mathbf{Rank^{NB}_3}$ = 1 if the national brand is ranked as number 3

$\mathbf{Distr^{NB}_1}$ = 1 if the national brand has a distribution level $\geq 70\%$
$\mathbf{Distr^{NB}_2}$ = 1 if the national brand has a distribution level between 30% and 70%
$\mathbf{Distr^{NB}_3}$ = 1 if the national brand has a distribution level $\leq 30\%$

Figures and Tables

Figure 3 Price development French fries

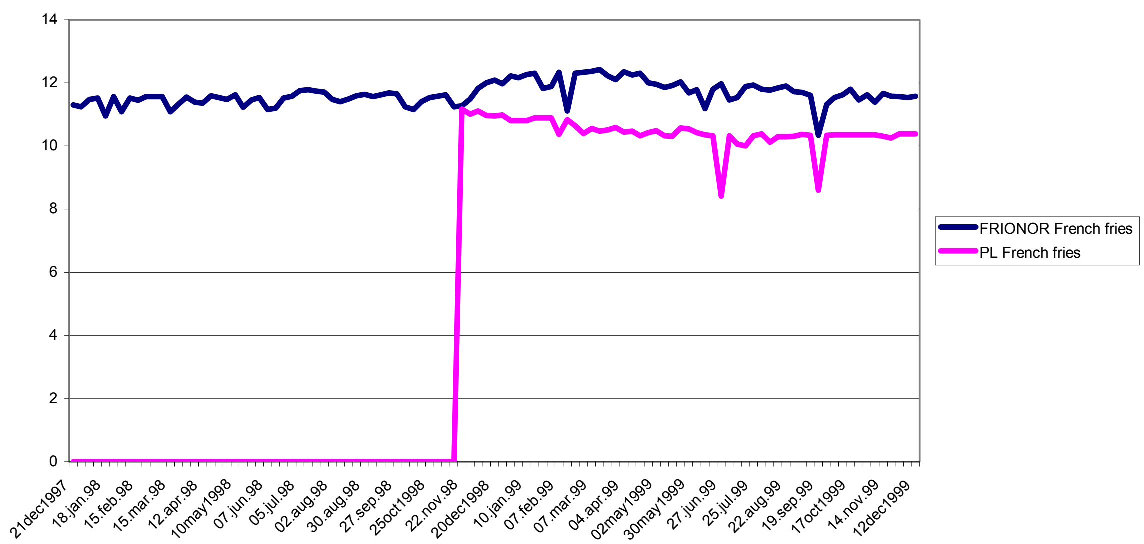

Figure 4 Price development Spaghetti

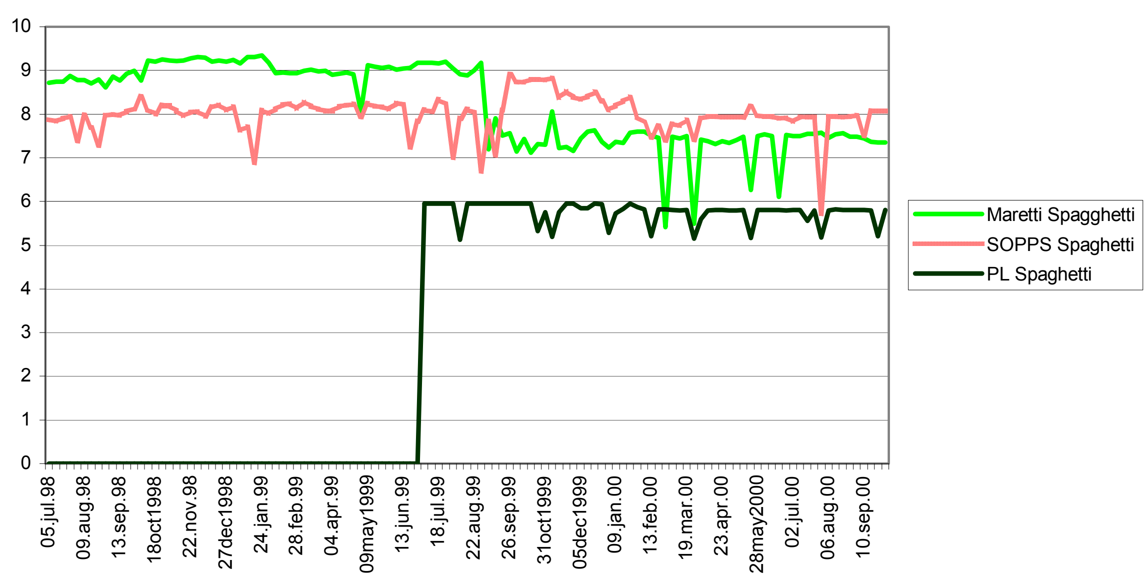

Figure 5 Price development flour

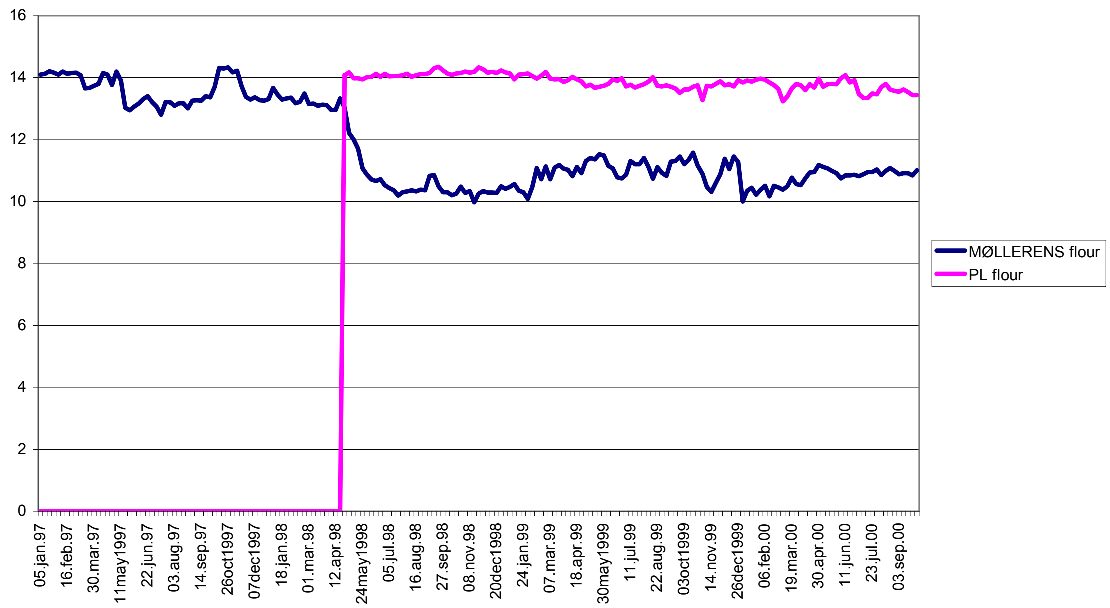

Table 2 Econometric results equation (2) for all 83 product matches

Market Segm. Number (r)	Market segment Product	Matched National brand	β	SE(β)	Market share PL	n
10	Frozen vegetables	Nora Blomkålblanding 800	0.020*	0.003	76.2 %	191
10	Frozen vegetables	Nora Amerikansk Blanding	0.022*	0.004	76.2 %	196
5	Soft drink lemon	Seven Up Prb 1.5 L	0.035*	0.009	32.8 %	196
18	Spaghetti	Maretti Spaghetti 12 Min	0.070*	0.019	32.6 %	196
9	French fries	Frionor Pommes Frites 600	0.025*	0.007	75.5 %	196
26	Rice	Uncle Ben's Jasminris 2 K	0.058*	0.017	46.2 %	166
4	Soft drink lemon	Seven Up Prb 1.5 L	0.134*	0.040	32.1 %	196
35	White cheese	Norvegia F45 Skf Ppk. 500	0.026*	0.008	12.0 %	196
13	Nectar Apple	Nora Eplenektar 1 L	0.043*	0.017	76.5 %	196
15	Coffee	Evergood Filtermalt 250 G	0.068*	0.029	12.6 %	196
11	Orange Juice	Nora Appelsin Juice 1 L	0.042*	0.018	44.9 %	196
9	French Fries	Frionor Pommes Strips 600	0.016*	0.007	75.5 %	196
15	Coffee	Krone Gull Filtermalt 250	0.075*	0.035	12.6 %	196
32	Chips	Maarud Potetgull Lett Sal	0.028*	0.014	13.1 %	196
10	Frozen vegetables	Frionor Erter/Gulrøtter 8	0.020*	0.010	76.2 %	196
16	Instant Coffee	Nescafe Gull 200 Gr	0.008**	0.004	5.5 %	196
20	Spaghetti	Maretti Spaghetti 12 Min	0.014**	0.007	18.2 %	196
29	Rice for porridge	Ming Grøtris Blå 750 Gr	0.010**	0.005	7.0 %	196
14	Coffee	Coop Rød Filtermalt 250 G	0.107**	0.061	7.1 %	196
19	Spaghetti	Sopps Spaghetti 500 Gr	0.014**	0.009	17.2 %	196
1	Coca Cola	Pepsi Max Prb 1.5 L	0.053	0.035	11.2 %	196
21	Macaroni	Maretti Makaroni 5 Min 50	0.030	0.020	26.2 %	196
22	Macaroni	Maretti Makaroni 5 Min 50	0.030	0.020	0.7 %	196
23	Macaroni	Maretti Makaroni 5 Min 50	0.030	0.020	13.6 %	196
18	Spaghetti	Sopps Spaghetti 500 Gr	0.020	0.014	32.6 %	196
21	Macaroni	Sopps Makaroni Snarkokt 5	0.018	0.012	26.2 %	196
22	Macaroni	Sopps Makaroni Snarkokt 5	0.018	0.012	0.7 %	196
23	Macaroni	Sopps Makaroni Snarkokt 5	0.018	0.012	13.6 %	196
39	Baguettes	Wasa Kuvertbaguetter Fine	0.007	0.005	48.9 %	196
15	Coffee	Friele Frokost Kokmalt 25	0.040	0.028	12.6 %	196
31	Pizza	Stabburet Pizza Grandiosa	0.021	0.016	0.6 %	196
39	Ciabatta	Bakers Ciabatta Halvstekt	0.034	0.027	48.9 %	157
41	Olive oil	Mills Olivenolje 500 Ml	0.005	0.004	54.3 %	196
29	Rice for porridge	Geisha Grøtris 750 Gr	0.005	0.004	7.0 %	196
37	Baguettes	Wasa Baguetter Grove 2-Pk	0.011	0.010	46.3 %	194
4	Soft drink lemon	Sprite Prb 1.5 L	0.038	0.036	32.1 %	196
7	Soft drink champagne	Villa Champagne 1.5 L	0.036	0.034	73.8 %	196
19	Spaghetti	Buitoni Spaghetti 500 Gr	0.013	0.015	5.5 %	196
10	Frozen vegetables	Nora Erter/Gulrøtter 800	0.011	0.015	76.2 %	191
10	Frozen vegetables	Nora Fransk Blanding 800	0.011	0.016	76.2 %	194
5	Soft drink lemon	Sprite Prb 1.5 L	0.007	0.011	32.8 %	196

Market segm. Number (r)	Market segment Product	Matched National brand	β	SE(β)	Market share PL	n
24	Pasta.	Buitoni Penne Rigate 500	0.018	0.029	2.9 %	196
30	Pizza	Stabburet Pizza Big One C	0.018	0.032	0.3 %	156
24	Pasta.	Buitoni Penne Rigate 500	0.016	0.029	2.9 %	196
24	Pasta.	Buitoni Penne Rigate 500	0.016	0.029	2.9 %	196
16	Instant coffee	Nescafe Gull 200 Gr	0.002	0.005	1.9 %	196
6	Cider	Mozell Drue & Eple Prb 1.	0.017	0.038	48.1 %	196
20	Spaghetti	Sopps Spaghetti 500 Gr	0.001	0.004	18.2 %	196
1	Coca Cola	Coca-Cola Prb 1.5 L	0.008	0.031	11.2 %	196
38	Baguettes	Wasa Kuvertbaguetter Fine	0.002	0.014	41.0 %	196
14	Coffee	Friele Frokost Kokmalt 25	0.003	0.030	0.1 %	196
32	Chips	Kims Chips Salt 250 Gr	-0.001	0.024	13.1 %	196
8	Soft drink Champagne	Villa Champagne 1.5 L	-0.0005	0.007	76.2 %	196
28	Rice	Uncle Ben's Jasminris 2 K	-0.0002	0.003	43.8 %	172
28	Rice	Uncle Ben's Jasminris 2 K	-0.0002	0.003	43.8 %	172
35	White Cheese	Synnøve Gulost Ca 500 Gr	-0.008	0.060	12.0 %	120
24	Pasta.	Buitoni Eliche 500 Gr	-0.006	0.029	50.5 %	196
2	Soft drink Orange	Fanta Appelsin 1.5 L	-0.008	0.037	30.3 %	196
12	Orange Juice	Meierienes Appelsinjuice	-0.001	0.005	35.5 %	196
35	White Cheese	Jarlsberg F45 Skf 500 Gr	-0.005	0.019	12.0 %	179
30	Pizza	Stabburet Pizza Grandiosa	-0.006	0.019	4.5 %	196
25	Pasta.	Buitoni Penne Rigate 500	-0.006	0.017	28.8 %	196
25	Pasta	Buitoni Penne Rigate 500	-0.006	0.017	28.8 %	196
25	Pasta.	Buitoni Penne Rigate 500	-0.006	0.017	28.8 %	196
3	Soft drink Orrnge	Fanta Appelsin 1.5 L	-0.006	0.017	30.9 %	196
27	Rice	Uncle Ben's Jasminris 2 K	-0.002	0.005	14.3 %	171
2	Soft drink Orange	Solo Prb 1.5 L	-0.014	0.036	30.3 %	196
33	Nuts	Kims Cashewnøtter 100 Gr	-0.006	0.014	8.0 %	139
36	Baguettes	Wasa Baguetter Fine 2-Pk	-0.013	0.019	74.5 %	196
31	Pizza	Stabburet Pizza Big One C	-0.017	0.026	0.5 %	156
3	Soft drink Orange	Solo Prb 1.5 L	-0.016	0.019	30.9 %	196
38	Ciabatta	Bakers Ciabatta Halvstekt	-0.034	0.039	41.0 %	156
10	Frozen vegetables	Frionor Fransk Blanding	-0.007	0.007	76.2 %	196
37	Baguettes	Wasa Baguetter Fine 2-Pk	-0.005	0.005	46.3 %	196
10	Frozen vegetables	Frionor Blomkålblanding	-0.007	0.006	76.2 %	196
32	Chips	Pringles Potetchips Origi	-0.014	0.013	13.1 %	115
11	Orange Juice	Meierienes Appelsinjuice	-0.008	0.005	44.9 %	196
34	Tomato purée	Heinz Tomatpure 145 Gr	-0.008**	0.005	90.4 %	196
41	Olive oil	Ybarra Olivenolje 500 Ml	-0.015**	0.009	54.3 %	196
12	Orange Juice	Nen Appelsinjuice 1 L	-0.005**	0.003	35.5 %	196
40	Olive oil	Ybarra Olivenolje 500 Ml	-0.023**	0.012	50.0 %	196
10	Frozen vegetables	Frionor Amerikansk Blandi	-0.013*	0.005	76.2 %	196
17	Flour	Møllerens Hvetemel Siktet	-0.052*	0.009	73.0 %	196

Table 3 First order correlation coefficients between the estimated βs and market shares, rank and distribution ratio

	PL market share within market segment within chain	PL market share in market segment in Norway	National brand Market share within chain	National brand Rank	National brand Distribution Ratio
All products					
Correlation	-0.175	-0.145	0.131	0.054	-0.068
(P-value)	(0.115)	(0.191)	(0.240)	(0.625)	(0.54)
All significant Product matches (5% two tailed test)					
Correlation	-0.636	-0.557	0.445	-0.22	0.108
(P-value)	(0.005)	(0.016)	(0.065)	(0.367)	(0.671)

Table 4 Empirical results for the dynamic panel data models 3 to 5

	Model 3	Model 4.1 (distrib)	Model 4.2 (rank)	Model 4.3 (PLms)	Model 5.1 (β_{jk} j: distrib k:PL ms)	Model 5.2 (β_{jk} j: rank. k:PL ms)
ρ	0.804*	0.804*	0.802*	0.803*	0.797*	0.796*
	(0.004)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)
λ	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	(0.00009)	(0.00009)	(0.00009)	(0.00009)	(0.00009)	(0.00009)
γ	-0.167	-0.167	-0.183	-0.165	-0.165	-0.181
	(0.178)	(0.178)	(0.178)	(0.178)	(0.177)	(0.178)
Coffee price	0.039*	0.039*	0.041*	0.039*	0.048*	0.041*
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
β	-0.0003					
	(0.002)					
β_1		-0.0002	-0.004***	0.0019		
		(0.0025)	(0.0025)	(0.0037)		
β_2		-0.0007	0.004	-0.0020		
		(0.0030)	(0.0029)	(0.0032)		
β_3		-0.00007	-0.003	-0.0001		
		(0.0031)	(0.0036)	(0.0028)		
β_{11}					0.041*	0.022*
					(0.008)	(0.006)
β_{12}					0.014*	-0.006***
					(0.006)	(0.003)
β_{13}					-0.006***	-0.007*
					(0.003)	(0.003)
β_{21}					-0.006	-0.039*
					(0.006)	(0.010)
β_{22}					-0.007	5.6e-06
					(0.005)	(0.005)
β_{23}					0.006	0.006**
					(0.004)	(0.003)
β_{31}					-0.002	-0.003
					(0.005)	(0.004)
β_{32}					-0.006	-0.0008
					(0.004)	(0.007)
β_{33}					0.008**	-0.003
					(0.004)	(0.004)
R^2	0.999	0.999	0.999	0.999	0.999	0.999
N	15761	15761	15761	15761	15761	15761
$H^0: \beta_1 = \beta_2 = \beta_3 = 0$ F-test$_{(3, 15713)}$		0.02	4.86*	0.33		

*/ Significant on a 1% level **/significant at a 5% level, ***/significant on a 10% level

Table 5 Joint tests of hypotheses the dynamic panel data model 5

	Model 5.1 β_{jk} *j*: distrib *k*:PL ms	Model 5.2 β_{jk} *j*: rank. *k*:PL ms)
Joint importance of Distribution or Rank		
High Distribution or Rank = 0 $H_0^1 : \beta_{11} = \beta_{12} = \beta_{13} = 0$	12.96*	8.04*
Medium Distribution or Rank=0 $H_0^2 : \beta_{21} = \beta_{22} = \beta_{23} = 0$	2.54	6.65*
Low Distribution or Rank = 0 $H_0^3 : \beta_{31} = \beta_{32} = \beta_{33} = 0$	2.53	0.42
Joint importance of PL market share		
High PL market share = 0 $H_0^4 : \beta_{11} = \beta_{21} = \beta_{31} = 0$	9.95*	11.72*
Medium PL market share = 0 $H_0^5 : \beta_{21} = \beta_{22} = \beta_{23} = 0$	4.28*	1.32
Low PL market share = 0 $H_0^6 : \beta_{13} = \beta_{23} = \beta_{33} = 0$	5.02*	8.99*

*/ Significant on a 1% level **/significant at a 5% level, ***/significant on a 10% level

Table 6 A summary of the results from models 5.1 and 5.2 (β s and joint F-tests)

	PL market share			
	High K=1	Medium K=2	Low K=3	*Joint test of "row" (Table 4)*
<u>Distribution</u>				
High J=1	+*	+*	-***	H_0^1 *
Medium J=2	0	0	0	H_0^2
Low J=3	0	0	+**	H_0^3
Joint test of "column" (Table 4)	H_0^4 *	H_0^5 *	H_0^6 *	
<u>Rank</u>				
"1" J=1	+*	-***	-*	H_0^1 *
"2" J=2	-*	0	+**	H_0^2 *
"3" J=3	0	0	0	H_0^3
Joint test of "column" (Table 4)	H_0^4 *	H_0^5	H_0^6 *	

*/ Significant on a 1% level **/significant at a 5% level, ***/significant on a 10% level