PRICING BEHAVIOUR AT THE UK SUPERMARKETS: DOES QUALITY MATTER?

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ABSTRACT

We use an econometric model of simultaneous equations with error components to detect the relative importance of between supermarket and within supermarket competition to determine supermarket patterns of price setting for the different categories they sell: brand products, high quality own brand products and low quality own brand products. We design tests to analyze: price leadership for quality categories, relationship between horizontal product differentiation possibilities and intensity of between supermarket competition and price interdependence between quality categories within the supermarket. The multiproduct nature of the supermarket is captured by using a panel of micro level price data. The results confirm that between supermarket price dependence is more important for those categories with less possibilities of horizontal product differentiation: brand products and low quality own brand products. Within supermarket, we found for the intermediate quality that the price influence of its higher quality neighbour (brand product) is greater than that of its lower quality neighbour (low quality own brand product).

KEYWORDS: supermarkets, price competition, product differentiation, panel data
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1. Introduction

The UK supermarkets offer to the consumer three quality variants for most of the products they sell. These are, listed from higher to lower quality: brand products (BP), high quality own brand products (HQ) and low quality own brand products (LQ). When setting the price of a given quality variant of a product, supermarkets have to take into account not only the competition within the supermarket by variants of different quality but also the competition by other supermarkets for the same quality variant.

We consider the price setting decision by the supermarket as the final stage of a multistage game. In the first stage of the game the supermarket takes the long run decision about the range of quality variants to sell and the specific quality of the variants. In the second stage the supermarket sets prices[1]. Most of the studies carried out about retailing ignore either between or within supermarket competition. Bliss (1988) deliberately does not consider the existence of own brand products and therefore the existence of different quality variants competing within the supermarket. However, the increasing market share of sales represented by the own brand products (around 30% of the total sales in value) makes it essential to consider within supermarket competition in the analysis of the supermarket price setting. Mills (1995) sets the conditions under which it is profitable for the supermarket to sell an own brand product in addition to the BP, but does so assuming it to be a multiproduct monopolist. Hence, he ignores the influence of the competition among supermarkets when the supermarket chooses sequentially quality and price. For the purpose of this paper, we consider just the second stage of the game, the pricing decision

We hypothesize that the consumers according to their willigness to pay for quality make an a priori decision about the quality variant to buy before going to the supermarket. However, the final quality variant bought will depend on the comparison in the supermarket of the prices of the different quality variants. As regards the consumers' decision about the store, we believe that the variables influencing this decision vary across consumers depending on the quality variant they are more likely to buy. As BP are homogeneous across supermarkets, for those consumers whose shopping basket is integrated mostly by BP, location and supermarket average level of prices will be the main determinats of the store decision. Because of their character of very basic products the possibilities of supermarket differentiation for the LQ are very small. As a result, location an average level of prices are again the main variables considered when choosing the supermarket. The HQ are the quality variant with

[1]See Moorthy (1988) for an explanation of this multistage game.

greater possibilities of supermarket differentiation, hence those consumers whose shopping basket is mainly composed of HQ products will consider an additional choice variable: the supermarket-characteristics of the products[2].

Therefore, we assume that the supermarket will set prices for the three quality variants to maximize profits taking into account the competition by other supermarkets, i.e. the prices set by other supermarkets.

In this paper, we build an econometric model that allows for control of both the effects of between and within supermarket competition on the price setting of the different quality variants considered. In addition, we analyze relevant points for supermarket pricing policies and competition issues such as:

- the relationship between product differentiation possibilities and price setting interdependence between supermarkets;

- the detection of supermarket price leadership for the different quality variants;

- the interdependence between the price setting of the different quality categories within the supermarket;

- assessing the importance of direct and indirect between supermarket price effects, where we understand as indirect price effect those that take place through the within supermarket price readjustment;

- between vs within supermarket competition as determinants of price setting.

In addition, we explore the role played by the differences in intensity of price competition across quality variants to explain the higher profits of the UK supermarkets with respect to their continental counterparts (The Economist, March, 1995).

The analysis is performed using a panel of micro level price data. These prices were directly taken in three adjacent supermarkets that correspond to the three chains with largest market share in the UK: Tesco, Sainsbury and Safeway. We obtain efficient and consistent estimations of the system of simultaneous equations characterising the supermarket behaviour by using an EC3SLS estimator. In addition the joint consideration of both structural and reduced form parameters of this system of equations allow us to control for both direct and indirect between supermarket price effects.

The empirical work detects the presence of price leadership by Tesco for the high quality own brand products. This fact is not surprising if we consider that in the last years Tesco has taken over Sainsbury's leadership in the sector. As expected, the results confirm the

[2]While we can find Heinz Baked Beans at all the supermarket we only can find Sainsbury Baked Beans with its particular taste and packaging at Saisnbury.

existence of an inverse relationship between horizontal product differentiation possibilities and supermarkets price interdependence. Price interdependence between supermarkets is higher for the categories with less scope for horizontal product differentiation: branded products and low quality own brand products. Within supermarket, it is true for all the three supermarkets that the price setting of the intermediate quality (HQ) is affected more by the price setting of the higher quality (BP) than by the price setting of the lower quality (LQ). This is just reflecting the objective of the supermarkets when introducing the HQ: competing with the BP.

The joint consideration of the high market share of the HQ and the comparative lower degree of between supermarket competition for this category provides an additional explanation to the higher profits of the UK supermarkets in comparison with other EU supermarkets.

The rest of the paper is organized as follows. A brief characterization of the UK retailing system is offered in section 2. Section 3 introduces the theoretical framework. Section 4 describes the data used in the analysis. Section 5 is devoted to the methodology. Section 6 deals with the analysis of the results. Finally the conclusions are presented in Section 7.

2. Brief characterization of the retailing system in the UK

2.1. Characterization of the product spaces of the retailing system in the UK

In all the product spaces analyzed in this work it is possible to distinguish three quality variants: a brand product (BP), a high quality own brand product (HQ) and a low quality own brand product (LQ). The BP also called sometimes National Brand is the product which created the product space. The HQ were first introduced in the supermarkets with the aim of competing against the BP already present in the market. Although in the recession of the late eighties and early nineties supermarkets followed a "value for money" approach with these own brand products, today they are considered of very similar quality to the BP and they are used by the supermarket to create consumer loyalty (Corstjens, Corstjens and Lal, 1995).

Table 2.1: Estimated Own Brand Share of Total Retail Sales (1990-1996)

	1990	1991	1992	1993	1994	1995	1996
Own Brand Share	24.1	25.7	27.8	31.2	32	34.1	36.7

Source: Keynote

High Quality Own Brand Products enjoy a series of advantages from the point of view of the retailer:

- higher gross profit margins than BP, usually 20 or 30 percent higher (Hoch, 1996);

- possibility of using them to create reputation for quality and loyalty to the supermarket (Mills, 1995);

- possibility of using an umbrella brand to advertise them all.

An important consequence of the increasing importance of the HQ's is that the supermarkets have destocked second brands. In most of the product spaces analysed in this empirical work 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 branded products and high quality own brand products.With respect to the LQ, their origin is more recent and it can be related to the introduction into the UK of the discounter formula[3] that offers products of lower quality than the BP or the HQ and at a lower price. The development of this type of retailers represented a new form of competition for the supermarkets, because the segment of most price-conscious consumers might prefer to buy at the discounter even at the risk of a lower quality. The supermarkets faced this new form of competition by launching a new line of low quality or discount own brand products. These products, located on the shelves very close to the BP and HQ of their respective product categories, are given a generic name so as to establish a clear distinction with the HQ.[4] Unlike the HQ, whose package try to mimic that of the brand product, the packaging of the LQ is chosen to reduce production costs.

2.2. Characterization of the outlet structure in the analysis

The analysis considers price competition among the three supermarkets with highest market share in Britain. Listed from the largest to the smallest they are: Tesco (13.7%)[5], Sainsbury (12.5%) and Safeway (7.5%)[6].

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 2.2). The proportion of sales HQ/LQ in the own brand products sales are shown in Table 2.3. When analysing the small share represented by the LQ sales

[3] In particular following entry by discount chains such as Aldi,Netto...

[4] While the HQ are given the generic name of the supermarket the LQ are given a particular name suggesting its competitive price approach: Tesco Value, Sainsbury Essential, Safeway Savers.

[5] Market Shares at December 95.

[6] Other supermarket's market share

	Asda	Somerfield	Kwik Save	Others
MS(%)	7.4	4.3	4.3	50

Source: The Grocer, 14/4/96

over the total own brand sales it should be taken into account that on the one hand these products are much cheaper than the HQ 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 2.2: Own Label Sales in Major Supermarkets (% in value)

	1993	1994	1995	1996
SAFEWAY	36.4	36.9	39.0	41.1
SAINSBURY	54.1	53.8	54.0	53.3
TESCO	42.9	44.9	46	45.1

Source: Marketing Week , 28th June 1996.

Table 2.3: Proportion HQ-LQ in supermarkets sales (% in value). March-96

	Total Own Label	HQ	LQ
SAFEWAY	40.2	36.6.	3.6
SAINSBURY	53.7	52.4	1.3
TESCO	44.8	41.0	3.8

Source: Marketing Week , 28th June 1996

3. Theoretical Framework

A supermarket product faces both competition from variants of different quality as well as competition from horizontally differentiated variants of the same quality. In our study the first form of competition will be referred to as within supermarket competition. The idea is to model the competition that takes place within the supermarket between the quality ranges they sell: BP, HQ and LQ, e.g. DelMonte Orange Juice vs. Sainsbury Orange Juice. The horizontally differentiated competition is understood in terms of competition between quality equivalent products across supermarkets, e.g. Sainsbury orange juice vs. Tesco Orange Juice. This form of competition will be referred to as between supermarket competition. The between supermarket competition assumes quality equivalence of quality ranges across supermarkets.

3.1. Within supermarket competition

In order to analyze within supermarket competition we can consider the supermarket as a multiproduct monopolist (Mills, 1995) selling three variants of the same product with perceived qualities $q_{BP} > q_{HQ} > q_{LQ}$ at prices $p_{BP} > p_{HQ} > p_{LQ}$ .With the aim of simplifying the notation we make $q_{BP} = q_3, q_{HQ} = q_2$ and $q_{LQ} = q_1$.

Let us consider a continuum of consumers identical in tastes but differing in their willingness to pay for quality. Consumers' willingness to pay for quality (t) is assumed to be uniformly distributed[7] with density equal to 1 on [a,b]. The consumer makes indivisible and mutually exclusive purchases among the three goods sold at the supermarket. It means that the consumer buy either exactly one unit of the good or none. Utility from consuming a good of quality q_k is assumed to take the specific form (Gabszewicz et al, 1986) :

$$U_k = q_k(t_k - p_k)$$

the utility obtained for consuming nothing, U_0, is referred as $q_0 t$.[8]

Where, t_k is the willingness to pay for quality such that the consumer with this particular willingness to pay for quality is indifferent between buying the good of quality k and the good of quality $k-1$

$$t_k = \frac{q_k}{q_k - q_{k-1}} p_k - \frac{q_{k-1}}{q_k - q_{k-1}} p_{k-1}$$

We can make use of this willingness to pay-splitting property (everyone within a specific willingness to pay band buys a given quality) to write demands for each one of the qualities as:

$D_{LQ} = t_2 - t_1$
$D_{HQ} = t_3 - t_2$
$D_{BP} = b - t_3$

The profits of the monopolist multiproduct supermarket are given by:

$$\pi_s = D_{LQ}(p_{LQ} - c_{LQ}) + D_{HQ}(p_{HQ} - c_{HQ}) + D_{BP}(p_{BP} - c_{BP})$$

and from the first order conditions we can derive the "within supermarket" best response functions. In these best response functions the price setting for each one of the qualities depends on the price setting for its quality neighbour/neighbours[9].

[7] Although unrealistic it simplifies the theoretical analysis.
[8] U_0 can be interpreted as the utility of the outside option.
[9] The parameters have the following functional form:

$$\gamma_{11} = \frac{1}{2}\left(1 + \frac{q_2}{q_3}\right)$$

$$\gamma_{21} = \frac{1}{2}\left(1 + \frac{q_1 q_3 - q_2^2}{q_2 (q_3 - q_1)}\right), \gamma_{22} = \frac{1}{2}\left(1 + \frac{q_2^2 - q_1 q_3}{q_2 (q_3 - q_1)}\right)$$

$$\gamma_{31} = \frac{1}{2}\left(1 + \frac{q_1^2 - q_1 q_0}{q_1 (q_2 - q_0)}\right)$$

$\frac{\partial \pi_s}{\partial p_{BP}} = 0;\ p_{BP} = \alpha_1 + \gamma_{11} p_{HQ}$
$\frac{\partial \pi_s}{\partial p_{BP}} = 0;\ p_{HQ} = \alpha_2 + \gamma_{21} p_{BP+} \gamma_{22} p_{LQ}$
$\frac{\partial \pi_s}{\partial p_{LQ}} = 0;\ p_{LQ} = \alpha_1 + \gamma_{31} p_{HQ}$

The supermarkets articulate their price-quality space maximization by choosing price for the BP and quality and price for HQ and LQ. For the purpose of this analysis we will take the long run quality decision as given. The existence of brand loyal consumers force the supermarkets to keep in stock BP. The role played by the HQ is to compete against the BP for those consumers located in the upper and medium segment of the market that are willing to exchange the brand name for a price discount buying a product of very similar objective quality. The cost advantage enjoyed by the supermarket as a multiproduct firm (economies of scale in advertising and product development, umbrella branding, etc) allows it to offer a product of similar quality to the BP at lower price.

However, when introducing the LQ the main concern of the supermarkets was not quality but price. In order to fight back against the discounter for the lower and more price sensitive segment of the market, the supermarkets introduced a range of products of manifestly lower quality than BP and HQ sold at a very adjusted price. To avoid the risk of sales cannibalization between the two ranges of own brand products, the supermarkets from the beginning established a clear distinction in terms of quality packaging, advertising and brand name.

On the basis of the different supermarkets' strategies for each one of their own brand products range, we formulate the two following hypothesis:

- BP price setting has greater influence than LQ price setting on HQ price setting, i.e. $\gamma_{21} > \gamma_{22}$;

- within the supermarket, HQ price setting influences BP price setting more than LQ price setting, i.e. $\gamma_{11} > \gamma_{31}$.

3.2. Between supermarket competition

In order to model between supermarket price competition consider three supermarkets (J, K, L) selling horizontally differentiated variants of the same quality of the product i that are strategic complements. If we assume that when setting the price at time t each one of the supermarkets can observe the price of the other supermarkets at period $t-1$, their upward sloping best response functions will take the following form:

$p_{J_{it}} = \alpha_J + \beta_{KJ} p_{K_{it-1}} + \beta_{LJ} p_{L_{it-1}}$
$p_{K_{it}} = \alpha_K + \beta_{JK} p_{J_{it-1}} + \beta_{LK} p_{L_{it-1}}$
$p_{L_{it}} = \alpha_L + \beta_{JL} p_{J_{it-1}} + \beta_{KL} p_{K_{it-1}}$

As we are interested on the influence of between supermarket competition over price setting we need to consider the determinants of the β's more carefully.

One might expect the β's to establish a negative relationship between horizontal product differentiation possibilities and β's relative size. However it is possible that the β's are catching some form of supermarket price leadership. We think that if there exists an explicit dominance of the influence of the price setting by one of the supermarkets over the other supermarket's price setting we should control for the possibility of price leadership[10].

Therefore, the interpretation of the β's should first account for price leadership and then the relationships between horizontal product differentiation possibilities and β's size.

Hence, the next step is to analyze the horizontal product differentiation possibilities for the three groups of products considered (BP, HQ and LQ) to make predictions about the relative magnitudes of the β's.

One first factor that should be taken into account when explaining supermarket possibilities of horizontal product differentiation is that any new service introduced in one of the supermarkets can be quickly and easily copied by other supermarkets[11]. This involves that the final effect of this new service provided by the supermarket will not necessarily be an increase in its market share.(Corstjens, 1995).

The implication of this is that the only possibility of horizontal product differentiation for the highest quality products, the BP, is the location of the supermarket. These products provided with the manufacturer specifications are necessarily homogeneous *per se.*

The own nature of the LQ is limiting their possibilities of horizontal product differentiation. The LQ are basic products addressed to compete in price for the lowest segment of the market. Any additional product refinement would increase the price of the product and contradicts the aim for which they were created.

We find that the range of products that allows for more product differentiation is the intermediate quality range. This range of products destined to compete against the BP for the upper segment of the consumer distribution are not homogeneous across supermarkets. For the HQ, the supermarkets still have the possibility of introducing elements of horizontal product differentiation by means for example of advertising or packaging. In fact, these differences in terms of horizontal product differentiation are used by the supermarket to create loyalty, i.e. we can find DelMonte Orange Juice at all the three supermarkets but Tesco Orange Juice with its particular packaging colours and taste only at Tesco.

[10] A test for controlling for price leadership is designed in Section 6.1.2

[11] Example of this phenomenon in the recent times are the extension of the opening hours or the clerck assistance to pack the shopping.

To understand the difference in the possibilities of introducing horizontal product differentiation for the two categories of own brand products we can appeal to the asymmetric consumer behaviour noted by Katz [1984]. While the upper segment of the distribution of consumers is concerned about the horizontal attributes of the products, the lower is mainly worried about the price. Offering the lowest possible price neglects the introduction of horizontal product differentiation attributes.

To sum up, we believe that in absence of any price leadership phenomenon, the following should be true

For all $K \neq J$ $\beta_{KJ}^{HQ} < \beta_{KJ}^{BP}$
For all $K \neq J$ $\beta_{KJ}^{HQ} < \beta_{KJ}^{LQ}$

It is hypothesized that for any supermarket pair between supermarket competition will influence the price setting of BP and LQ more than the pricing behaviour of the HQ.

3.3. A model of within vs. between supermarket competition

The problem of considering separately *within* and *between* supermarket competition is that we are ignoring the effect of one or the other on supermarket price setting. The next step will consist of defining an econometric model that allows for joint consideration of both forms of competition.

In order to define this model we assume that supermarket J when setting the prices for the three quality variants of product m at time t has perfect information about the prices at time $t-1$ of the three quality variants of product m at supermarkets H and K . Using this information and given qualities, supermarket J choose prices according to the following system of simultaneous equations:

$$p_{J_{it}}^{BP} = \alpha_1^J + \gamma_{11}^J p_{J_{it}}^{HQ} + \beta_{11}^J p_{H_{it-1}}^{BP} + \beta_{12}^J p_{K_{it-1}}^{BP}$$
$$p_{J_{it}}^{HQ} = \alpha_2^J + \gamma_{21}^J p_{J_{it}}^{BP} + \gamma_{22}^J p_{J_{it}}^{LQ} + \beta_{21}^J p_{H_{it-1}}^{HQ} + \beta_{22}^J p_{K_{it-1}}^{HQ}$$
$$p_{J_{it}}^{LQ} = \alpha_3^J + \gamma_{31}^J p_{J_{it}}^{HQ} + \beta_{11}^J p_{H_{it-1}}^{LQ} + \beta_{12}^J p_{K_{it-1}}^{LQ}$$

where:

J, H, K: supermarkets considered in the analysis

$i = 1...n$ products considered in the analysis.

$t = 1...T$ number of periods considered in the analysis

$p_{J_{it}}^{q}$:price of the variant of quality q of product i at supermarket J in period t.

In this system of symultaneous equations we introduce in the right hand side of each equation those price variables directly related with the left hand side variable via between or within supermarket competition.

We will consider as many systems of equations as supermarkets included in the analysis. In this case three.

As the system of symultaneous equations is just identified, we can solve it for p_J^{BP}, p_J^{HQ} and p_J^{LQ} in terms of the prices of the other two supermarkets for the three quality variants in period $t-1$, and we get the following system of reduced form equations[12]:

$$p_{J_{it}}^{BP} = A_1 + \pi_{11} p_{H_{it-1}}^{BP} + \pi_{12} p_{K_{it-1}}^{BP} + \pi_{13} p_{H_{it-1}}^{HQ} + \pi_{14} p_{K_{it-1}}^{HQ} + \pi_{15} p_{H_{it-1}}^{LQ} + \pi_{16} p_{K_{it-1}}^{LQ}$$

$$p_{J_{it}}^{HQ} = A_2 + \pi_{21} p_{H_{it-1}}^{BP} + \pi_{22} p_{K_{it-1}}^{BP} + \pi_{23} p_{H_{it-1}}^{HQ} + \pi_{24} p_{K_{it-1}}^{HQ} + \pi_{25} p_{H_{it-1}}^{LQ} + \pi_{26} p_{K_{it-1}}^{LQ}$$

$$p_{J_{it}}^{LQ} = A_3 + \pi_{31} p_{H_{it-1}}^{BP} + \pi_{32} p_{K_{it-1}}^{BP} + \pi_{33} p_{H_{it-1}}^{HQ} + \pi_{34} p_{K_{it-1}}^{HQ} + \pi_{35} p_{H_{it-1}}^{LQ} + \pi_{36} p_{K_{it-1}}^{LQ}$$

In order to analyse "between supermarket" price effects we have to distinguish between:

1. Price effects between supermarkets-differentiated variants of the same quality. The total price effect of $p_{J_{it-1}}^q$over $p_{H_{it}}^q$ can be divided in direct price effect and indirect price effect. Whereas the direct price effect considers the impact of a change in the price of supermarket J over the price of supermarket H assuming constant all the other prices, the total price effect takes into account that the direct price effect starts a within supermarket price readjustment process for the three quality variants H sells. As the total price effect is given by the correspondent reduced form parameter, and the direct price effect is given by the correspondent structural form parameter, we can calculate the indirect price just as the difference between the two of them.

2. Price effects between supermarket-differentiated variants of different quality. In this case the whole total price effect should be considered as an indirect price effect. A change in the price setting for a given quality variant q_L at supermarket K has an effect over the price for the quality variant q_H at supermarket J only through the direct effect over the price setting of the quality variant q_L sold at the same supermarket, i.e. the whole effect takes place when the supermarket readjusts the prices of the three quality variants. Therefore, the parameters of the reduced form equations that correspond to price effects between supermarket-differentiated variants of different quality should be interpreted as indirect price effects.

[12] The expresion for the reduced form parameters can be seen in Appendix I

As regards the price effects between quality neighbour/neighbours sold at a given supermarket (within supermarket price effects) we obtain them from the correspondent structural form parameters. They should be interpreted as direct or partial effects holding constant all the other prices.

We capture the multiproduct nature of the supermarket[13]by means of a panel data set of supermarket products prices[14].

On the basis of the theoretical considerations made above we are interested in exploring the following questions:

- detection of possible price leaderships for the price setting of the three quality ranges considered;

- between supermarket: analysing the effects of horizontal product differentiation possibilities on price setting interdependence and assessing the importance of direct and indirect price effects;

- within supermarket: exploring the price relationships between the different quality ranges sold by the supermarket;

- controlling for the relative importance of between supermarket vs within supermarket competition for the different quality ranges considered.

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 chain or any other chain geographically located closer to any one of them. Asda, the fourth biggest supermarket in the UK, has a market share (7%) which is closer to the three biggest ones than to the other competitors. However, it was not included in the analysis because it has no superstore in the south of Coventry. The smallest distance between the closest Asda superstore and one of these supermarkets (Safeway) is 7.8 kms. In addition, this Asda superstore is located 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 differ across geographical areas depending upon socieconomic 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.

[13]Multiproduct in the sense that the supermarket sells the three quality variants for a full range of products.

[14]The use of panel data provides additional advantages as controlling for individual hetereogeneity (Hsiao, 1986).

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 were taken.

Table 4.1: Distances between supermarkets (Kms)

	Distance(Kms)
TESCO-SAFEWAY	4.6
TESCO-SAINSBURY	2.3
SAFEWAY-SAINSBURY	2.5

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;

- when possible we tried to select a product from each one of the broad categories considered in the publication "Shaws Guide of Recommended Fair Prices". This publication offers quite an exhaustive classification of the goods sold in the supermarkets informing monthly about their recommended price ;

- 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 III.

5. Methodology

5.1. Estimation Model

The final simultaneous equation model for each one of the supermarket is as follows:

Tesco's Structural System of Simultaneous Equations

$$p^{BP}_{TE_{it}} = \alpha^T_1 + \gamma^T_{11} p^{HQ}_{TE_{it}} + \beta^T_{11} p^{BP}_{SA_{it-1}} + \beta^T_{12} p^{BP}_{SF_{it-1}} + u_1$$
$$p^{HQ}_{TE_{it}} = \alpha^T_2 + \gamma^T_{21} p^{BP}_{TE_{it}} + \gamma^T_{22} p^{LQ}_{TE_{it}} + \beta^T_{21} p^{HQ}_{SA_{it-1}} + \beta^T_{22} p^{HQ}_{SF_{it-1}} + u_2$$
$$p^{LQ}_{TE_{it}} = \alpha^T_3 + \gamma^T_{31} p^{HQ}_{TE_{it}} + \beta^T_{31} p^{LQ}_{SA_{it-1}} + \beta^T_{32} p^{LQ}_{SF_{it-1}} + u_3$$

Sainsbury's Structural Systeme of Simultaneous Equations

$$p^{BP}_{SA_{it}} = \alpha^{SA}_1 + \gamma^{SA}_{11} p^{HQ}_{SA_{it}} + \beta^{SA}_{11} p^{BP}_{TE_{it-1}} + \beta^{SA}_{12} p^{BP}_{SF_{it-1}} + u_1$$
$$p^{HQ}_{SA_{it}} = \alpha^{SA}_2 + \gamma^{SA}_{21} p^{BP}_{SA_{it}} + \gamma^{SA}_{22} p^{LQ}_{SA_{it}} + \beta^{SA}_{21} p^{HQ}_{TE_{it-1}} + \beta^{SA}_{22} p^{HQ}_{SF_{it-1}} + u_2$$
$$p^{LQ}_{SA_{it}} = \alpha^{SA}_3 + \gamma^{SA}_{31} p^{HQ}_{SA_{it}} + \beta^{SA}_{31} p^{LQ}_{TE_{it-1}} + \beta^{SA}_{32} p^{LQ}_{SF_{it-1}} + u_3$$

Safeway's Structural System of Simultaneous Equations

$$p^{BP}_{SF_{it}} = \alpha^{SF}_1 + \gamma^{SF}_{11} p^{HQ}_{SF_{it}} + \beta^{SF}_{11} p^{BP}_{TE_{it-1}} + \beta^{SF}_{12} p^{BP}_{SA_{it-1}} + u_1$$
$$p^{HQ}_{SF_{it}} = \alpha^{SF}_2 + \gamma^{SF}_{21} p^{BP}_{SF_{it}} + \gamma^{SF}_{22} p^{LQ}_{SF_{it}} + \beta^{SF}_{21} p^{HQ}_{TE_{it-1}} + \beta^{SF}_{22} p^{HQ}_{SA_{it-1}} + u_2$$
$$p^{LQ}_{SF_{it}} = \alpha^{SF}_3 + \gamma^{SF}_{31} p^{HQ}_{SF_{it}} + \beta^{SF}_{31} p^{LQ}_{TE_{it-1}} + \beta^{SF}_{32} p^{LQ}_{SA_{it-1}} + u_3$$

Variable definition:

$p^h_{J_{it}}$: logarithm of the price of the quality variant h of product i in week t at supermarket J

J : Supermarkets considered: Tesco, Sainsbury, Safeway.

H : quality variants: Brand Product (BP), High Quality Own Brand Product (HQ) and Low Quality Own Brand Product (LQ).

$i = 1, ..., 46$ products in the sample

$t = 1, ..., 27$ fortnightly observations

When estimating these structural systems of simultaneous equations with panel data we have to choose between a Least Squares with Dummy Variables Method (LSDV) and an error components model (Kinal and Lahiri, 1993). In our case, the use of LSDV would restrict the analysis to the within product dimension of the data and would leave out of the analysis the variation of the data across products. Therefore, in order to obtain more efficient estimators both taking into account the variation of the data across products and the variation of the data within product along time we will use a one-way error components model.

For each one of the equations' disturbances the usual assumptions in a one-way error component model are the following (Baltagi, 1995):

The disturbance of the j equation u_j is given by:

$$u_j = Z_\mu + v_j \text{ for } j = 1,...,M$$

where $Z_\mu = (I_N \quad i_t)$ [15] and $\mu'_j = (\mu_{1j}, \mu_{2j}, ..., \mu_{Nj})$ and

$v'_j = (v_{11j}, v_{12j}, ..., v_{1Tj}, ..., v_{11j}, v_{12j}, ..., v_{1Tj})$ are random vectors with zero mean and covariance matrix

[15] I_N : identity matrix of dimension N
i_t : vector of ones of dimension T
J_T : matrix of ones of dimension T
: Kronecker product

$$_{jl} = E(u_j u_l') = \sigma^2_{\mu_{jl}}(I_N \quad J_T) + \sigma^2_{v_{jl}}(I_N \quad I_T)$$

The variance-covariance matrix for the set of M structural equations is given by:

$$= \Sigma\,(uu') = \Sigma_\mu \quad (I_N \quad J_T) + \Sigma_\mu \quad (I_N \quad I_T)$$

where $u' = (u_1', u_2', ...u_M')$ is a $1\times\ MNT$ vector of disturbances.$\Sigma_\mu = \left[\sigma^2_{\mu_{jl}}\right]$ and $\Sigma_v = \left[\sigma^2_{v_{jl}}\right]$ are $M \times M$ matrices.

5.2. Identification and estimation method

5.2.1. Identification

Before proceeding to estimation we need to study identification.

We assume that at time t supermarket J, when setting the prices for the three quality variants of product m, has perfect information about the prices at time $t-1$ of the three quality variants of product m at supermarkets H and K[16]. Using this information and given qualities, supermarket J chooses prices to maximize profits. With this assumptions, we can consider as exogenous for the estimation of supermarket J the variables representing the prices set by supermarkets H and K at time $t-1$. The simultaneoulsy decided prices of the three quality variants sold at supermarket J are considered as endogenous variables.

Given the identical structure of the structural form of the three systems of simultaneous equations specified above, we will illustrate identification using Tesco's system of simultaneous equations. For this system we consider as endogenous variables: $p^{BP}_{TE_{it}}, p^{HQ}_{TE_{it}}$ and $p^{LQ}_{TE_{it}}$.We consider as exogenous variables for the estimation of Tesco's system: $p^{BP}_{SA_{it-1}}, p^{HQ}_{SA_{it-1}}$, $p^{LQ}_{SA_{it-1}}, p^{BP}_{SF_{it-1}}, p^{HQ}_{SF_{it-1}}$ and $p^{LQ}_{SF_{it-1}}$.

We say that structural equation i is identified if the number of excluded exogenous variables (k_2) is larger than or equal to the number of right hand side endogenous variables (g_1)[17]. All the three equations of the identically structured systems of equations considered above satisfy this condition and therefore we can procede to the estimation.[18]

[16] This seems quite reasonable when we find advertising like this one by Tesco: " *We check more than 18000 prices every week so you do not have to do it*"

[17] Usually the identification condition is expressed as $k_2 > g_1$ for each one of the equations.

[18] It is possible to show that all the three equations of the identically structured systems of simultaneous equations satisfy the rank condition for identification both ex ante and ex post the estimation.

5.2.2. Estimation

Because the endogenous variables included in the right-hand side of each structural equation are correlated with the disturbances, usual OLS procedures provide inconsistent estimates of the structural parameters . We can consider two approaches that solve the inconsistency problem using instrumental variables. Single equation estimation methods like two-stage least squares (2SLS) obtain consistent estimations by estimating each equation separately. System methods of estimation like three-stage least squares (3SLS) that allow to control for relationships between equations provide an increase in efficiency (Greene, 1996).

When using a one-way error component model the equivalent estimation procedures to 2SLS and 3SLS are Error Components two-stage least squares (EC2SLS) and Error Components three-stage least squares (EC3SLS) as described by Baltagi (1995).

Given the efficiency gains of EC3SLS over EC2SLS, we will use EC3SLS as the estimation method. The estimation of the structural system of simultaneous equations provides us with estimators for the direct between and within supermarket price effects.

From the coefficients and variance-covariance matrix obtained in the estimation of the structural system of equations for each one of the supermarkets we can obtain estimations for the reduced form parameters and their correspondent variance-covariance matrix. We will use them to carry out tests concerning between supermarket total price effects.

6. Analysis of the results

The results of the estimations of the three systems of equations both in their structural form and reduced form are included in Appendix II.

It is possible to observe that except one all the coefficients of the structural system of equation describing the supermarkets' pricing behaviour are different from zero at 10% significance level (most of them at 5%). Therefore, both between and within supermarket factors seem to be important to explain supermarkets' pricing behaviour.

We start the interpretation of the result by analysing between suprrmarket competition in section 6.1 and 6.2. In order to check the predictions of the model about between supermarket competition, section 6.1 is devoted to the analysis of between supermarket price effects between supermarket-differentiated variants of the same quality. In section 6.2 we analyse indirect price effects between supermarket-differentiated variants of different quality to assess their relative importance with respect to the price effects between supermarket-differentiated variants of the same quality. Section 6.3 is addressed to test the predictions of the theoretical

model about within supermarket competition and in section 6.4 we compare for each one of the quality variants the importance of within and between supermarket competition as determinants of supermarkets' price setting.

6.1. Between supermarket competition: price effects between supermarket differentiated variants of the same quality

6.1.1. Between supermarket price effects: direct and indirect effects

When analysing between supermarket price effects between variants of the same quality, we can distinguish between the direct price effects caught by the structural form coefficients and the total price effects caught by the reduced form coefficients. The difference between direct price effects and total price effects, the indirect price effects, is given by the price readjustment process that takes place in each supermarket when facing changes in prices by the other supermarkets.

In Table 6.1, we can observe that direct price effects (DPE) always represent at least 90% of the total price effects (TPE) . This evidence suggests us that most of the total effect of a change in the price of the variant q at supermarket J over the price of variant q at supermarket H takes place through the direct change in the price of this quality variant and only a small portion of the change is explained through the price readjustment for the three quality variants that the supermarkets carries out to maximize the price quality space.

Table 6.1: Total and Direct Price Effects

BP	$p^{BP}_{TE_{it}}$		$p^{BP}_{SA_{it}}$		$p^{BP}_{SF_{it}}$	
	TPE	DPE	TPE	DPE	TPE	DPE
$p^{BP}_{TE_{it-1}}$			0.403	0.382	0.449	0.420
$p^{BP}_{SA_{it-1}}$	0.354	0.336			0.366	0.343
$p^{BP}_{SF_{it-1}}$	0.566	0.538	0.471	0.446		
HQ	$p^{HQ}_{TE_{it}}$		$p^{HQ}_{SA_{it}}$		$p^{HQ}_{SF_{it}}$	
	TPE	DPE	TPE	DPE	TPE	DPE
$p^{HQ}_{TE_{it-1}}$			0.516	0.486	0.447	0.414
$p^{HQ}_{SA_{it-1}}$	0.258	0.244			0.123	0.114
$p^{HQ}_{SF_{it-1}}$	0.282	0.267	0.154	0.145		
LQ	$p^{LQ}_{TE_{it}}$		$p^{LQ}_{SA_{it}}$		$p^{LQ}_{SF_{it}}$	
	TPE	DPE	TPE	DPE	TPE	DPE
$p^{LQ}_{TE_{it-1}}$			0.213	0.212	0.500	0.492
$p^{LQ}_{SA_{it-1}}$	0.330	0.328			0.407	0.401
$p^{LQ}_{SF_{it-1}}$	0.581	0.579	0.268	0.266		

As we are interested in the total between supermarket effect once considered price read-

justment within the supermarket, we analyse between supermarket competition using the reduced form coefficients.

6.1.2. Testing for price leadership

Before interpreting the estimated coefficients of the variables representing between supermarket competition as inversely related with the possibilities of horizontal product differentiation for each one of the quality variants considered in the analysis, we should check for price leadership. We understand that price leadership of supermarket J for a given quality variant h exists if both:

- the influence of price setting by supermarket J at time $t-1$ over price setting by supermarket H (K) at time t is significantly greater than the influence of price setting by supermarket $K(H)$ at time $t-1$ over price setting by supermarket $H(K)$ at t . For example, to check for price leadership by Sainsbury in the HQ category we require that : $\widehat{\pi}_{23}^{TE} > \widehat{\pi}_{24}^{TE}$ and $\widehat{\pi}_{24}^{SF} > \widehat{\pi}_{23}^{SF}$

- and the influence of price setting by supermarket $H(K)$ at time $t-1$ over the price setting by supermarket J at time t has to be significantly smaller than the influence of price setting by supermarket J at time $t-1$ over the price setting by supermarket $H(K)$ at time t. For example, to check for price leadership by Sainsbury in the HQ category we require: $\widehat{\pi}_{23}^{SA} < \widehat{\pi}_{23}^{TE}$ and $\widehat{\pi}_{24}^{SA} < \widehat{\pi}_{24}^{SF}$.

The only phenomenon of price leadership that we detect is that by Tesco for the HQ[19]. In order to prove it we can check that Tesco's HQ price setting fulfills the two conditions that we have imposed for price leadership.

Both for Sainsbury's and the Safeway's systems the coefficients that correspond to $p_{TH_{it-1}}$ (0.516 and 0.447) are significantly higher than the coefficients of the other price variables introduced to catch between supermarket[20] competition ($p_{SFH_{it}-1}[0.154]$ and $p_{SAH_{it-1}}[0.123]$ respectively). Therefore, the first of the conditions for price leadership is satisfied.

The fulfillment of the second condition, and so the price leadership by Tesco in the HQ category, is confirmed when comparing the estimated coefficients that correspond to between supermarket competition in Tesco's system with the coefficients of $p_{TH_{it-1}}$in Safeway's and Sainsbury's systems. Both the estimated coefficients for $p_{SAH_{it-1}}$ (0.258) and $p_{SFH_{it-1}}$(0.282) in Tesco's system of simultaneous equations are lower than the coefficients for $p_{TH_{it-1}}$ in the

[19]The statistical analysis of Tesco's HQ price leadership is presented in Appendix I.

[20]From now on, when talking about between supermarket competition if nothing is specified, it should be understood that we are referring to price effects between supermarket differentiated variants of the same quality.

other two systems of simultaneous equations (0.516 in the Sainsbury's system and 0.447 in Safeway's system)

Further insights about a possible Tesco's price leadership in the other quality groups have a negative result. The estimated coefficients representing the between supermarket influence of Tesco's price setting for BP and LQ are not significantly higher than those representing the price settings by Sainsbury and Safeway.

6.1.3. Testing for Between supermarket competition: supermarket differentiated variants of the same quality.

Once tested for price leadership and on the basis of the horizontal product differentiation possibilities for each one of the quality variants, we consider two main predictions to be tested about between supermarket competition for a given supermarket J :

1.- The influence of BP price setting by supermarket $H(K)$ on BP price setting by supermarket J should be greater than the influence of HQ price setting by supermarket $H(K)$ on HQ price setting by supermarket J. As we are testing separately for the influences by supermarkets H and K, we will check this prediction by means of two identical one-sided t-tests with null and alternative hypotheses[21]:

H-Influence	K-influence
$H_{031}^J : \widehat{\varphi}_{31}^J = \widehat{\pi}_{11}^J - \widehat{\pi}_{23}^J = 0$	$H_{032}^J : \widehat{\varphi}_{32}^J = \widehat{\pi}_{12}^J - \widehat{\pi}_{24}^J = 0$
$H_{131}^J : \widehat{\varphi}_{31}^J = \widehat{\pi}_{11}^J - \widehat{\pi}_{23}^J > 0$	$H_{132}^J : \widehat{\varphi}_{32}^J = \widehat{\pi}_{12}^J - \widehat{\pi}_{24}^J > 0$

For example, for the Tesco's system of simultaneous equations we could be testing if Tesco's BP price setting is more influenced by Sainsbury's BP price setting than Tesco's HQ price setting is influenced by Sainsbury's HQ price setting.

2.- The influence of LQ price setting by supermarket $H(K)$ on LQ price setting by supermarket J should be greater than the influence of HQ price setting by supermarket $H(K)$ on HQ price setting by supermarket J. As in predicition 1, the null and alternative hypotheses are:

H-Influence	K-influence
$H_{041}^J : \widehat{\varphi}_{41}^J = \widehat{\pi}_{35}^J - \widehat{\pi}_{23}^J = 0$	$H_{042}^J : \widehat{\varphi}_{42}^J = \widehat{\pi}_{36}^J - \widehat{\pi}_{24}^J = 0$
$H_{141}^J : \widehat{\varphi}_{41}^J = \widehat{\pi}_{35}^J - \widehat{\pi}_{23}^J > 0$	$H_{142}^J : \widehat{\varphi}_{42}^J = \widehat{\pi}_{36}^J - \widehat{\pi}_{24}^J > 0$

For example for Tesco's system of simultaneous equations, we could be testing if Safeways's LQ price setting affects Tesco's LQ price setting more than Safeway's HQ price setting affects

[21] With respect to the subindex of the null and alternative hipotheses. The first number of the subindex is 0 if we are referring to a null hypothesis and 1 if we are referring to an alternative hypothesis. The two following numbers are test indicators. For example, H_{01} is the null hypothesis of test 1.

Table 6.2: Between supermarket price effects between variants of the same quality

	Description	Coefficient	Std.Dev.
TESCO			
$H_{031}: \widehat{\varphi}_{31}^{TE} = 0;\ H_{131}: \widehat{\varphi}_{31}^{TE} > 0$	SA→TE	0.096*	0.036
$H_{032}: \widehat{\varphi}_{32}^{TE} = 0;\ H_{132}: \widehat{\varphi}_{32}^{TE} > 0$	SF→TE	0.284*	0.036
$H_{041}: \widehat{\varphi}_{41}^{TE} = 0;\ H_{141}: \widehat{\varphi}_{41}^{TE} > 0$	SA→TE	0.071*	0.041
$H_{042}: \widehat{\varphi}_{41}^{TE} = 0;\ H_{142}: \widehat{\varphi}_{42}^{TE} > 0$	SF→TE	0.299*	0.037
SAINSBURY			
$H_{031}: \widehat{\varphi}_{31}^{SA} = 0;\ H_{131}: \widehat{\varphi}_{31}^{SA} > 0$	TE→SA	$\widehat{\varphi}_{31}^{SA} < 0$	
$H_{032}: \widehat{\varphi}_{32}^{SA} = 0;\ H_{132}: \widehat{\varphi}_{32}^{SA} > 0$	SF→SA	0.317*	0.045
$H_{041}: \widehat{\varphi}_{41}^{SA} = 0;\ H_{141}: \widehat{\varphi}_{41}^{SA} > 0$	TE→SA	$\widehat{\varphi}_{41}^{SA} < 0$	
$H_{042}: \widehat{\varphi}_{42}^{SA} = 0;\ H_{142}: \widehat{\varphi}_{42}^{SA} > 0$	SF→SA	0.114*	0.035
SAFEWAY			
$H_{031}: \widehat{\varphi}_{31}^{SF} = 0;\ H_{131}: \widehat{\varphi}_{31}^{SF} > 0$	TE→SF	0.001	0.047
$H_{032}: \widehat{\varphi}_{32}^{SF} = 0;\ H_{132}: \widehat{\varphi}_{32}^{SF} > 0$	SA→SF	0.249*	0.045
$H_{041}: \widehat{\varphi}_{41}^{SF} = 0;\ H_{141}: \widehat{\varphi}_{41}^{SF} > 0$	TE→SF	0.053	0.047
$H_{042}: \widehat{\varphi}_{42}^{SF} = 0;\ H_{142}: \widehat{\varphi}_{42}^{SF} > 0$	SA→SF	0.283*	0.044

* Rejection of the null hypothesis (5% level of significance)

Tesco's HQ price setting

We can observe in Table 6.2 that for Tesco the two predictions made about between supermarket competition are confirmed. The influence of between supermarket competition on Tesco's price setting is higher for BP and LQ than for HQ (H_{031}, H_{032} and H_{041}, H_{042} are rejected). Therefore for Tesco, we find an inverse relationship between product differentiation possibilities and between supermarket influence in the patterns of price setting.

Obviously, all the tests concerning Sainsbury and Safeway will be conditioned by Tesco's strong price leadership for the HQ category. Whereas Sainsbury's influence on Safeway's price setting and viceversa confirm the predictions about product differentiation possibilities (H_{032} and H_{042} are rejected), these predictions are not true for those comparisons in which the coeffcients representing Tesco's HQ price leadership are present.

To sum up the analysis of between supermarket competition sheds light on two facts. On the one hand, the recognition of Tesco's leadership for HQ price setting. On the other hand, if we isolate this leadership, the hypothesis of a negative relationship between product differentiation possibilities and intensity of between supermarket price competition seems to be true. Therefore, horizontal product differentiation can be used by the supermarkets to relax price competition.

We can use this result to explain the high profits enjoyed by the UK supermarkets in comparison with their continental counterparts (Table 6.3).

Table 6.3: Profit Margins-Net Profit after tax in per cent (1994)

	1994
Carrefour	1.3
Promodes	0.8
Casino	0.8
Sainsbury	5.2
Tesco	4.8
Safeway	4.8

The traditional factors used to explain this phenomenon are: more advanced supply management systems and the existence of high property costs acting as barriers to entry (The Economist, 1995). However, we believe that this study provides an additional explanation to the higher profits of UK supermarkets even ignoring the traditional factors. Because the market share of HQ in total supermarket sales is greater in the UK than in any other country of the EU (Table 6.4), we believe that the softer intensity of price competition for the HQ is a key factor to understand these higher profits. This seems even more evident if we take into account that gross profit margins are 20-30% higher for the HQ than for the BP (Section 2).

Table 6.4: 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

6.2. Between supermarket competition: price effects between supermarket differentiated variants of different quality.

As a result of the assumptions of the theoretical model, price effects between supermarket-differentiated variants of different quality only take place through price adjustment within the supermarket and therefore they are considered as indirect price effects. For example, a change in p_{TEH} only has an effect over p_{SAB} through the within supermarket price readjustement process that starts the direct price effect of p_{TEH} on p_{SAH}. Whereas the structural coefficients do not catch indirect price effects, these are caught by the reduced form coefficients that correspond to supermarket-differentiated variants of different quality.

Our aim in this section is on the one hand to compare between supermarket price effects between variants of the same quality with between supermarket price effects between variants

of different quality and on the other hand to assess the intensity of between supermarket price effects between variants of different quality across quality variants.

6.2.1. Between supermarket price efffects between variants of the same quality vs. between supermarket price effects between variants of different quality

In general, we expect price effects between supermarket-differentiated variants of the same quality to be no smaller and most of the time greater than price efffects between supermarket-differentiaited variants of different quality.

It is possible to observe in Table 6.5 that the BP confirm this prediction at all the supermarkets. The price efffects within[22] the BP quality variant are greater than the price effects over the BP of any of the other quality variants. Even more, both for Tesco and Sainsbury other supermarkets LQ prices do not have a significant effect over the BP.

Table 6.5: Price effects between supermarket differentiated variants of the same quality versus price effects between supermarket differentiaited variants of different quality

	TESCO		SAINS		SAFE	
	SA→TE	SF→TE	TE→SA	SF→SA	TE→SF	SA→SF
BP-BP vs HQ-BP	0.323*	0.533*	0.317*	0.445*	0.344*	0.337*
	(0.027)	(0.027)	(0.038)	(0.036)	(0.033)	(0.030)
BP-BP vs LQ-BP	-	-	-	-	0.429*	0.350*
	-	-	-	-	(0.028)	(0.028)
HQ-HQ vs BP-HQ	0.110*	0.045	0.389*	0.006	0.323*	0.022
	(0.032)	(0.038)	(0.044)	(0.039)	(0.050)	(0.040)
HQ-HQ vs LQ-HQ	-	-	-	-	0.360*	0.152*
	-	-	-	-	(0.042)	(0.037)
LQ-LQ vs BP-LQ	0.317*	0.561*	0.158*	0.203*	0.489*	0.397*
	(0.035)	(0.028)	(0.031)	(0.031)	(0.030)	(0.037)
LQ-LQ vs HQ-LQ	0.308*	0.558*	–0.011	0.201*	0.459*	0.395*
	(0.037)	(0.029)	(0.037)	(0.032)	(0.035)	(0.037)

* Rejection of the null hypothesis of no difference in price effects (at 5% level of significance)

For the HQ, within quality variant price effects are significantly greater than the effects of LQ prices (other supermarkets LQ prices do not have a significant influence over HQ prices at Tesco and Sainsbury). However, BP price effects $SF_{BP} \rightarrow TE_{HQ}$, $SF_{BP} \rightarrow SA_{HQ}$ and $SA_{BP} \rightarrow SF_{HQ}$ have a similar importance to their respective within quality variants price effects. We find two factors explaining this phenomenon: on the one hand, once we have taken into account Tesco's HQ price leadership, within quality variant price effects are significantly

[22] Price effects between supermarket differentiated variants of the same quality.

smaller for the HQ than for the BP or LQ, signalling a lower degree of price competition in this category; on the other hand, the within supermarket price effects of BP on HQ are greater than the within supermarket price effects of HQ on BP and in the supermarket price readjustment process most of the other supermarket BP price effects act through this within supermarket price effect of BP on HQ.

As regards the LQ, within quality variant price effects are significantly greater than price effects of supermarket differentiated variants of different quality except for the price effect of Tesco's HQ on Sainsbury's LQ. The combination of the direct influence of Tesco's HQ price setting over Sainsbury's HQ price setting (Tesco's HQ price leadership) and the high influence of HQ price setting on LQ price setting within Sainsbury could explain this result.

6.2.2. Price effects between supermarket-differentiated variants of different quality.

With respect to the price effects between supermarket-differentiated variants of different qualities, we expect price effects to be greater between quality neighbours. Therefore, we expect that for a given supermarket price setting, the influence of other supermarkets BP(LQ) price setting will be greater on HQ than in LQ(BP). We can check these predictions by means of two identical structured one sided t-tests.

In the first, we test if the influence of BP price setting by supermarket $H(K)$ is greater on the HQ price setting than on the LQ price setting by supermarket J.

H-Influence	K-influence
$H^J_{051}: \widehat{\varphi}^J_{51} = \widehat{\pi}^J_{21} - \widehat{\pi}^J_{31} = 0$	$H^J_{052}: \widehat{\varphi}^J_{52} = \widehat{\pi}^J_{22} - \widehat{\pi}^J_{32} = 0$
$H^J_{151}: \widehat{\varphi}^J_{51} = \widehat{\pi}^J_{21} - \widehat{\pi}^J_{31} > 0$	$H^J_{152}: \widehat{\varphi}^J_{52} = \widehat{\pi}^J_{22} - \widehat{\pi}^J_{32} > 0$

In the second one, if the influence of LQ price setting by supermarket $H(K)$ is greater on the HQ price setting than on the BP price setting by supermarket J.

H-Influence	K-influence
$H^J_{061}: \widehat{\varphi}^J_{61} = \widehat{\pi}^J_{25} - \widehat{\pi}^J_{15} = 0$	$H^J_{062}: \widehat{\varphi}^J_{62} = \widehat{\pi}^J_{26} - \widehat{\pi}^J_{16} = 0$
$H^J_{161}: \widehat{\varphi}^J_{61} = \widehat{\pi}^J_{25} - \widehat{\pi}^J_{15} > 0$	$H^J_{162}: \widehat{\varphi}^J_{62} = \widehat{\pi}^J_{26} - \widehat{\pi}^J_{16} > 0$

As it is possible to observe in Table 6.6 the results of the first pair of tests confirm the predictions in all the cases: for a given supermarket the influence of other supermarkets' BP price setting is greater over its HQ than over its LQ price setting. Neither BP nor HQ at Tesco and Sainsbury are significantly influenced by LQ prices at the other two supermarkets. For Safeway, the results of the second pair of tests described above confirm the prediction of a greater influence of the LQ price setting by the other two supermarkets over its HQ than over its BP price setting.

Table 6.6: Price effects between supermarket differentiated variants of different quality

	Description	Coefficient	Std.Dev.
Tesco			
$H_{051}: \widehat{\varphi}_{51}^{TE} = 0; H_{151}: \widehat{\varphi}_{51}^{TE} > 0$	SA→TE	0.135*	0.015
$H_{052}: \widehat{\varphi}_{52}^{TE} = 0; H_{152}: \widehat{\varphi}_{52}^{TE} > 0$	SF→TE	0.217*	0.020
$H_{061}: \widehat{\varphi}_{61}^{TE} = 0; H_{161}: \widehat{\varphi}_{61}^{TE} > 0$	SA→TE	-	-
$H_{062}: \widehat{\varphi}_{62}^{TE} = 0; H_{162}: \widehat{\varphi}_{62}^{TE} > 0$	SF→TE	-	-
$H_{071}: \widehat{\varphi}_{71}^{TE} = 0; H_{171}: \widehat{\varphi}_{71}^{TE} \neq 0$	SA→TE	-0.009	0.008
$H_{072}: \widehat{\varphi}_{72}^{TE} = 0; H_{172}: \widehat{\varphi}_{72}^{TE} \neq 0$	SF→TE	-0.010	0.009
Sainsbury			
$H_{051}: \widehat{\varphi}_{51}^{SA} = 0; H_{151}: \widehat{\varphi}_{51}^{SA} > 0$	TE→SA	0.071*	0.010
$H_{052}: \widehat{\varphi}_{52}^{SA} = 0; H_{152}: \widehat{\varphi}_{52}^{SA} > 0$	SF→SA	0.083*	0.012
$H_{061}: \widehat{\varphi}_{61}^{SA} = 0; H_{161}: \widehat{\varphi}_{61}^{SA} > 0$	TE→SA	-	-
$H_{062}: \widehat{\varphi}_{62}^{SA} = 0; H_{162}: \widehat{\varphi}_{62}^{SA} > 0$	SF→SA	-	-
$H_{071}: \widehat{\varphi}_{71}^{SA} = 0; H_{171}: \widehat{\varphi}_{71}^{SA} \neq 0$	TE→SA	0.141*	0.020
$H_{072}: \widehat{\varphi}_{72}^{SA} = 0; H_{172}: \widehat{\varphi}_{72}^{SA} \neq 0$	SF→SA	0.042*	0.010
Safeway			
$H_{051}: \widehat{\varphi}_{51}^{SF} = 0; H_{151}: \widehat{\varphi}_{51}^{SF} > 0$	TE→SF	0.112*	0.020
$H_{052}: \widehat{\varphi}_{52}^{SF} = 0; H_{152}: \widehat{\varphi}_{52}^{SF} > 0$	TE→SF	0.091*	0.016
$H_{061}: \widehat{\varphi}_{61}^{SF} = 0; H_{161}: \widehat{\varphi}_{61}^{SF} > 0$	TE→SF	0.066*	0.012
$H_{062}: \widehat{\varphi}_{62}^{SF} = 0; H_{162}: \widehat{\varphi}_{62}^{SF} > 0$	TE→SF	0.054*	0.011
$H_{071}: \widehat{\varphi}_{71}^{SF} = 0; H_{171}: \widehat{\varphi}_{71}^{SF} \neq 0$	TE→SF	-0.063*	0.018
$H_{072}: \widehat{\varphi}_{72}^{SF} = 0; H_{172}: \widehat{\varphi}_{72}^{SF} \neq 0$	TE→SF	-0.017*	0.006

* Rejection of the null hypothesis at 5% level of significance

Hence, these two pair of tests confirm for all the three supermarkets that between supermarkets BP and LQ price effects are greater over their quality neighbour variant, (HQ), than over the variant for which they do not have a direct within supermarket relationship (LQ and BP respectively)

For the HQ, with two quality neighbours, we are interested in finding out if there is any difference between the influence of HQ price setting by supermarkets $H(K)$ on BP price setting and on HQ price setting by supermarket J. We can test if this difference exists using a two-sided t-test with the following null and alternative hypotheses:

H-Influence	K-influence
$H_{071}^{J}: \widehat{\varphi}_{71}^{J} = \widehat{\pi}_{33}^{J} - \widehat{\pi}_{13}^{J} = 0$	$H_{072}^{J}: \widehat{\varphi}_{72}^{J} = \widehat{\pi}_{34}^{J} - \widehat{\pi}_{14}^{J} = 0$
$H_{171}^{J}: \widehat{\varphi}_{71}^{J} = \widehat{\pi}_{33}^{J} - \widehat{\pi}_{13}^{J} \neq 0$	$H_{172}^{J}: \widehat{\varphi}_{72}^{J} = \widehat{\pi}_{34}^{J} - \widehat{\pi}_{14}^{J} \neq 0$

As we can observe in Table 6.6, the result of this test varies across supermarkets. Although both for Safeway and Sainsbury we reject the null hypothesis, further testing reveals that whereas other supermarkets' HQ price setting affects more Safeways's BP price setting than Safeway's LQ price setting for Sainsbury the opposite is true. For Tesco, the result of the

tests does not show any difference between the influence of other supermarkets HQ price setting over its price setting for BP and LQ. The effect of supermarket J HQ price setting on supermarket H BP and LQ price setting depends on the direct between supermarket price effect of J HQ price setting on H HQ price setting and on the within supermarket H price effect of HQ on BP and LQ . The study of within supermarket price effects in the next section reveals that the main cause of the differences detected here is differences in within supermarket price efffects of HQ over BP and LQ.

6.3. Within supermarket price competition

In order to analyse within supermarket price competition, we consider as an indicator of within supermarket price competition the correspondent reduced form coefficients, i.e. we analyse how the change in the price of one of the quality variants sold by the supermarket affects to the price of its quality neighbour/neighbours assuming that all the other prices remain unchanged.

On the basis of the aims for which the two own brand variants were introduced in the supermarkets (section 3.1), we consider two main predictions to be tested about within supermarket competition:

1.- For a given supermarket J at time t : HQ price setting is influenced more by BP price setting than by LQ price setting.

If we define $\widehat{\gamma}_1^J = \widehat{\gamma}_{21}^J - \widehat{\gamma}_{22}^J$, we can check the prediction above by means of a one-sided t-test with the following null and alternative hypotheses:

$H_{01}^J : \widehat{\gamma}_1^J = 0$

$H_{11}^J : \widehat{\gamma}_1^J > 0$

We can observe in Table 6.7 that the results of this test always lead to reject H_{01}. For all the three supermarkets, the influence of BP price setting on HQ price setting is greater then the influence of LQ price setting on HQ price setting. Within the supermarket, the price setting of the HQ variant mainly depends on the price of the variant they were created to compete with. Price movements by the LQ variant, introduced in the supermarket to fight back the discounter, have a much lower influence.

2.- For a given supermarket J at time t: the influence of HQ price setting on BP price setting should be greater than on LQ price setting. In order to test this prediction we first define $\widehat{\gamma}_2^J = \widehat{\gamma}_{11}^J - \widehat{\gamma}_{31}^J$ and then we carry out a one-sided t-test with the following null and alternative hypotheses:

$H_{02}^J : \widehat{\gamma}_2^J = 0$

$H_{12}^J : \widehat{\gamma}_2^J > 0$

Safeway is the only supermarket that confirms the above prediction. At this supermarket, price adjustment of the HQ variant affects the price setting of the BP variant more than the price setting of the LQ variant. Sainsbury represents the opposite situation: when adjusting prices to maximize the price-quality space, given qualities, the effect of HQ price setting is greater over LQ than over BP price setting. At Tesco, there is no significant difference between the effect on BP and LQ price setting.

Table 6.7: Within supermarket price effects

	Description	Coefficient	Std. Dev.
TESCO			
$H_{01} : \widehat{\gamma}_1^{TE} = 0;\ H_1 : \widehat{\gamma}_1^{TE} > 0$	Tesco	0.374*	0.020
$H_{02} : \widehat{\gamma}_2^{TE} = 0;\ H_2 : \widehat{\gamma}_2^{TE} > 0$	Tesco	0.038	0.033
SAINSBURY			
$H_{01} : \widehat{\gamma}_1^{SA} = 0;\ H_{11} : \widehat{\gamma}_1^{SA} > 0$	Sains.	0.296*	0.056
$H_{02} : \widehat{\gamma}_2^{SA} = 0;\ H_{12} : \widehat{\gamma}_2^{SA} > 0$	Sains.	$\widehat{\gamma}_2^{SA} < 0$	
SAFEWAY			
$H_{01} : \widehat{\gamma}_1^{SF} = 0;\ H_{11} : \widehat{\gamma}_1^{SF} > 0$	Safe.	0.109*	0.056
$H_{02} : \widehat{\gamma}_2^{SF} = 0;\ H_{12} : \widehat{\gamma}_2^{SF} > 0$	Safe	0.142*	0.040

* Rejection of the null hypothesis (5% level of significance)

For Tesco and Sainsbury, the effect of the price choice for BP on the price of the HQ is significantly greater than the effect of HQ on BP. For Safeway no significant difference could be found.[23]. There are two possible explanations for this. On the one hand, while the supermarkets have the total control over the price setting of the HQ, the price setting for the BP is conditioned by the BP manufacturer wholesale price. On the other hand, if consumer distribution is asymmetric (Katz,1984), for the upper segment of the consumer distribution product attributes will be more important than price when making the purchase decision and so there will exist some kind of brand preference (Rao, 1991). If there is brand preference in the upper segment of the consumer distribution the supermarket has an incentive to follow both increases and decreases in the price of the BP caused by an increase/decrease of the wholesale price with similar changes in the HQ. However, the supermarket will have an incentive to increase the price of BP when increasing the price of the HQ but not to decrease

[23] The results of testing :
$H_0 : \widehat{\delta}_w = \widehat{\gamma}_{21}^J - \widehat{\gamma}_{11}^J = 0$
$H_1 : \widehat{\delta}_w = \widehat{\gamma}_{21}^J - \widehat{\gamma}_{11}^J > 0$
for $J = TE, SA, SF$ are the following:

	TE	SA	SF
$\widehat{\delta}_w$	0.2975	0.1453	0.038
Standard Error	(0.0363)	(0.0417)	(0.0435)

the price of the BP when reducing the price of the HQ because it could induce loosing the upper part of the usual HQ purchasers.

With respect to the relationship within supermarket between the price setting for HQ and LQ this varies across supermarkets. The main fact that calls our attention is that the coefficient of $p_{SAH_{it}}$ in the third equation of Sainsbury system (0.4401) is much higher than the correspondent coefficients for Tesco and Safeway systems (0.0829 and 0.0913 respectively). The greater influence of HQ price setting on LQ price setting at Sainsbury could be signalling that this supermarket managers are specially concerned about the possibility of consumers' switching between the HQ and LQ due to changes in HQ prices and so HQ price changes are followed by price changes for the LQ.

6.4. Between vs. within supermarket competition

The objective of this part of the analysis is to detect whether between or within supermarket competition is more important in determining the price setting for each quality variant. As indicators of between and within supermarket competition we use the correspondent structural form coefficients.

Using as example the BP category, we carry out the test of between vs. within supermarket competition in the following way:

1.- Define $\widehat{\delta}_{J-H} = \widehat{\beta}^{J}_{11} - \widehat{\gamma}^{J}_{11}$

2.- If $\widehat{\delta}_{J-H} > 0$ then we test for predominance of between supermarket competition and if $\widehat{\delta}_{J-H} < 0$ then we test for within supermarket dominance[24]. Whereas the null hypotheses of the one-sided t-test used is the same in both cases, the alternative hypotheses are respectively: $\widehat{\delta}_{J-H} > 0$ and $\widehat{\delta}_{J-H} < 0$.[25]

As it is possible to observe in Table 6.8,for the BP in all the three supermarkets the predominance of between supermarket competition is verified. We find two possible factors explaining this behaviour: the first is related with the product homogeneity of BP across supermarkets that limits the possibilities of product differentiation; the second one is related with the influence of wholesale prices on BP price setting but we cannot control for this second factor.

[24] With basis on the results of within supermarket analysis, when testing between vs within supermarket competition for the HQ category, we use as indicator of the influence of within supermarket competition on HQ price setting the estimated coefficent of the BP price setting. It is because within supermarket, BP price setting seems to be the main within supermarket determinant of HQ price setting.

[25] In Table 6.8, B means that the alternative hypotheses of the test is predominance of Between supermarket competition. W means that the alternative hypotheses is the predominance of within supermarket competition.

Table 6.8: Between vs Within Supermarket Price effects

	Description	Coefficient	Std. Dev.
TESCO			
Between vs. Within BP	SA-TE (B)	0.217*	0.035
	SF-SA (B)	0.420*	0.061
Between vs. Within HQ	SA-TE (W)	0.172*	0.048
	SF-TE (W)	0.149*	0.049
Between vs. Within LQ	SA-TE (B)	0.246*	0.053
	SF-TE (B)	0.496*	0.045
SAINSBURY			
Between vs. Within BP	TE-SA (B)	0.215*	0.046
	SF-SA (B)	0.280*	0.053
Between vs. Within HQ	TE-SA (B)	0.174*	0.056
	SF-SA (W)	0.167*	0.059
Between vs. Within LQ	TE-SA (W)	0.228*	0.047
	SF-SA (W)	0.173*	0.052
SAFEWAY			
Between vs. Within BP	TE-SF (B)	0.187*	0.042
	SA-SF (B)	0.109*	0.043
Between vs. Within BP	TE-SF (B)	0.141*	0.070
	SA-SF (W)	0.158*	0.059
Between vs. Within LQ	TE-SF (B)	0.401*	0.049
	SA-SF (B)	0.309*	0.059

* Rejection of the null hypothesis (5% level of significance)

We argued that HQ are the quality group with the biggest possibilities of product differentiation and so it is in this group that we expect the influence of between supermarket competition on price setting to be smaller and more similar to the influence of within supermarket competition. Tesco's simultaneous system of equations confirms this a priori hypothesis: the importance of within supermarket competition is higher than the importance of between supermarket competition in determining the price setting for the HQ. For Sainsbury and Safeway this comparison within-between supermarket competition is conditioned by the Tesco's HQ price leadership identified above. For these two supermarkets the influence of Tesco's HQ price setting is more important than the influence of within supermarket price setting. However, within supermarket price setting dominates over the HQ price setting influence of Sainsbury over Safeway and viceversa. Again, if we isolate Tesco's price leadership our a priori predictions seem to be true.

As argued in section 3.2 , there are not many horizontal product differentiation possibilities for the LQ. Therefore, we expect the importance of between supermarket competition in LQ price setting to be greater than the importance of within supermarket competition. This

prediction is confirmed for both Tesco and Safeway but not for Sainsbury. This Sainsbury's result is caused by the relative high magnitude of the estimated coefficient representing within supermarket competition for the LQ at Sainsbury (0.4401 for $p_{SAH_{it}}$). A possible explanation for this was given in Section 6.3.

To sum up, between supermarket competition predominates over within supermarket competition for the BP. Once accounted for Tesco's HQ price leadership, the opposite is true for the HQ.

7. Conclusions

Our econometric analysis shows the relevance of taking into account both the influences of between and within supermarket competition when analyzing supermarket price setting.

The use of panel data allows the multiproduct-multiquality nature of the supermarket to be taken into account. In addition, the use of EC3SLS estimation provides efficient and consistent estimators of the parameters representing between supermarket and within supermarket price competition.

The analysis performed clearly reveals the price leadership by Tesco in the HQ category. This result is not surprising if we consider that in the last years Tesco has taken over Sainsbury's leadership in the sector. Once this price leadership is taken into account, the results of the between supermarket analysis confirm the predictions of the model. Price interdependence between supermarkets seems to be higher for the quality categories for which the possibilities of product differentiation are smaller: brand products and low quality own brand products. This suggest that supermarkets can relax price competition through horizontal product differentiation.

Whereas in other markets as the car market, (Berry, Levinshon and Pakes, 1995 and Feenstra and Levinshon, 1995) cross price elasticities are lower in the high quality segment, for the supermarkets price interdependence between supermarkets is not necessarily lower in the high quality segment. This is related again to horizontal product differentiation possibilities and its inverse relationship with price competition. While high quality cars offer the biggest possibilities of horizontal product differentiation, in the case of supermarkets it was argued above that the biggest possibilities of horizontal product differentiation do not correspond to the top quality (BP) but rather to the intermediate quality (HQ).

The softer intensity of price competition for the HQ provides an additional explanation to the traditional explanations of the high profits of the UK supermarket in comparison to

their continental counterparts based on the existence of high property costs that act as a barrier to entry and on the use of more advanced supply systems in the UK. This additional explanation is based on the joint consideration of the softer price price competition for the HQ and the fact that the HQ market share over the total supermarket sales is higher in the UK than in any other country of the EU.

Within supermarket results are related to the supermarket perception of the underlying distribution of consumers. The fact that in all the supermarkets HQ are more affected by BP price setting than by LQ price setting suggests that the supermarkets are more concerned about consumers' possible switching between HQ and BP due to a change in BP prices not followed by HQ prices rather than consumers' switching between HQ and LQ due to changes in LQ prices not followed by HQ prices. Across supermarkets, we do not find homogeneity in the influence of HQ price setting on BP and LQ price setting. For Sainsbury, HQ price influence is greater on LQ than on BP; this is signalling that Sainsbury is setting prices assuming that changes in HQ prices will trigger consumers' switch between LQ and HQ goods rather than between BP and HQ goods. Price setting by Safeway seems to be based on the opposite assumptions about consumers' behaviour: when we look at changes in the HQ prices, these affect more BP price setting than LQ price setting. To finish, it seems that Tesco is setting prices as if HQ price changes were triggering similar consumers' switches between HQ-LQ and between HQ-BP.

The analysis of within supermarket vs. between supermarket competition as determinants of price setting reveals that for the BP between supermarket competition is always more important. For the HQ, once accounted for Tesco's price leadership, within supermarket competition is more important. For the LQ, the situation varies across supermarkets: at Tesco and Safeway between supermarket competition is more important; for Sainsbury the opposite is true. Therefore, if we isolate Tesco's HQ price leadership the predominance of between supermarket competition seems to be in general inversely related with the possibilities of horizontal product differentiation but for the LQ at Sainsbury.

Further research should look deeper into the relationship between the underlying consumer distribution perceived by each supermarket and the price interdependence between quality variants within the supermarket.

Appendix I

Reduced Form Parameters (Dropping the J superindex)

1st Equation		2nd Equation		3rd Equation	
A_1	$[\alpha_1(1-\gamma_{22}\gamma_{31})+$ $\alpha_2\gamma_{11}+\alpha_3\gamma_{11}\gamma_{22}]/M$	A_2	$[\alpha_2+\gamma_{21}\alpha_1+$ $\gamma_{22}\alpha_3]/M$	A_3	$[\alpha_3(1-\gamma_{11}\gamma_{21})+$ $\alpha_2\gamma_{31}+\alpha_1\gamma_{21}\gamma_{31}]/M$
π_{11}	$\beta_{11}(1-\gamma_{32}\gamma_{31})/M$	π_{21}	$\gamma_{21}\beta_{11}/M$	π_{31}	$\gamma_{31}\gamma_{21}\beta_{11}/M$
π_{12}	$\beta_{12}(1-\gamma_{32}\gamma_{31})/M$	π_{22}	$\gamma_{21}\beta_{12}/M$	π_{32}	$\gamma_{31}\gamma_{21}\beta_{12}/M$
π_{13}	$\gamma_{11}\beta_{21}/M$	π_{23}	β_{21}/M	π_{33}	$\gamma_{31}\beta_{21}/M$
π_{14}	$\gamma_{11}\beta_{22}/M$	π_{24}	β_{22}/M	π_{34}	$\gamma_{31}\beta_{22}/M$
π_{15}	$\gamma_{11}\gamma_{22}\beta_{31}/M$	π_{25}	$\gamma_{22}\beta_{31}/M$	π_{35}	$\beta_{31}(1-\gamma_{21}\gamma_{11})/M$
π_{16}	$\gamma_{11}\gamma_{22}\beta_{32}/M$	π_{26}	$\gamma_{22}\beta_{32}/M$	π_{36}	$\beta_{32}(1-\gamma_{21}\gamma_{11})/M$

$$M = 1-\gamma_{11}\gamma_{21}-\gamma_{22}\gamma_{31}$$

Appendix II

Table II.1: **EC3SLS estimation results: structural equations**

First Equation

	$p_{TB_{it}}$		$p_{SAB_{it}}$		$p_{SFB_{it}}$
α_1	0.0601*	α_1	0.0627*	α_1	0.0792*
	(0.0230)		(0.0304)		(0.0369)
$p_{TH_{it}}$	0.1190*	$p_{SAH_{it}}$	0.1671*	$p_{SFH_{it}}$	0.2337*
	(0.01792)		(0.0237)		(0.0242)
$p_{SAB_{it-1}}$	0.3363*	$p_{TB_{it-1}}$	0.3825*	$p_{TB_{it-1}}$	0.4203*
	(0.0255)		(0.0330)		(0.0266)
$p_{SFB_{it-1}}$	0.5387*	$p_{SFB_{it-1}}$	0.4469*	$p_{SAB_{it-1}}$	0.3430*
	(0.0258)		(0.0337)		(0.0268)

Second Equation

	$p_{TH_{it}}$		$p_{SAH_{it}}$		$p_{SFH_{it}}$
α_2	0.0301	α_2	0.1144**	α_2	0.1999*
	(0.0718)		(0.0665)		(0.0818)
$p_{TB_{it}}$	0.4165*	$p_{SAB_{it}}$	0.3124*	$p_{SFB_{it}}$	0.2717*
	(0.0345)		(0.0382)		(0.0442)
$p_{TL_{it}}$	0.0420**	$p_{SAL_{it}}$	0.0169	$p_{SFL_{it}}$	0.1628*
	(0.0241)		(0.0299)		(0.0290)
$p_{SAH_{it-1}}$	0.2446*	$p_{TH_{it-1}}$	0.4860*	$p_{TH_{it-1}}$	0.4142*
	(0.0230)		(0.0341)		(0.0365)
$p_{SFH_{it-1}}$	0.2676*	$p_{SFH_{it-1}}$	0.1452*	$p_{SAH_{it-1}}$	0.1140*
	(0.0245)		(0.0274)		(0.0301)

Third Equation

	$p_{TL_{it}}$		$p_{SAL_{it}}$		$p_{SFL_{it}}$
α_3	-0.0593	α_3	0.0772	α_3	0.0158
	(0.0616)		(0.0858)		(0.0662)
$p_{TH_{it}}$	0.0829*	$p_{SAH_{it}}$	0.4401*	$p_{SFH_{it}}$	0.0913*
	(0.0281)		(0.0301)		(0.0321)
$p_{SAL_{it-1}}$	0.3287*	$p_{TL_{it-1}}$	0.2121*	$p_{TL_{it-1}}$	0.4924*
	(0.0325)		(0.0280)		(0.0293)
$p_{SFL_{it-1}}$	0.5794*	$p_{SF_{it-1}}$	0.2665*	$p_{SAL_{it-1}}$	0.4006*
	(0.0265)		(0.0280)		(0.0352)

Standard errors between brackets.

* Significant at 5% level.** Significant at 10% level

	Tesco System	Sainsbury System	Safeway System
$\overline{R}^2$	0.9958	0.9903	0.9815

Table II.2: Estimations of the reduced form coefficients

First Equation

	$p_{TB_{it}}$		$p_{SAB_{it}}$		$p_{SFB_{it}}$
A_1	0.0667*	A_1	0.0868*	A_1	0.1361*
	(0.0243)		(0.0337)		(0.0436)
$p_{SAB_{it-1}}$	0.3539*	$p_{TEB_{it-1}}$	0.4038*	$p_{TEB_{it-1}}$	0.4493*
	(0.0261)		(0.0340)		(0.0274)
$p_{SFB_{it-1}}$	0.5669*	$p_{SFB_{it-1}}$	0.4715*	$p_{SAB_{it-1}}$	0.3667*
	(0.0259)		(0.0345)		(0.0277)
$p_{SAH_{it-1}}$	0.0307*	$p_{TEH_{it-1}}$	0.0863*	$p_{TEH_{it-1}}$	0.0104*
	(0.0054)		(0.0133)		(0.0133)
$p_{SFH_{it-1}}$	0.0336*	$p_{SFH_{it-1}}$	0.0258*	$p_{SAH_{it-1}}$	0.0289*
	(0.0058)		(0.0060)		(0.0081)
$p_{SAL_{it-1}}$	0.0017	$p_{TEL_{it-1}}$	0.0006	$p_{TEL_{it-1}}$	0.0203*
	(0.0010)		(0.0011)		(0.0042)
$p_{SFL_{it-1}}$	0.0031	$p_{SFL_{it-1}}$	0.0008	$p_{SAL_{it-1}}$	0.0165*
	(0.0018)		(0.0014)		(0.0037)

Second Equation

	$p_{TH_{it}}$		$p_{SAH_{it}}$		$p_{SFH_{it}}$
A_2	0.0555	A_2	0.1439*	A_2	0.2431*
	(0.0742)		(0.0703)		(0.0874)
$p_{SAB_{it-1}}$	0.1479*	$p_{TEB_{it-1}}$	0.1273*	$p_{TEB_{it-1}}$	0.1239*
	(0.0165)		(0.0184)		(0.022)
$p_{SFB_{it-1}}$	0.2369*	$p_{SFB_{it-1}}$	0.1484*	$p_{SAB_{it-1}}$	0.1011*
	(0.0227)		(0.0212)		(0.018)
$p_{SAH_{it-1}}$	0.2584*	$p_{TEH_{it-1}}$	0.5168*	$p_{TEH_{it-1}}$	0.4475*
	(0.0238)		(0.0331)		(0.0369)
$p_{SFH_{it-1}}$	0.2826*	$p_{SFH_{it-1}}$	0.1544*	$p_{SAH_{it-1}}$	0.1237*
	(0.0252)		(0.0285)		(0.0323)
$p_{SAL_{it-1}}$	0.0146	$p_{TEL_{it-1}}$	0.0038	$p_{TEL_{it-1}}$	0.0870*
	(0.0087)		(0.0068)		(0.0158)
$p_{SFLQ_{it-1}}$	0.0257	$p_{SFLQ_{it-1}}$	0.0048	$p_{SALQ_{it-1}}$	0.0707*
	(0.0148)		(0.0085)		(0.0141)

Third Equation

	$p_{TEL_{it}}$		$p_{SAL_{it}}$		$p_{SFL_{it}}$
A_3	-0.0547	A_3	0.1405	A_3	0.0380
	(0.0631)		(0.0989)		(0.0636)
$p_{SAB_{it-1}}$	0.0122*	$p_{TEB_{it-1}}$	0.0559*	$p_{TEB_{it-1}}$	0.0113*
	(0.0045)		(0.0093)		(0.0046)
$p_{SFB_{it-1}}$	0.0196*	$p_{SFB_{it-1}}$	0.0653*	$p_{SAB_{it-1}}$	0.0092*
	(0.0072)		(0.0107)		(0.0037)
$p_{SAH_{it-1}}$	0.0214*	$p_{TEH_{it-1}}$	0.2274*	$p_{TEH_{it-1}}$	0.0408*
	(0.0076)		(0.0196)		(0.0149)
$p_{SFH_{it-1}}$	0.0234*	$p_{SFH_{it-1}}$	0.0679*	$p_{SAH_{it-1}}$	0.0110*
	(0.0083)		(0.0134)		(0.0050)
$p_{SAL_{it-1}}$	0.3299*	$p_{TEl_{it-1}}$	0.2138*	$p_{TEL_{it-1}}$	0.5004*
	(0.0325)		(0.0283)		(0.0291)
$p_{SFL_{it-1}}$	0.5815*	$p_{SFL_{it-1}}$	0.2687*	$p_{SAL_{it-1}}$	0.4070*
	(0.0265)		(0.0281)		(0.0351)

* Significant at 5% level

I.1 Testing for Tesco's price leadership in the HQ

1.- The influence of price setting by Tesco at time $t-1$ over price setting by Sainsbury (Safeway) is significantly higher than the influence of price setting by Safeway (Sainsbury) at time $t-1$over price setting by Sainsbury(Safeway) at time t.

1.a Tesco-Sainsbury

$H_0 : \widehat{\lambda}_1 = \widehat{\pi}_{23}^{SA} - \widehat{\pi}_{24}^{SA} = 0$

$H_1 : \widehat{\lambda}_1 = \widehat{\pi}_{23}^{SA} - \widehat{\pi}_{24}^{SA} > 0$

$\widehat{\lambda}_1 = 0.5168 - 0.1544 = 0.3624$

$\widehat{\sigma}_{\widehat{\lambda}_1} = 0.05319$

$$t = \frac{0.3624}{0.05318} = 6.8145 \rightarrow \text{Re } H_0$$

1.b Tesco-Safeway

$H_0 : \widehat{\lambda}_2 = \widehat{\pi}_{23}^{SF} - \widehat{\pi}_{24}^{SF} = 0$

$H_0 : \widehat{\lambda}_2 = \widehat{\pi}_{23}^{SF} - \widehat{\pi}_{24}^{SF} > 0$

$\widehat{\lambda}_2 = 0.4476 - 0.1237 = 0.3239$

$\widehat{\sigma}_{\widehat{\lambda}_2} = 0.060017$

$$t = \frac{0.3229}{0.06001} = 5.396 \rightarrow \text{Re } H_0$$

2.- The influence of price setting by Sainsbury (Safeway) at time $t-1$ over the price setting at Tesco at time t have to be significantly smaller than the influence of price setting by Tesco at $t-1$ over the price setting by Sainsbury (Safeway) at time t.

As we are making here inter-system comparison we cannot perform the statistical test above.

- 2.a TE-SA

$\widehat{\pi}_{23}^{SA}(Sainsbury\ System) - \widehat{\pi}_{23}^{TE}(Tesco\ System) > 0$

0.51686-0.25840=0.25846>0

- 2.b TE-SF

$\widehat{\pi}_{23}^{SF}(Safeway\ System) - \widehat{\pi}_{24}^{TE}(Tesco\ System) > 0$

0.44759-0.28263=0.16496>0

Hence, Tesco HQ price leader has been shown.

Appendix III

	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)
	Conditiones (Lenor Ultra Plus Fabric Conditioner 2l)
	Kitchen Foil (Bacofoil 450mm x5m)
	Kitchen Towel (Andrex Kitchen Towel Twin Pa)
	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)

References

[1] Baltagi B.H. (1995): *Econometric Analysis of Panel Data*, John Wiley and Sons Ltd.

[2] Berry, S. Levinsohn, J. and Pakes, A. (1995): "Automobile Prices in Market Equilibrium', *Econometrica*, 63, pp.841-890.

[3] Bliss, C. (1988): "A Theory of Retail Pricing", *Journal of Industrial Economics*, 36, pp. 375-391.

[4] Cortsjens, J. and M. Corstjens (1995): *Store Wars. The Battle for Selfspace and Mindspace*. John Wiley and Sons Ltd.

[5] Corstjens, J., M. Corstjens and R. Lal (1995): "Retail Competition in the Fast-Moving Consumer Good Industry: The case of France and the UK", *European Management Journal*, 13, pp. 336-373.

[6] Feenstra, R.C. and Levinsohn J.A. (1995): "Estimating Markups and Market Conduct with Multidemensional Product Attributes", *Review of Economic Studies*, 62,pp. 19-52.

[7] Gabszewicz, J.J, A. Shaked, J. Sutton and J.F. Thisse (1986): "Segmenting the Market: The Monopolist's Optimal Product Mix", *Journal of Economic Theory*, 39, pp, 273-289.

[8] Greene, W. H. (1996): *Econometric Analysis. Third Edition*, MacMillan Publishing Company.

[9] Hoch, S. J. (1996):"How Should National Brands to Think about Private Labels".*Sloan Managament Review*, pp. 89-101.

[10] Hsiao, C. (1986): *Analysis of Panel Data*, Cambridge University Press.

[11] Kinal, T. and K. Lahiri (1993): "On the Estimation of Simultaneous Equations Error Components Models with an Application to a model of Developing Country Foreign Trade", *Journal of Applied Econometrics*, 8, pp.81-92.

[12] Katz, M. (1984): "Firm-specific Differentiation and competition among Multiproduct Firms", *Journal of Business*, 57, S149-S166.

[13] Mills, D.E. (1995): "Why Retailers sell Private Labels", *Journal of Economics and Management Studies,* 4, pp.509-528.

[14] Moorthy, K.S. (1988): "Product and price competition in a duopoly", *Marketing Science*, 7, pp.141-168.

[15] Rao R.C. (1991): "Pricing and Promotions in Asymetric Duopolies", *Marketing Science*, Vol. 10, No. 2, pp.131-144.

[16] The Economist (1995): *The Retailing Survey*, 4th March