PRICE COMPETITION AND PRICE DISPERSION IN THE UK SUPERMARKETS

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ABSTRACT

This paper investigates, using micro level price data, the determinants of the differences in price dispersion and intensity of price competition across the three quality variants sold at the UK\ supermarkets: branded products, high quality own brand products and low quality own brand products. The results of the analysis confirm that intensity of price competition is greater for those quality variants with less possibilities of horizontal product differentiation: branded products and low quality own brand products. Therefore, we explore the role played by the high quality own brand products to explain the coexistence of tight between-supermarkets competition (as claimed by the supermarket managers) with high levels of profits

KEYWORDS: supermarkets, price competition, price dispersion, product differentiation.
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1. Introduction

Food retailing is the most important component of UK retail sales, covering in 1997 46.9% of the total market. In the nineties, the large supermarket chains have become the main player of food retailing as indicated by the fact that in 1997 four supermarket chains (from larger to smaller Tesco, Sainsbury, Asda and Safeway) controlled 67.5% of the market.

All these large supermarket chains are actively involved in quality segmentation and offer a range of three quality variants for most of the products they sell. The top quality variant is the branded product (BP) sold under the manufacturer brand name (e.g. Heinz Baked Beans). Both the intermediate and the low quality variants are own brand products, where by own brand products we will understand those products sold under the supermarket brand name. The intermediate quality variant is the high-quality own brand product (HQ), which is the result of the evolution of the first own brand products introduced in the UK supermarkets. At the moment the products of this variant can be considered as very similar in quality to the Branded Products. The HQ compete with the BP for those consumers in the upper medium segment of the consumer distribution that are willing to exchange the brand name for a price discount buying a product of very similar quality. The lowest quality variant is the low quality own brand product (LQ). UK supermarket chains introduced the low quality own brand products (e.g. Tesco Value Baked Beans) since the middle of the nineties as a reaction to the arrival in the UK of the continental discounters. These latter retailers offer a limited range of low quality products sold at very reduced price. Therefore, they supposed a new form of competition for the supermarket, specially for the lowest segment of the consumer distribution. Supermarket chains faced this competition launching the LQ: very basic products whose relevant dimension is the price.

The purpose of this paper is to investigate price dispersion and price competition among UK supermarkets chains with the novel feature of considering the supermarket

as a multiquality firm. In this paper we define price dispersion and price coordination indexes and analyse the causes of their differences across quality variants.

We argue that the utility obtained by consuming a given product does not depends only on the quality variant but also on the supermarket in which the product is purchased[1]. This difference is explained by the characteristics of the product that are intrinsic to the supermarket in which it is sold. It is in this framework that we study between-supermarket differences in the degree of price dispersion and price competition across quality variants. As regards price dispersion we are interested in discriminating between cost-side and demand-side factors[2] as possible sources of the differences in the degree of between-supermarket price dispersion observed across quality variants. With respect to price competition we are interested in analysing the relationship between the possibilities of supermarket product differentiation and intensity of between-supermarket price competition across quality variants.

Additionally, we also explore the role played by the own brand products to explain an important paradox in the UK food retailing system: while the managers of the supermarkets usually claim the existence of a tight price competition across supermarkets, the profits of the UK supermarkets are the highest in the EU [The Economist, 1995].

Particular novel features of this paper include (i) consideration of the supermarket as a multiproduct-multiquality retailer, (ii) use of a micro level data set of prices directly taken in three superstores in the south of Coventry that correspond to three of the four supermarket chains with largest market share in the UK (Tesco, Sainsbury and Safeway) and (iii) use of non-parametric tests for all the statistical analysis to avoid possible problems that can arise if the samples do not satisfy the distributional assumptions of the parametric tests[3].

[1] Dobson and Waterson [1996] in a theoretical paper take a similar approach with two product variants and two firms, but they consider two products of the same quality.

[2] Possible differences in cross and own brand price elasticities across supermarkets.

[3] Even if the samples do not satisfy the distributional assumptions required by the parametric tests, the non-parametric tests used here are still valid.

The results of the empirical analysis suggest that whereas differences in the degree of between-supermarket price dispersion across quality variants are cost driven, between-supermarket price competition is less intense for the quality variant with greater possibilities of supermarket product differentiation, the HQ. The joint consideration of this last result and the fact that the market share of the HQs in the UK is greater than in any other EU country offers a new explanation of the higher profits of the UK supermarkets in comparison with their continental counterparts.

The paper is organized as follows. A characterization of the quality variants is offered in section 2. Section 3 characterizes the outlet structure in the analysis. Section 4 describes the data used in the analysis. Section 5 includes an analysis of between-supermarket price dispersion. Section 6 deals with the analysis of between-supermarket price competition. Finally the conclusions are presented in section 7.

2. Characterization of the quality variants: product differentiation possibilities and process of formation of the wholesale price

All the major UK supermarkets chains offer three quality variants for a big range of products: a brand product variant (BP) and two own brand products variants (OBP). These are the high quality own brand product variant (HQ) and the low quality own brand product variant (LQ).

We argue that the utility provided by the consumption of a given good does not depend only on the quality of the good but also on the supermarket providing the good. If we assume quality equivalence within quality variants across supermarkets[4], other supermarket characteristics[5] of the product are the only factor left to explain the differences in the utility obtained when consuming a product of the same quality variant at differ-

[4]For example, we assume that Tesco HQ Baked Beans are quality equivalent to Sainsbury HQ Baked beans and to Safeway HQ baked beans. When introducing the characteristics of each one of the quality variants we argue about the reasons behind this assumption.

[5]From now on, when talking about supermarkets characteristics of a product, we will refer to the characteristics of the products intrinsic to the supermarket it is sold other than quality.

ent supermarkets. These supermarkets characteristics include: level of service quality provided by the supermarket, physic characteristics of the product intrinsic to the supermarket other than quality, and location of the supermarket. Whereas the last two of these characteristics can be considered as horizontal attributes of the product, the level of service quality is definitely a vertical attribute. By service quality we understand the characteristics of the shopping environment and services provided by the supermarket when selling the products such as loyalty cards, assistance when packaging, etc. Shopping environment and services provided by the large UK supermarket chains in their superstores can be considered as homogeneous. Most of these superstores are located out of town with large parking areas. All of them offer a large range of food and non food products in a nice shopping environment and with wide opening hours. Services provided do not vary from one large chain to the other: all of them offer loyalty cards and associated discounts, accept debit and credit cards, they are involved in charities, etc. Furthermore, we should take into account that any new service provided by one of the supermarkets that successfully attracts shoppers can be quickly copied by the other supermarkets and the only final effect will be an increase in costs for all competitors and/or increase of consumer surplus [Corstjens *et al*, 1995][6]. Therefore, we should agree that for the large UK supermarket chains the possibilities of differentiating their products from those of other supermarket chains by means of service quality are limited. However, we think that the supermarket can differentiate their products by means of the introduction of elements of horizontal product differentiation, and that supermarket possibilities of introducing elements of horizontal product differentiation (others than location) vary across quality variants.

The BPs are supported by intense manufacturer advertising and product development and provided with identical specifications to all the supermarkets, therefore supermarket

[6]Example of this phenomenon in the recent times is the extension of the opening hours or the clerck assistence to pack the shopping.

differentiation for this quality variant is restricted to service quality and location. As we explained above, we consider the level of service as virtually homogeneous across supermarkets chains. Hence, the only possibility of supermarket differentiation for the products of the BP variant is given by the supermarket location.

The quality level of HQs has been improving over the last years and now is considered very close, if not identical, to the quality of the BPs. The supermarket uses the HQs to compete against the BPs for those consumers located in the upper and medium segment of the consumer distribution that are willing to exchange the brand name for a price discount.

An important consequence of the increasing importance of the HQs in the UK is that the supermarkets have de-stocked second brands. In most of the product spaces analyzed in this paper the only branded product sold at the supermarket is the brand leader. Therefore, competition within the supermarket between branded products has lost importance in favour of the competition between BPs and HQs. The HQs manufactured by own brand manufacturers[7] to the requisites of the supermarkets are the quality variant that allows for more supermarket differentiation. For the HQs the supermarkets have the possibility of introducing elements of horizontal product differentiation by means for example of advertising, taste, packaging, etc. i.e. we can find Heinz Baked Beans in all the supermarkets but Tesco Baked Beans with its particular packaging colours and taste only at Tesco.

The own aim of the LQs is limiting their possibilities of supermarket differentiation. The LQs are very basic products introduced to face the competition of continental discounters for the lowest segment of the consumer distribution. The relevant competition dimension is the price and so any product refinement that could contribute to differentiate the product is avoided in order to get the lowest possible price. The result is products

[7]The own brand product manufacturer can be a firm that produces exclusively own brand products or alternatively a production division of a BP manufacturer.

that are very similar across supermarkets even in packaging and names (Essentials, Value, Savers). Unlike the HQ variant whose package tries to mimic that of the BPs, the packaging of the LQs is basic with the aim of reducing production costs, signalling its "cheap" attribute and avoiding confusions with the HQ variant.

In order to understand better the differences in the possibilities of introducing elements of horizontal product differentiation for the two categories of own brand products we can appeal to the asymmetric consumer distribution noted by Katz [1984] and Canoy and Peitz [1997]. While the upper segment of the consumers distribution is concerned about the horizontal attributes of the products, the lower one is concerned mainly about prices. Offering the lowest possible price hampers the introduction of supermarket product differentiation attributes.

As regards the assumption of quality equivalence within quality variant across supermarkets, BPs are necessarily identical across supermarkets. Supermarkets' competition for the LQs is focused on price, the need to reduce costs to adjust price leads to the supermarkets to offer products that as we noted before are extremely similar even in their basic packaging. With respect to the HQs, during the eighties Sainsbury's HQs were recognised as products of higher quality than Tesco's or Safeway's HQs, however in the last years Tesco and Safeway have replicated Sainsbury's high quality approach moving upwards the quality perceptions of their HQs [Cortsjens and Corstjens, 1995; KeyNote, 1997].

Another important factor that distinguishes BPs and OBPs is the process of formation of their wholesale price. As in Giulietti [1996] we think that supermarket wholesale prices respond to a model of bilateral bargaining involving a vertical relationship between the upstream supplier and the downstream supermarket. The final wholesale price will be the result of the relative bargaining power of manufacturer and retailer. In general we can think of the UK food retailing system as a retailer-led system [Cotterill, 1997][8], and hence

[8]The UK retailing system is characterized by Cotterill as if "relatively few very large market share

the large supermarket chains considered in the analysis enjoy an advantageous position in their bargaining process with the manufacturers. Notwithstanding, the supermarket bargaining strength varies across quality variants.

In the bargaining process determining the BP wholesale prices, the retailers interact with powerful producers[9] (Kellogs, Coca-Cola, etc.) leaders of the retailing food system in other countries (e.g. the USA). Even though size, information about consumers needs and tastes, and marketing of own brand products with very similar characteristics (HQ variant) confer to the supermarkets a substantial bargaining power, this is limited by the impossibility of de-listing the BPs. Removing the BP variants from the supermarket shelves would involve losing the segment of brand-loyal consumers that would look for these products at other supermarkets. As no differences are expected in the bargaining power of the three supermarkets considered in this analysis (three of the four supermarkets with the highest market share in the UK), we expect very similar BP wholesale prices for all these supermarkets except for special deals offered by the BP manufacturer to a subset of supermarkets related with occasional product promotions.

As regards the own brand products, retailers control most of the bargaining power. Most of the times the OBP wholesale price results from a bidding competition among producers to supply a product tailored to the supermarkets specifications. Among the bids the supermarket will choose the one that meets its requirements (quality, conditions of delivery, adoption of particular technologies...) and offers the lowest price [Dobson, 1997]. Furthermore, the supermarket usually requires an exclusive supply agreement with the own brand product manufacturer. OBP wholesale prices are expected to differ across supermarkets because they are set via different supply contracts, with different conditions and mostly with different manufacturers. Moreover, whereas for the BPs the timing of change of wholesale prices is expected to be homogeneous across supermarkets,

supermarket retail firms serve as marketing channel captains in the food system".

[9]The analysis as BP producers considers only the leaders in their respective product categories.

this timing for the OBPs is linked to a supplying contract with specific start and duration.

3. Characterization of the outlet structure in the analysis

The analysis considers three of the four supermarkets chains with highest market share in UK. Listed from the largest to the smallest they are: Tesco (23.6%)[10], Sainsbury (19.6%) and Safeway (10.8%).

These supermarkets have highly developed lines of both high quality and low quality own brand products. Sainsbury is the retailer in which the own brand products have the largest share of the sales (Table 3.1). The proportion of sales HQ/LQ in the own brand products sales of these three supermarkets are shown in Table 3.2. When analysing the small share represented by the LQ sales over the total own brand sales it should be taken into account that on the one hand these products are much cheaper than the HQs and sales are calculated in value; and on the other hand that the LQ range of products is smaller than the HQ range of products.

Table 3.1: Own Label Sales in Major Supermarkets (% in value)

	SAFEWAY	SAINSBURY	TESCO
1995	54.2	65.6	55.1

Source: Nielsen 1996.

Table 3.2: Proportion HQ-LQ own brand products (% over total own brand sales in value). March-96

	HQ	LQ
SAFEWAY	88.6	11.4
SAINSBURY	97.6	2.4
TESCO	91.5	8.5

Source: Marketing Week , 28th June 1996

It is also relevant for further analysis to note the high profits enjoyed by the UK supermarkets in comparison with their continental counterpart. The Economist (6-2-99) reports that net profits margins of British supermarkets (averaging 6%) are double

[10] Market Shares in 1997.

those of the supermarkets in the continent. The traditional factors used to explain this phenomenon are: more advanced supply management system, proactive store development programs, exploitation of scanner data [Wrigley, 1997] and the existence of high property costs that act as barriers to entry [The Economist, 1995].

4. The data

The data used in this analysis are micro level data about prices that were taken directly in three selected superstores in the south of Coventry: Tesco, Sainsbury and Safeway. There is no other superstore belonging to these chains or any other chain geographically located closer to any one of them. The data set comprises 27 price observations for each one of the products taken from November 1995 to March 1997. Prices have been taken every two weeks but for the Christmas periods. For each one of the products considered the price of the BP, the HQ and LQ variants were taken.

Asda, the third biggest supermarket chain in the UK, with a market share (13.5%), was not included in the analysis because it has no superstore in the south of Coventry. The closest Asda superstore is located more than five miles away from these supermarkets, in the north of the city (Walsgrave triangle), an area which is quite different from a socioeconomic point of view. Although it is known that price levels can differ across geographical areas depending upon socioeconomic variables, in general we expect that the patterns of price competition among supermarkets will be similar to the patterns found in the area under study.

Table 4.1: Distances between supermarkets (miles)

	Distance(miles)
TESCO-SAFEWAY	2.8
TESCO-SAINSBURY	1.4
SAFEWAY-SAINSBURY	1.5

In order to select the products to include in the sample the following criteria have

been used:

- a BP, a HQ and a LQ should be available in the three supermarkets considered. The BP considered is the brand leader of its product space ;

- most of them should be present in the shopping basket of the representative English consumer;

- given that usually the LQ is available in only one package size, this size was chosen for the analysis.

If more than one price for a product was shown on the shelves the lowest one has been used for the analysis because this is the price at which the product is available for the consumers.

The list of the products used in the analysis is included in the Appendix C.

5. An analysis of supermarket price dispersion

In imperfectly competitive markets price dispersion can arise either from heterogeneities in own and cross-price elasticities among firms or from cost asymmetries. Previous research about price dispersion in the supermarkets sector has focused exclusively on the analysis of price dispersion for the branded products[11] [Giulietti and Waterson, 1997 and Walsh and Whelan, 1999[12]]. When analysing price dispersion for multiquality retailers as the UK supermarkets, we should keep in mind differences in characteristics across quality variants that can have an influence in price dispersion as: possibilities of supermarket-differentiation for each one of the quality variants and differences in the process of formation of the wholesale price for BPs and OBPs.

[11] Other interesting studies of price dispersion:

Shepard [1991] studies price dispersion in the context of gasoline stations considering full and self service pumps as two different quality variants. However, her analysis considers the fact of being a single or multiple service station as the main source of price dispersion across gasoline stations. Possible causes of price dispersion for a given quality varians across gasoline stations serving both quality variants are not analysed.

Borenstein and Rose [1994] study of price dispersion in the US airline industry is involved with the study of intra-carrier and no inter-carries price dispersion.

[12] They extend Holmes [1989] model to the case of heterogeneous costs and heterogeneous own and cross price elasticities, to analyse price dispersion in the Irish Independent Grocery Sector.

In order to carry out the price dispersion analysis we use as analytical tool the Degree of Price Dispersion Index (DPDI)[13]. We define the Degree of Price Dispersion between supermarkets J and K for product i in fortnight t as:

$$DPD_{it}^{J-K} = \begin{cases} 1 - \dfrac{p_{it}^{K}}{p_{it}^{J}} \text{ if } p_{it}^{J} \geq p_{it}^{K} \\ \\ 1 - \dfrac{p_{it}^{J}}{p_{it}^{K}} \text{ if } p_{it}^{K} > p_{it}^{J} \end{cases}$$

where:

p_{it}^{J} : is the price of product i in fortnight t at supermarket J.

t =1,...,27 fortnightly taken observations and i = 1,...,46 products

The Degree of Price Dispersion index between supermarkets J and K for product i is defined as:

$$\mathbf{DPDI}_{i}^{J-K} = \frac{1}{27}\sum_{t=1}^{27} DPD_{it}^{J-K}$$

We calculate this index for each one of the products and for each one of the supermarket pairs (TE-SA, TE-SF and SA-SF). The results is three series of **DPDI**s for each one of the three quality variants considered in the analysis[14]. For example the series $\mathbf{DPDI}_{HQ}^{TE-SA}$ would contain $\mathbf{DPDI}_{i,HQ}^{TE-SA}$ for i=1,...,46.

5.1. Between-supermarket price dispersion across quality variants

The aim of this section is to disentangle if price dispersion is either based on asymmetries in costs or on asymmetries in demand (own and cross price elasticities heterogeneities). Hence, we should start by analysing the impact of these two possible sources of price dispersion over each one of the quality variants considered in the analysis:

1. Asymmetries in demand. If we assume quality equivalence of quality variants across supermarkets, differences in own and cross-price elasticities can be only originated by

[13] The characteristics of this index are explained in Appendix B.

[14] A list of all the variables used in the paper including descriptive statistics can be found in Appendix A.

differences in the supermarket attributes of the product. As HQ is the quality variant with the greatest possibilities of supermarket differentiation (as stated in section 2), it is also the variant for which differences in own and cross-price elasticities should be greater. Hence, if price dispersion across supermarkets is driven by differences in cross price elasticities, price dispersion should be greater for HQs than for BPs or LQs,

$$\mathbf{DPDI}_{HQ}^{J-K} > \mathbf{DPDI}_{BP}^{J-K}$$
$$\mathbf{DPDI}_{HQ}^{J-K} > \mathbf{DPDI}_{LQ}^{J-K}$$

2. Cost asymmetries. Because the BP supplier is the same for all the supermarkets it was argued in section 2 that differences in the BP wholesale price across supermarkets should be small and caused for special deals offered by the BP producer at a subset of the supermarkets considered in the analysis. However, the OBP supplier can vary across supermarket and so the existence of asymmetries in costs across supermarkets is more likely for the two OBP quality variants sold at the supermarket. Therefore, greater price dispersion for the HQs and LQs should be interpreted as evidence in favour of cost asymmetries driven price dispersion.

$$\mathbf{DPDI}_{HQ}^{J-K} > \mathbf{DPDI}_{BP}^{J-K}$$
$$\mathbf{DPDI}_{LQ}^{J-K} > \mathbf{DPDI}_{BP}^{J-K}$$

Both under the hypothesis of demand-asymmetries driven price dispersion and under the hypothesis of cost-asymmetries driven price dispersions, it should be true that the degree of price dispersion is higher for the HQs than for the BPs. Hence, a prior step to the discrimination between hypothesis should be to check this common prediction. We carry out this verification by means of a battery of one-sided Wilconxon tests for Matched Pair Observations [15] for which the alternative hypothesis is just the common prediction

[15] This non-parametric test should be used to detect differences in average between two samples when each observation in one sample has some kind of natural link with an observation in the other sample.

to both hypotheses (**Test I**):

H_0: *On average, there is no difference between* $\mathbf{DPDI}_{HQ}^{J-K}$ *and* $\mathbf{DPDI}_{BP}^{J-K}$.

H_1: *On average,* $\mathbf{DPDI}_{HQ}^{J-K}$ *is greater than* $\mathbf{DPDI}_{BP}^{J-K}$.

Observation of Table 5.1 reveals that the null hypothesis of no differences between the average level of **DPDI** for the BPs and the HQs is rejected for all the three supermarket pairs (TE-SA, SA-SF, TE-SF). Thus, the results of the tests confirm the common prediction of both hypothesis about price dispersion: on average, $\mathbf{DPDI}_{HQ}^{J-K} > \mathbf{DPDI}_{BP}^{J-K}$

Table 5.1: Wilconxon Test for Differences in Price Dispersion across Quality Variants

Test I	**BP-HQ**	T	CV 5%*	CSS	One/Two-Sided
	TE-SA	171	389	46	One-Sided
	TE-SF	130	389	46	One-Sided
	SA-SF	94	389	46	One-Sided
Test II	**HQ-LQ**				
	TE-SA	507	371	45	One-Sided
	TE-SF	398	371	45	One-Sided
	SA-SF	455	389	46	One-Sided
Test III	**BP-LQ**				
	TE-SA	204	371	45	One-Sided
	TE-SF	275	389	46	One-Sided
	SA-SF	295	389	46	One-Sided

*Critical Value at 5% significance level. Rejection of the H_0 if $T \leq CV5\%$.
Corrected Sample Size (CSS)= Sample size − Number of Zero Differences

In order to discriminate between the two conjectures presented above, we can use a sequence of two one-sided Wilconxon tests based on the comparison of the predictions

In our case, if we are detecting differences in average between $\mathbf{DPDI}_{HQ}^{TE-SA}$ and $\mathbf{DPDI}_{LQ}^{TE-SA}$, the price dispersion index that corresponds to the Baked Beans in the first series is matched with the index that corresponds to the same product in the second sample (and so with all the products).

The Wilconxon test is based in ranking the differences of each pair of observations and then summing the rank of the positive and negative differences. If H_1 is one-sided then the T statistic is given by that sum of ranks that is expected to be smaller if the H_1 were true. If H_1 is two sided then T is whichever of the sum of ranks that turned out to be smaller. If any of the differences between pairs of observations is zero we ignore them and reduce the sample size accordingly. A correction of the T is needed if any tied differences exists. Therefore, in each one of the tables referred to a Wilconxon test, we will state if H_1 is one-sided or two-sided and specify the corrected sample size that we obtain as the difference between the original sample size and the number of zero differences. We reject the null hypothesis of no difference on the average level of the variable under analysis for the matched samples considered if $T \leq$ *critical value*. A complete description of this test can be found in Neave and Worthington [1988]; the critical values of the test in Table D of the same book.

of these two conjectures about the degree of price dispersion for each one of the quality variants. The first one of these tests compares the degree of price dispersion of the two OBP variants: HQ and LQ (**Test II)**. The null hypothesis of this test is based on the cost-asymmetries conjecture, this conjecture does not establish any a priori difference in the degree of price dispersion between the two own-brand product variants (H_0 : *On average, there is no difference between* $\mathbf{DPDI}_{HQ}^{J-K}$ and $\mathbf{DPDI}_{LQ}^{J-K}$). The alternative hypothesis is based on the demand-asymmetries conjecture. This conjecture predicts that price dispersion should be higher for the own-brand product variant with greater possibilities of horizontal product differentiation: the HQ (H_1 : *On average,* $\mathbf{DPDI}_{HQ}^{J-K}$ *is higher than* $\mathbf{DPDI}_{LQ}^{J-K}$). The results of **Test II** (Table 5.1) imply not to reject the null hypothesis for each one of the supermarket pairs. Therefore, they are evidence in favour of the cost-asymmetries hypothesis.

The second test compares the degree of price dispersion of BP and LQ (**Test III**). The null hypothesis of this test is based on the demand-asymmetries conjecture. This conjecture does not establish any a priori difference in the degree of price dispersion of the two quality variants with low possibilities of supermarket product differentiation: BP and LQ (H_0 : *On average, there is no difference between* $\mathbf{DPDI}_{LQ}^{J-K}$ *and* $\mathbf{DPDI}_{BP}^{J-K}$). The alternative hypothesis is based on the cost-asymmetries conjecture that expects price dispersion to be higher for the own-brand product variant (H_1 : *On average,* $\mathbf{DPDI}_{LQ}^{J-K}$ *is higher than* $\mathbf{DPDI}_{BP}^{J-K}$). As it is possible to observe in Table 5.1, the results of the tests for each one of the supermarket pairs (rejection of the null hypothesis) confirm the prediction of the cost-driven hypothesis: on average, $\mathbf{DPDI}_{LQ}^{J-K} > \mathbf{DPDI}_{BP}^{J-K}$

Hence, the results of **Tests I, II** and **III** are evidence in favour of the cost asymmetries hypothesis. Price dispersion is greater for the OBP variants than for the BP variant, and no differences are observed in the degree of price dispersion of the OBP variants. This empirical result is just identical to the prediction of the cost-asymmetries hypothesis. Consequently, we should conclude that the main explanatory factor of the observed degree

of price dispersion is the extent of cost asymmetries across supermarkets for each one of these quality variants.

6. Analysis of the patterns of competition among supermarkets

When considering the supermarket as a multiquality-multiproduct firm it is important to analyse differences in intensity of between supermarket price competition for the different quality variants sold. If price competition is relatively less intense in a quality variant than in the others, and a supermarket fails to develope a range of products for this quality variant, this could result in lower profits.

As a proxy for the degree of between-supermarket price coordination we use the Dynamic Degree of Price Matching Index (**DDPMI**)[16]. We build this index in the following way:

Let be p_{it}^J the price set by supermarket J in fortnight t for product i. Where:

i = 1,...,46 products included in the sample and t = 1,...,27 fortnightly taken price observations

J = TE, SA, SF stores included in the sample.

then if we define:

$$g_{it}^J = \frac{p_{it}^J - p_{it-1}^J}{p_{it-1}^J}$$

the Dynamic Degree of Price Matching between stores J and H (for all $J \neq H$) for product i in fortnight t is calculated as:

$$DDPM_{it}^{J-H} = \begin{cases} 1 \text{ if } g_{it}^J = g_{it}^H = 0 \\ \\ \dfrac{g_{it}^J}{g_{it}^H} \text{ if } \left|g_{it}^H\right| \geq \left|g_{it}^J\right| \\ \\ \dfrac{g_{it}^H}{g_{it}^J} \text{ if } \left|g_{it}^J\right| > \left|g_{it}^H\right| \end{cases}$$

[16] The characteristics of this index are explained in Appendix B.

and the Dynamic Degree of Price Matching Index between supermarkets H and J for product i along the period of the sample as:

$$DDPMI_i^{J-H} = \frac{1}{26}\sum_{t=2}^{27} DDPM_{it}^{J-H}$$

We calculate a **DDPMI** for every product and every supermarket pair (TE-SA, TE-SF, SA-SF). The result is three series of **DDPMIs** for each one of the three quality variants considered in the analysis. For example, the $\mathbf{DDPMI}_{BP}^{TE-SF}$ would contain $\mathbf{DDPMI}_{BP,i}^{TE-SF}$ for $i = 1, ..., 46$.

6.1. Between-supermarket price competition across quality variants

By means of the **DDPMI** we catch the simultaneity in the pricing behaviour between supermarket pairs and the extent of this simultaneity when prices change. High values of this index for a given quality variant can be the result of both simultaneous movements in wholesale prices for all the three supermarkets translated into final prices, and of the recognition of an intense price competition between supermarkets for this quality variant. In order to discriminate between these two possible sources of between-supermarket price coordination, we can compare the predictions arising from them with the real patterns of price coordination for each one of the quality variants.

If price coordination is due to simultaneous movements of wholesale prices translated into final prices the quality variant that should show a greater degree of price coordination is the BP:

$$\mathbf{DDPMI}_{BP}^{J-K} > \mathbf{DDPMI}_{HQ}^{J-K}$$

$$\mathbf{DDPMI}_{BP}^{J-K} > \mathbf{DDPMI}_{LQ}^{J-K}$$

As explained in section 2, the supplier of the BP is the same for all the supermarkets and given the similar bargaining power across the supermarkets considered in the sample, usually wholesale prices for this quality variant will not vary across supermarkets. As

regards the OBP quality variants, their supplier usually varies across supermarkets and therefore wholesale prices for the OBP quality variants will differ most of the times across supermarkets. Notwithstanding, when studying price coordination we are interested not only in wholesale price levels but also in the timing of change of the wholesale price. There exists no a priori reason to think that the BP producers will not change simultaneously the wholesale price offered to the three supermarkets considered in the analysis. However, the existence of heterogeneous OBP suppliers across supermarkets makes much more unlikely the event of simultaneity in the changes of the wholesale price faced by the supermarkets for the products of the two own brand quality variants. Furthermore, supermarkets when negotiating the supplying conditions with the OBP producer use their greater bargaining power to establish the price over a period of time, and the OBP producer bears the risk of changes in the raw material prices.

If price coordination varies with intensity of price competition, we expect price competition to be more intense for those quality variants with less possibilities of supermarket product differentiation: BP and LQ. For the HQs, greater supermarket product differentiation reduces the degree of substitutability and allows to the supermarkets to exercise some power over their price in the market. Hence, between-supermarket price competition should be less intense for the HQ variant than for the variants with less possibilities of supermarket product differentiation: BP and LQ.

$$\begin{aligned} \mathbf{DDPMI}_{BP}^{J-K} &> \mathbf{DDPMI}_{HQ}^{J-K} \\ \mathbf{DDPMI}_{LQ}^{J-K} &> \mathbf{DDPMI}_{HQ}^{J-K} \end{aligned}$$

Summing up, the **DDPMI** could be interpreted as an indicator of price competition if its average level is greater for the two extreme quality variants (BP and LQ) than for the intermediate quality variant (HQ). Nevertheless, if the average level of **DDPMI** is significantly greater for the BP quality variant that for the OBP quality variants then

DDPMI should be interpreted as measuring price coordination due to simultaneity in cost changes.

Both conjectures about the possible sources of between-supermarket price coordination predict that this should be higher for the BP than for HQ. Hence, any attempt to discriminate between these two sources of price coordination must include as a previous step the verification of this prediction. We examine it by means of a one-sided Wilconxon test for Pair Matched Observations (**Test IV**). The alternative hypothesis of this test is just the prediction we are checking:

H_0 : *On average, there is no difference between* $\mathbf{DDPMI}_{BP}^{J-H}$ *and* $\mathbf{DDPMI}_{HQ}^{J-H}$, *i.e. on average, there is no difference in the degree of price coordination between supermarkets J and H for BPs and HQs.*

H_1 : *On average,* $\mathbf{DDPMI}_{BP}^{J-H}$ *is greater than* $\mathbf{DDPMI}_{HQ}^{J-H}$, *i.e. on average, the degree of price coordination between supermarkets J and H for BPs is greater than for HQs.*

The results of the tests comparing the degree of price coordination for BP and HQ are shown in Table 6.1. Observation of this table reveals that on average the degree of price coordination is significantly greater for the BP than for the HQ except for the TE-SA pair and so the common prediction to both theories seems to be true except for this supermarket pair.

In order to discriminate between the two possible conjectures explaining between-supermarket price coordination, we make use of a sequence of two one-sided Wilconxon test for Matched Pair observations. The null and alternative hypotheses of these tests arise from the comparison of the predictions of these two conjectures about the degree of price coordination for each one of the quality variants.

Thus, the first one of these tests compares the degree of between-supermarket price coordination of the two OBP variants (**Test V**). The null hypothesis of this test arises from the conjecture that relates between-supermarket price coordination with simulta-

Table 6.1: Wilconxon Test for Differences in Price Coordination across Quality Variants

Test IV	**BP-HQ**	T	CV 5%	CSS	One/Two Sided
	TE-SA	408	389	46	One-sided
	TE-SF	290.5	389	46	One-sided
	SA-SF	320	389	46	One-sided
Test V	**LQ-HQ**	T	CV 5%		
	TE-SA	335	336	43	One-sided
	TE-SF	317.5	389	46	One-sided
	SA-SF	351.5	389	46	One-sided
Test VI	**BP-LQ**	T	CV 5%		
	TE-SA	490.5	353	44	One-sided
	TE-SF	488	371	45	One-sided
	SA-SF	577	389	46	One-sided

*Critical Value at 5% significance level. Rejection of the H_0 if $T \leq CV$ 5%.
Corrected Sample Size = Sample Size − Number of Zero Differences

neous movements of the wholesale prices, this conjecture does no establish any a priori difference in the degree of between-supermarket price coordination of the two own-brand product variants (H_0 :*On average, there is no difference between* $\mathbf{DDPMI}_{LQ}^{J-K}$ *and* $\mathbf{DDPMI}_{HQ}^{J-K}$). Likewise, the alternative hypothesis arises from the conjecture that relates between-supermarket price coordination with intensity of price competition. Under this conjecture, between-supermarket price coordination should be higher for the LQs than for the HQs (H_1 :*On average,* $\mathbf{DDPMI}_{LQ}^{J-K}$ *is higher than* $\mathbf{DDPMI}_{HQ}^{J-K}$). The results of this test lead to reject the null hypothesis for the three supermarket pairs considered (Table 6.1). On average $\mathbf{DDPMI}_{LQ}^{J-K}$ is higher than $\mathbf{DDPMI}_{HQ}^{J-K}$ and the prediction of the hypothesis that relates the degree of between-supermarket price coordination with intensity of price competition is confirmed.

The second one of the tests compares the degree of price coordination of BPs and LQs (**Test VI)**. The null hypothesis of this test is based on the conjecture that relates between-supermarket price coordination with intensity of price competition, this conjecture does not signal any difference in the degree of between-supermarket price coordination between the two variants with low possibilities of supermarket product differentiation: BP and LQ (H_0 : *On average, there is no difference between* $\mathbf{DDPMI}_{BP}^{J-K}$ *and* $\mathbf{DDPMI}_{LQ}^{J-K}$). The

alternative hypothesis arises from the conjecture that relates between-supermarket price coordination with simultaneous movement of the wholesale costs. This conjecture predicts that price coordination should be higher for the BPs than for the LQs (H_1 : *On average,* $\mathbf{DDPMI}_{BP}^{J-K}$ *is greater than* $\mathbf{DDPMI}_{LQ}^{J-K}$). We can observe in Table 6.1 that the null hypotheses of **Test VI** is not rejected for any of the supermarket pairs. Hence, the results of this test are evidence in favour of the hypothesis relating price coordination with intensity of price competition.

The results of the sequence of test carried out suggest that on average price coordination is higher for BPs and LQs than for HQs. These results confirm the predictions of the hypothesis relating between-supermarket price coordination with intensity of price competition (except in **Test IV** for the pair TE-SA) and advice to interpret the **DDPMI** as an indicator of price competition. Higher levels of between-supermarket price coordination for a given quality variant are the result of higher price competition and not of a similar pattern of wholesale price variation across supermarkets. In general we can say that there exists a negative relationship between supermarket product differentiation possibilities for a given quality variant and between-supermarket price competition for this quality variant. Therefore, horizontal product differentiation can be used by the supermarket to relax price competition.

We can use these findings to explain the paradox "tight competition-high profits" presented in the introduction. We cannot neglect that UK supermarkets are facing tough price competition for those variants with less possibilities of horizontal product differentiation: BP and LQ. However, it is also true that price competition is significantly softer for the HQs, a variant that represents no less than 48% of the sales of the three supermarkets considered in the analysis (see Tables 3.1 and 3.2) and for which the gross profit margins are in average 20-30% higher than for the BPs [Hoch, 1996]. Whereas the main UK supermarkets have been successful in developing a whole range of HQs most of the continental supermarkets have failed in the attempt [Corstjens *et al*, 1995]. Therefore, the

joint consideration of the greater HQ percentage over sales (see table 6.2) and the lower degree of competition for this variant is a key factor to explain the high profits enjoyed by the English supermarkets in comparison with their continental counterparts.

Table 6.2: Own Label Market Share (% in value), 1994.

Country	% in value	Country	% in value
UK	30	Belgium	17
Germany	25	Holland	16
France	21	Spain	8
Denmark	18	Italy	8

Source: The Economist,4th March 1995

7. Concluding Remarks

The empirical confirmation of heterogeneity in the degree of between-supermarket price dispersion and price competition across quality variants sheds light about the importance of considering the supermarket a multiquality firm and analysing its different patterns in the price setting for each one of the quality variants.

Our results indicate that differences in the degree of price dispersion across quality variants are mainly explained by cost-asymmetries. Price dispersion is greater for HQ and LQ variants. The existence of a common BP supplier for all the supermarkets while the OBP supplier varies across supermarkets can explain greater cost asymmetries in the OBP variants.

Independently of differences in the process of formation of the wholesale price between BPs and OBPs, price competition is more intense for those quality variants with less possibilities of supermarket product differentiation, the BP and the LQ variants than for the HQ variant. The main results of our work confirm empirically the effectiveness of supermarket/horizontal product differentiation as an instrument to relax between-supermarket price competition.

We use this finding about heterogeneity of intensity of price competition across quality

variants to explain the existence of the economic paradox "tight competition-high profits" in the UK food retailing system. Whereas it is true that the UK supermarkets are facing tight competition for those quality variants with less possibilities of supermarket product differentiation (BP and LQ), it is also true that competition is significantly softer for the HQ variant. The sales of this quality variant represent no less than 48% of the sales of the three supermarkets considered in the analysis and its gross profit margins are in average 20-30% higher than for the BP. Furthermore, the joint consideration of the greater market share of the HQs in the UK supermarkets and the lower intensity of price competition for this variant provides an innovative explanation of the high profits enjoyed by the UK supermarket in comparison with their continental counterparts.

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8. Appendices

A: Variables description and Descriptive Statistics

Variable	Description	Observations	Mean	Standar
$DPDI_{BP}^{TE-SA}$	Degree of price dispersion TE-SA for BP	46	0.0259	0
$DPDI_{BP}^{TE-SF}$	Degree of price dispersion TE-SF for BP	46	0.0271	0
$DPDI_{BP}^{SA-SF}$	Degree of price dispersion SA-SF for BP	46	0.0294	0
$DPDI_{HQ}^{TE-SA}$	Degree of price dispersion TE-SA for HQ	46	0.0609	0
$DPDI_{HQ}^{TE-SF}$	Degree of price dispersion TE-SF for HQ	46	0.0687	0
$DPDI_{HQ}^{SA-SF}$	Degree of price dispersion SA-SF for HQ	46	0.0693	0
$DPDI_{LQ}^{TE-SA}$	Degree of price dispersion TE-SA for LQ	46	0.0664	0
$DPDI_{LQ}^{TE-SF}$	Degree of price dispersion TE-SF for LQ	46	0.0545	0
$DPDI_{LQ}^{SA-SF}$	Degree of price dispersion SA-SF for LQ	46	0.0634	0
$DDPMI_{BP}^{TE-SA}$	Degree of price coordination TE-SA for BP	46	0.7165	0
$DDPMI_{BP}^{TE-SF}$	Degree of price coordination TE-SF for BP	46	0.7326	0
$DDPMI_{BP}^{SA-SF}$	Degree of price coordination SA-SF for BP	46	0.7081	0
$DDPMI_{HQ}^{TE-SA}$	Degree of price coordination TE-SA for HQ	46	0.6594	0
$DDPMI_{HQ}^{TE-SF}$	Degree of price coordination TE-SF for HQ	46	0.6562	0
$DDPMI_{HQ}^{SA-SF}$	Degree of price coordination SA-SF for HQ	46	0.6264	0
$DDPMI_{LQ}^{TE-SA}$	Degree of price coordination TE-SA for LQ	46	0.7204	0
$DDPMI_{LQ}^{TE-SF}$	Degree of price coordination TE-SF for LQ	46	0.7392	0
$DDPMI_{LQ}^{SA-SF}$	Degree of price coordination SA-SF for LQ	46	0.6935	0

B: Price Dispersion and Price Coordination Indices

The Degree of Price Dispersion Index (DPDI)

We use as proxy for the degree of between-supermarkets price dispersion the **DPDI**. As explained in the main body of the paper, we define the Degree of Price Dispersion between supermarkets J and K for product i in fortnight t as:

$$DPD_{it}^{J-K} = \begin{cases} 1 - \dfrac{p_{it}^{K}}{p_{it}^{J}} \text{ if } p_{it}^{J} \geq p_{it}^{K} \\ \\ 1 - \dfrac{p_{it}^{J}}{p_{it}^{K}} \text{ if } p_{it}^{K} > p_{it}^{J} \end{cases}$$

where:

p_{it}^{J} : is the price of product i in fortnight t at supermarket J.

t =1,...,27 fortnightly taken observations and i = 1,...,46 products

The Degree of Price Dispersion index between supermarkets J and K for product i is defined as:

$$\mathbf{DPDI}_{i}^{J-K} = \frac{1}{27}\sum_{t=1}^{27} DPD_{it}^{J-K}$$

The properties of $\mathbf{DPDI}_{i}^{J-K}$, defined as a mean along the time of $\mathbf{DPD}_{it}^{J-K}$, are determined by the properties of $\mathbf{DPD}_{it}^{J-K}$, so we start by examining the properties of this index,

- If supermarkets J and K are setting the same price for product i in fortnight t then $\mathbf{DPD}_{t}^{J-K}$ takes value 0.
- The larger the difference between the prices set by supermarkets J and K for product i in fortnight t the smaller the ratio $\dfrac{p_{it}^{K}}{p_{it}^{J}}$ (we assume in this example that $p_{it}^{J} \geq p_{it}^{K}$) and the higher $\mathbf{DPD}_{it}^{J-K}$.
- By construction $\mathbf{DPD}_{it}^{J-K}$ cannot take negative values. In the ratio $\dfrac{p_{it}^{K}}{p_{it}^{J}}$, the higher price is always in the denominator and so it cannot be greater than 1.
- For strictly positive prices $\mathbf{DPD}_{it}^{J-K}$ is bounded away from 1 because $\dfrac{p_{it}^{K}}{p_{it}^{J}}$ is bounded away from zero.

Therefore, both $\mathbf{DPD}_{it}^{J-K}$ and $\mathbf{DPDI}_{i}^{J-K}$ take values in the interval [0,1[

The Dynamic Degree of Price Matching Index (DDPMI)

We use as proxy for the degree of between-supermarkets price coordination the **DDPMI**, we built this index in the following way.

Let be p_{it}^{J} the price set by supermarket J in fortnight t for product i. Where:

i = 1,...,46 products included in the sample and t = 1,...,27 fortnightly taken price observations

J = TE, SA, SF stores included in the sample.

then if we define:

$$g_{it}^{J} = \frac{p_{it}^{J} - p_{it-1}^{J}}{p_{it-1}^{J}}$$

the Dynamic Degree of Price Matching between stores J and H (for all $J \neq H$) for product i in fortnight t is calculated as:

$$DDPM_{it}^{J-H} = \begin{cases} 1 \text{ if } g_{it}^{J} = g_{it}^{H} = 0 \\ \\ \dfrac{g_{it}^{J}}{g_{it}^{H}} \text{ if } \left|g_{it}^{H}\right| \geq \left|g_{it}^{J}\right| \\ \\ \dfrac{g_{it}^{H}}{g_{it}^{J}} \text{ if } \left|g_{it}^{J}\right| > \left|g_{it}^{H}\right| \end{cases}$$

and the Dynamic Degree of Price Matching Index between supermarkets H and J for product i along the period of the sample as:

$$DDPMI_{i}^{J-H} = \frac{1}{26}\sum_{t=2}^{27} DDPM_{it}^{J-H}$$

$\mathbf{DDPMI}_{i}^{J-H}$ can be defined as a mean along the time of $\mathbf{DDPM}_{it}^{J-H}$. Hence, from the properties of this last index we can infer directly the properties of the first index,

- If in a given fortnight t both supermarkets J and H increase (decrease) the price of product i, $\mathbf{DDPM}_{it}^{J-H}$ takes a positive value and contributes positively to $\mathbf{DDPMI}_{i}^{J-H}$. This positive value is just reflecting that simultaneous movements of the prices in the same direction at the two supermarkets are interpreted as signal of price coordination and so they should contribute positively to a price coordination index. In the limit, when the rate of growth of the prices is the same in the two supermarket the index takes value 1.

- If in a given fortnight t one of the supermarkets increases its price for product i while the other is decreasing it (or viceversa), $\mathbf{DDPM}_{it}^{J-H}$ takes a negative value and contributes negatively to $\mathbf{DDPMI}_{i}^{J-H}$. We are just catching the idea that divergent price movements should have a negative impact over a price coordination index. In the limit, when the rate of growth of the prices at the two supermarkets is the same but with opposite signs $\mathbf{DDPM}_{it}^{J-H}$ takes value -1.

- When neither supermarket J nor supermarket H change their prices $\mathbf{DDPM}_{it}^{J-H}$ takes value 1. The fact that no one of the supermarkets change the price contributes positively to the price coordination index.

Therefore, both $\mathbf{DDPM}_{it}^{J-H}$ and $\mathbf{DDPMI}_{i}^{J-H}$ take values in the interval [1,-1]. $\mathbf{DDPMI}_{i}^{J-H}$ have the desirable property of catching the simultaneity in the pricing behaviour between supermarket pairs and the extent of this simultaneity when prices change.

C: List of Products in the sample

CANNED PRODUCTS (5)	Baked Beans in Tomato Sauce (Heinz 425 grs)
	Canned Peas (Hartley's Garden Peas)
	Canned Spaghetti (Heinz 200 grs)
	Canned Sweet Corn (Green Giant 340grs)
	Canned Tomatoes (Napolina Chopped Tomatoes 400grs)
HOUSEHOLD SUNDRIES (8)	Bleach (Domestos Bleach 2l)
	Conditioner (Lenor Ultra Plus Fabric Conditioner 2l)
	Kitchen Foil (Bacofoil 450mm x5m)
	Kitchen Towel (Andrex Kitchen Towel Twin Pack)
	Tissues (Ultra 90. Kleenex)
	Toilet Roll (Twin Andrex 4)
	Washing Powder (Ariel Future 2kgs)
	Washing Up Liquid (Fairy Excel Plus 500ml)
ALCOHOL PRODUCTS (1)	Beer (Heineken 330 ml)
GROCERIES (24)	Bread (Mighty White. 800 grs)
	Cat Food (Whiskas 400grs)
	Coffee (Nescafe 200grs)
	Cornflakes (Kellogs Cornflakes 500grs)
	Dog Food (Chum Original Large 400gr)
	Fish Fingers (10 Birds Eye)
	Flour (Homepride Flour 1,5kgs)
	Frozen Peas (Birds Eye 340 grs)
	Ice Cream (Walls Vanilla 750grs)
	Ketchup (Heinz 340grs)
	Margarine (Flora 500 grs)
	Mayonneise (Hellmans 400 grs)
	Oven Chips (McCain 1810 grs)
	Pasta Sauce (Dolmio Pasta sauce Original 475 grs)
	Peach Halves in Natural Juice (Del Monte 415 grs)
	Rice (Uncle Ben Long Grain Rice 1 kg)
	Salad Dressing (Heinz Salad Dressing 285 grs)
	Smoked Back (Danepack 8s)
	Spaghetti (Buitoni 500grs)
	Strawberry Jam (Robertson 454 grs)
	Tea (PG Tips 250 grs)
	Tuna in Oil (John West 200grs)
	Walkers Crisps (Variety Multipack. 6 packs)
	Yogourth (Muller Strawberry 200 grs)
SOFT DRINKS (2)	Coca-Cola (2 l)
	Orange Juice (Del Monte 1 L)
HYGIENIC PRODUCTS (6)	Deodorant (Sure 24 hours Apa 150 ml)
	Hair Shampoo (Timotei Herbs Shampoo 400grs)
	Sanitary towels (Always 16)
	Shower Gel (Imperial Leather 500ml)
	Soap (Dove 250 grs)
	Toothpaste (Colgate Total 100ml)