Market Disequilibria and Their Influence on Small Retail Store Pricing

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ABSTRACT. In this paper a quantitative model is developed to explain differences in average store price levels. We assume that stores may operate under different economic regimes, that is, under excess capacity or excess demand. Prices are expected to be higher than average in case of an excess demand regime and lower in an excess capacity situation. Actual information regarding the regime that applies to each individual store is not available. Therefore, we propose to use a so-called 'switching model' with endogenous regime choice to analyse the store price differences. The model developed in the paper is estimated using four largely differing types of stores from the Dutch retail trade. These samples consist mainly of small stores.

I. Introduction

The purpose of this study is to build a quantitative model explaining average price levels across retail stores. This study is part of a research program to build a complete model of small firm behaviour. For more information on this program see Thurik (1990) in this issue of *Small Business Economics*. Within the context of this program we want to explain average price levels across retail stores. The present study is a further development of Bode *et al.* (1988a), where the explanation of sales was a focal point.

In economic theory it is often assumed that prices are set so that demand equals supply (capacity). There are numerous markets for which this hypothesis holds. As formulated by Nooteboom *et al.* (1988, p. 999), 'There is general agreement that the price-auction view does approach reality in markets of *primary goods* (agricultural produce, raw materials).[1] Reasons for this are their (often) inelastic supply, homogeneity and easily accessible information on volumes and prices'. But they proceed (p. 999), 'Concerning *secondary goods* (manufacturing products), however, there is widespread doubt. Reasons for this are the pervasiveness of monopolistic or oligopolistic elements, product differentiation and non-price competition, opportunities for excess capacity to make supply elastic, and opportunities for other goals of firm than traditional profit maximization'. In the *tertiary sector* (commercial services), and particularly in retailing, which we study in this paper, most elements concerning the secondary goods markets hold. First, retailing does not satisfy the conditions of perfect competition in the sense that firms are price-takers with respect to a homogeneous product. According to Nooteboom (1980, pp. 17–18) retailing 'does not provide a physical product (utility of form) to be shipped to points of sale, but a utility of time and place at a point of sale. In the provision of the utility of place, the numerous retailers serve not one market but a cluster of geographically fragmented markets. In other words: there may be partial spatial monopolies'. Likewise, Hall (1949, pp. 38, 41) believes that 'retail trade is inherently imperfectly competitive' and that 'it is inherent in this situation that conditions of oligopoly may arise at any time'.[2] Second, there are many opportunities for product differentiation in retailing. The 'product' offered in

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retail stores is in fact a 'bundle of services'[3] with several dimensions, such as the price level, proximity, accessibility (parking space), availability of other products, and other aspects of service (helpfulness, opening time, spaciousness, atmosphere, etc.). Third, in conjunction with this, non-price competition plays a role in retail stores. Price is not the only competing instrument; other instruments are advertising, service level, image, assortment composition, etc. Fourth, there are opportunities for excess capacity in retailing to make supply elastic. Once a store is established, store supply capacity is more or less fixed, at least in the short run. This does not imply, however, that stores always operate at this capacity.[4] Actual supply (volume of sales) may vary at or below store capacity depending on the level of demand. Hence, (actual) store supply may be considered elastic to some extent. Fifth, apart from maximizing profits, storekeepers might seek to maximize their sales growth (Wood, 1975). It is even possible that the main goal of some storekeepers is independence and entrepreneurship itself, as part of the nature of small business. This is in accordance with the observation that stores sometimes continue to exist, although operating with gross profits below total operating costs.

Hence, suspicion is aroused that a considerable amount of stores might be in a situation of disequilibrium between store demand and store supply capacity. This suspicion is also supported empirically by a survey held among confectioners' stores.[5] Therefore, there are theoretical as well as empirical grounds that the price-auction equilibrium hypothesis does not hold for the tertiary sector, and retailing in particular.

The above implies that stores may operate under different economic regimes.[6] This is important for analysing differences in average store price levels. We expect prices to be high in the case of excess demand, and low in an excess capacity[7] situation. When modelling the average store price level, we explicity have to take into account the regime that applies to each individual store.

Usually this information is not available in surveys held among stores. The only variable observed is realized value of annual sales, which is the minimum of the (unobserved) values of demand and supply capacity. It will be shown that this problem can be solved by introducing a so-called 'switching model'. In such a model sales are either supply (capacity) determined or demand determined. As we do not know a priori which of the two regimes applies to each of the available observations, we have to include both possibilities in the model, and we leave the data to decide on the most likely regime distribution, i.e., we have a switching model with 'endogenous regime choice'.[8] The model presented not only has merits for retail studies, but also in a wider context of studies concerning markets that are not necessarily in equilibrium.

The outline of this paper is as follows: Section II deals with the conceptual framework of the model. The empirical specification of the model is given in Section III. Section IV deals with the data and the estimation method. The estimation results are presented in Section V and the final section contains a summary and some conclusions.

II. Conceptual framework

We start from the assumption that average store prices (p) arise as a mark-up (ρ) on average unit costs (κ), which include both purchasing costs and operating costs:

$$p = \kappa + \rho. \tag{1}$$

The idea of mark-up pricing is a well known economic concept. It is often practised by businessmen according to several enquiries.[9] Explanations have been given in terms of non-marginalist behaviour. However, mark-up pricing can be shown to be compatible with almost all hypotheses pertaining to explain the behaviour of the firm, such as profit maximization, sales maximization, and Cyert and March's satisficing behavioral model.[10] Nooteboom (1985) developed a mark-up relationship which explains differences in average percentage gross margins *between* different types of stores.[11] In Bode *et al.* (1986) an analogous margin relationship was presented at the level of individual stores *within* a type of stores. In this study the mark-up rule will be used to study *price differences* between the stores *within* a type of store.

The mark-up ρ is assumed to be a function of several variables including the 'tension' on the local market (T):

$$\rho = \rho(T, X^p), \tag{2}$$

where X^p stands for other variables influencing the price level (to be described in the next section). The tension on the market is a function of store demand (q^d) and store supply capacity (q^s):

$$T = T(q^d, q^s). \tag{3}$$

We cannot directly estimate eq. (1) (after substitution of (2) and (3)), because q^d and q^s are latent variables. This problem can be solved by specifying structural equations for the store demand q^d and the store supply capacity q^s, and by defining the realized volume of sales q as the minimum of these two variables:

$$\begin{aligned} q^d &= f^d(p; X^d) \\ q^s &= f^s(X^s) \\ q &= \min(q^d, q^s), \end{aligned} \tag{4}$$

where it is assumed that the price level p has an effect on the store demand, and where X^d and X^s are (other) variables affecting the store demand and the store supply capacity, respectively. These variables will be further specified in the next section. The minimum condition in (4) should be interpreted as follows: the storekeeper tries to meet store demand given his store supply capacity. Therefore, the realized volume of sales q is the minimum of q^d and q^s. Adding the equations (4) to the price equation (1), we now have the following simultaneous model (substituting (2) and (3)):

$$\begin{aligned} p &= \kappa + \rho[T(q^d, q^s), X^p] \\ q^d &= f^d(p; X^d) \\ q^s &= f^s(X^s) \\ q &= \min(q^d, q^s). \end{aligned} \tag{5}$$

The endogenous variables are p, q^d, q^s and q.

III. Empirical specification

In constructing an empirical specification for model (5) that can be used for estimation, we run into measurement problems concerning the theoretical variables p and q. In the cross-section data sets at our disposal these variables are not available; only their product $p \times q$, which equals total value of annual store sales (Q), is observed. Hence, it is necessary to construct some store price index. Following Kooiman *et al.* (1985), we shall approximate the store price level using $1 + M$, where $M = (Q - I)/I$, the fractional gross margin, and where I equals the purchasing value of annual store sales. In doing so, we implicitly assume that the volume of annual store sales q is proportional to the purchasing value of annual store sales I, for

$$Q = pq = (1 + M)I.$$

This assumption is reasonable for our data sets, because the samples of stores were gathered in such a way that groups of stores were obtained that are rather homogeneous with respect to assortment composition, extent of own production, service level and type of organisation.

Let us now specify the equations for demand and supply capacity as necessary ingredients in the price equation. We propose the following specification for the demand equation in (5):[12]

$$\begin{aligned} I^d = \exp[\delta_0]\, A^{\delta_1} S^{\delta_2} C^{\delta_3} \exp[\delta_4 F + \\ + \delta_5(1 + M) + \delta_6 Fs + \delta_7 Rg], \end{aligned} \tag{6}$$

where

- I^d: purchasing value of annual store demand;
- A: store's annual advertising expenses;
- S: service, measured as total labour volume per square metre of total floorspace;
- C: store's selling area;
- F: share in total sales value of a specific assortment group (depending on the type of stores considered; see Table I below);
- Fs: dummy shopping centre; equals one for stores located in large shopping centres, zero elsewhere;
- Rg: dummy region; equals one for stores located in densely populated areas, zero elsewhere.

The specification is multiplicative because we start from the assumption that the effect of one variable on the volume of demand depends on the level of the other variables. The exp(.) function is introduced to avoid that the demand equation becomes zero when F, Fs or Rg is zero. Eq. (6) reflects the idea that the volume of annual store demand is a function of

- *advertising expenses*: Stores with a relatively large amount of advertising expenses will probably achieve a larger volume of demand than comparable stores with no advertising efforts.
- *service*: We expect that the amount of service supplied by personnel affects demand positively.
- *selling area*: A relatively large selling area indicates a wide and deep assortment. A large number of products is offered, which has a positive effect on demand.
- *assortment*: Assortment composition is one of the marketing instruments of a retailer. It is one of the important components determining his commercial efficiency.
- *price level*: The exponential specification $\exp(\delta_5(1 + M))$ is chosen to meet a number of theoretical conditions that a demand-price relationship should satisfy: firstly, quantity demanded is inversely related to price (δ_5 is expected to be negative), which is a reasonable assumption for most goods. Secondly, as the price rises, quantity demanded declines to the extent that the value of quantity demanded (i.e., pq^d) approaches zero. Thirdly, the demand for a store's products is satiable, implying that very low prices (usually zero) result in a zero value of quantity demanded, despite the large volume of quantity demanded q^d. Fourthly, the mathematical specification should be analytically tractable. Therefore, the function should be twice differentiable on the range $p \geqslant 0$. Fifthly, the marginal demand $\partial q^d/\partial p$ should be continuous on the range $p \geqslant 0$. It should become zero both for very low prices (usually zero) and for very high prices[13] (see for example Van de Woestijne, Lamperjee and Coljée, 1986, ch. VI). It follows from (6) that the store price elasticity of demand equals

$$\frac{(1+M)}{I^d}\frac{\partial I^d}{\partial(1+M)} = \delta_5(1+M).$$

- *shopping centre*: If a store is located in a large shopping centre, many potential buyers will be attracted and demand will be higher.
- *population density*: If the store is located in a densely populated area, demand may be higher due to a large number of potential buyers.[14]

The supply capacity equation in (5) is specified as follows:

$$I^s = \exp(\beta_0 + \beta_1 F)H^{\beta_2}\, C^{\pi\varepsilon}(W - C)^{(1-\pi)\varepsilon}, \qquad (7)$$

where

I^s: purchasing value of annual store supply capacity;

H: occupancy costs per square metre of total floorspace;

W: store's total floorspace.

According to this equation store supply capacity is a function of

- *floorspace*: It is assumed that total floorspace, and the partitioning into selling area and remaining space, play a predominant role in the determination of supply capacity. Following Thurik and Koerts (1984a, 1984b) a beta-type specification is chosen.[15] According to (7) supply capacity is zero when selling area C is zero, or when remaining space $W - C$ is zero. The parameter π is called the distribution parameter.[16] It indicates the degree to which an establishment of a certain type of stores is selling area intensive. The parameter ε denotes the scale elasticity if C and $W - C$ are regarded as input factors.
- *assortment*: Our hypothesis is that the assortment composition not only affects store demand, but also the efficiency of floorspace in determining store supply capacity. This hypothesis was not yet considered in our earlier paper. (See for example Bode *et al.*, 1988a, eq. (3), p. 110).
- *occupancy costs per unit of floorspace*: We assume that floorspace is used more efficiently, when occupancy costs are high. Therefore, β_2 is expected to be positive.

Let us now consider the price equation in (5). We have chosen for the following specification:

$$1 + M = \alpha\left[\frac{I+K}{I}\right] + \rho_1(\ln I^d - \ln I^s) + + \rho_2 \ln I + \rho_3 F, \qquad (8)$$

where K stands for total operating costs excluding the reward for storekeeper's labour. In this equation prices are made a function of

- *costs*: According to the mark-up rule prices rise as a mark-up on average unit costs. The total purchasing value of annual sales and the total annual operating costs are divided by the purchasing value of annual sales to approximate these costs per 'volume unit' in stores. According to the mark-up hypothesis the parameter α should be equal to one.
- *tension on the market*: We propose to measure this variable by the difference between ln I^d and ln I^s.[17] Prices are expected to be higher than average in case of an excess demand regime, and lower than average in an excess capacity situation. Therefore, ρ_1 is expected to be positive. Since the tension variable is a function of both demand and supply capacity, prices are indirectly influenced by factors like advertising, service, etc. Eq. (8) implies that storekeepers' pricing behaviour is more sensitive to excess capacity than to excess demand.[18] This sounds realistic from an economic point of view and is comparable to Hall and Hitch (1951, p. 113) who state that 'a few (firms) might charge more in a period of exceptionally high demand, and a greater number ... might charge less in periods of exceptionally depressed demand'.
- *scale*: We want to test whether average price level in large stores differs from that in small stores.
- *assortment*: We want to test whether this variable also has a direct effect on the price level, apart from an indirect effect through ln I^d and ln I^s. For example, price level may be relatively high in supermarkets with a relatively large share of fresh products.

Finally, the equation $q = \min(q^d, q^s)$ in (5) is empirically specified as:

$$I = \min(I^d, I^s). \tag{9}$$

IV. Estimation method and data

Taking logarithms in (6), (7)[19] and (9), adding disturbances to the price equation, the demand equation and the supply capacity equation,[20] and adding observational indices, we derive the following model to be used for parameter estimation:

$$\begin{aligned}
&1 + M_t = \alpha(I_t + K_t)/I_t + \rho_1(\ln I_t^d - \ln I_t^s) + \\
&+ \rho_2 \ln I_t + \rho_3 F_t + \varepsilon_t^p \\
&\ln I_t^d = \delta_0 + \delta_1 \ln A_t + \delta_2 \ln S_t + \delta_3 \ln C_t + \\
&+ \delta_4 F_t + \delta_5(1 + M_t) + \delta_6 Fs_t + \delta_7 Rg_t + \varepsilon_t^d \\
&\ln I_t^s = \beta_0 + \beta_1 F_t + \beta_2 \ln H_t + \pi\varepsilon \ln C_t + \\
&+ (1 - \pi)\varepsilon \ln(W_t - C_t) + \varepsilon_t^s \\
&\ln I_t = \min(\ln I_t^d, \ln I_t^s).
\end{aligned} \tag{10}$$

The endogenous variables in the model are $1 + M_t$, $\ln I_t^d$, $\ln I_t^s$ and $\ln I_t$.

The model is estimated by means of the method of maximum likelihood. As is customary in this type of models, we assume that the disturbances ε_t^p, ε_t^d and ε_t^s are independently normally distributed with zero means and variances σ_p^2, σ_d^2 and σ_s^2, respectively. We refer to the Appendix to this paper for the derivation of the likelihood function $L(\bar{\theta})$ and the so called 'regime probabilities'. A comprehensive quasi-Newton algorithm (routine E04JBF from the NAG Fortran Library) is used for numerical minimization of $-\ln L$ with respect to the parameter vector $\bar{\theta}$. This yields an estimate $\hat{\bar{\theta}}_{ML}$ of $\bar{\theta}$. The asymptotic distribution of the maximum likelihood estimator $\hat{\bar{\theta}}_{ML}$ is multivariate normal with mean $\bar{\theta}$ and covariance matrix Σ. A consistent estimate of Σ is given by $\hat{\Sigma}$, where

$$\hat{\Sigma} = \left(\frac{-\partial^2 \ln L}{\partial\bar{\theta}\partial\bar{\theta}'} \right)^{-1} \text{evaluated at } \bar{\theta} = \hat{\bar{\theta}}_{ML}.$$

Dutch survey data are used, which were collected by the Research Institute for Small and Medium-Sized Business (EIM) in Zoetermeer, the Netherlands. Cross-section samples from four different types of stores are used, viz., supermarkets and superettes (1979), clothes stores (1979), stationary stores (1980) and furniture stores (1981). The surveying field force of EIM defined (after consultation with business representatives) a 'type of stores', and gathered the data in such a way that the samples obtained were rather homogeneous with respect to assortment composition, extent of own production, service level and type of organisation. The surveying field force also defined several assortment components for each type of stores. On the basis of these components we made a partitioning into three assortment groups. Clearly this partitioning depends on the type of store. See Table I.

We claim a substantial coverage of the retail trade because of considerable variation in the types of stores. In Tables II—V the mean, the standard deviation, the minimum and the maximum of the most important variables used are given. The samples mainly consist of small stores. As can be seen from these tables the average value of annual sales (Q) varies from 1,066,000 Dutch guilders (clothes stores) to 2,187,500 Dutch guilders (supermarkets and superettes). One U.S. dollar varied from 2 Dutch guilders in the years 1979—1980 to 2.50 Dutch guilders in 1981.

A further inspection of these tables shows that when the value of annual sales (Q) is taken as a measure of size, the average supermarket or superette is twice as large as the average store in the other store types. But when total floorspace (W) is taken as a size indicator, the average furniture store is about 3.5 times as large as the other three average stores. The average occupancy costs per unit of floorspace (H) is by far the lowest

TABLE I
Definitions of assortment groups

Supermarkets/superettes:	Ass. group 1.	fresh products: meat and meat products, vegetables, bread, etc.
	Ass. group 2.	non-foods
	Ass. group 3.	other foods (except fresh products)
Clothes stores:	Ass. group 1.	children's wear
	Ass. group 2.	men's wear
	Ass. group 3.	women's wear
Stationary stores:	Ass. group 1.	kernel assortment: paper products, writing and drawing-materials, machine supplies, etc.
	Ass. group 2.	complementary assortment: typewriters, calculators, office furniture, etc.
	Ass. group 3.	books, periodicals, newspapers, printing-works, copy service, etc.
Furniture stores:	Ass. group 1.	furniture
	Ass. group 2.	floor-covering, carpets
	Ass. group 3.	other furnishing like curtains

TABLE II
Supermarkets and superettes (208 observations)

Variable	Mean	St. dev.	Minimum value	Maximum value
W	4.14	2.53	0.73	16.90
C	2.87	1.87	0.38	10.00
Q	218.75	148.00	47.50	749.59
H	172.68	51.92	48.40	319.36
A	2.83	2.37	0.03	10.83
S	0.90	0.27	0.32	1.90
M	0.25	0.04	0.15	0.39
F_1	0.40	0.09	0.05	0.63
F_2	0.08	0.03	0.01	0.20
F_3	0.52	0.09	0.32	0.81
K	37.32	26.62	6.65	129.04

Note Table II: Total floorspace (W) and selling area (C) are measured in 100 m^2; annual sales (Q), operating costs (K) and advertising expenses (A) are measured in 10,000 Dutch guilders of the years of collection; the variable H is measured as the annual occupancy costs per square metre of total floorspace; the level of service (S) is measured as the average number of weekly working hours per square metre of total floorspace; and the assortment variables F_i are measured as the value of annual sales of assortment group i (Table I), divided by total value of annual sales ($i = 1, 2, 3$).

TABLE III
Clothes stores (189 observations)

Variable	Mean	St. dev.	Minimum value	Maximum value
W	3.71	2.59	0.65	20.40
C	2.72	1.83	0.50	13.60
Q	106.60	67.76	27.84	495.18
H	223.50	113.05	59.41	980.33
A	3.22	3.31	0.01	24.34
S	0.63	0.23	0.19	1.45
M	0.57	0.12	0.31	1.06
F_1	0.07	0.09	0.00	0.49
F_2	0.43	0.43	0.00	1.00
F_3	0.50	0.44	0.00	1.00
K	32.58	23.98	5.68	168.35

Note Table III: See note Table II.

TABLE IV
Stationary stores (138 observations)

Variable	Mean	St. dev.	Minimum value	Maximum value
W	3.41	2.80	0.52	16.18
C	1.84	1.45	0.25	9.00
Q	117.93	95.80	22.95	611.60
H	190.07	77.07	57.00	444.61
A	1.70	2.14	0.04	17.20
S	0.85	0.39	0.27	2.69
M	0.52	0.14	0.29	0.99
F_1	0.48	0.21	0.17	1.00
F_2	0.16	0.21	0.00	0.74
F_3	0.37	0.29	0.00	0.78
K	31.92	28.35	3.29	189.47

Note Table IV: See note Table II.

TABLE V
Furniture stores (176 observations)

Variable	Mean	St. dev.	Minimum value	Maximum value
W	12.74	10.40	1.20	47.50
C	9.34	7.84	0.50	34.00
Q	121.48	85.62	18.94	420.07
H	100.14	44.96	22.41	256.24
A	4.17	4.63	0.11	26.56
S	0.25	0.17	0.03	0.81
M	0.66	0.12	0.39	1.17
F_1	0.48	0.29	0.00	1.00
F_2	0.23	0.18	0.00	1.00
F_2	0.29	0.20	0.00	1.00
K	43.81	32.06	4.08	169.98

Note Table V: See note Table II.

for furniture stores. This may be due to the fact that a number of these stores are situated far outside the expensive city centres. In the case of stationary stores the average advertising expenses (A) are relatively low. Another feature of the data is the relatively low fractional gross margin (M) for supermarkets and superettes. The average value for the other three store types is about 30 percentage points higher.

V. Estimation results

Table VI shows the parameter estimates of model (10) for the four types of stores. The number of observations, the value of the log likelihood ($\ln L$), as well as the average probability of excess capacity (see Appendix), are also given in this table.

The following conclusions can be drawn regarding the parameters of the price equation:

- $\hat{\alpha}$ (*costs*): $\hat{\alpha}$ does not differ significantly from 1 at a 10% level of significance in all four cases, which means that the mark-up hypothesis is empirically supported.
- $\hat{\rho}_1$ (*tension on the market*): The tension on the market has a significantly positive effect on the average store price level in three out of the four cases. The significant values of $\hat{\rho}_1$ vary from 0.20 for supermarkets and superettes to 0.31 for furniture stores. This means, for example, that the price level in furniture stores that are confronted with a demand that is 10% below store capacity (i.e., $I^d/I^s = 0.9$), is on the average $0.31 * \ln(0.9) = -0.03$ higher (or 0.03 lower) than the price level in furniture stores that operate at store capacity.
- $\hat{\rho}_2$ (*scale*): There appears to be no significant scale effect on the average store price level. An exception should be made with respect to clothes stores, where $\hat{\rho}_2$ is significantly positive. This implies that prices in large clothes stores are somewhat higher on the average than in small clothes stores.
- $\hat{\rho}_3$ (*assortment*): In two out of the four cases the value of $\hat{\rho}_3$ differs significantly from zero. The definition of the assortment variable F depends on the type of stores (see Table I). F equals $F_1/(F_1 + F_2 + F_3)$ for all types of stores. This means that in case of supermarkets and superettes, F is the share of fresh products; in the case of clothes stores, F is the share of children's wear; in the case of stationary stores, F is the share of the products belonging to the kernel assortment; and in the case of furniture stores, F is the share of furniture sales in total value of annual sales. It appears that stores with a relatively large share of fresh products (in the case of supermarkets and superettes), and stores with a relatively large share of products that belong to the kernel assortment (in the case of stationary stores), in general have a higher price level.

TABLE VI
Estimation results of model (10)

Type of stores	Supermarkets and superettes	Clothes stores	Stationary stores	Furniture stores
Price parameters				
α (costs)	1.03	0.91	0.98	1.08
	(0.05)	(0.06)	(0.04)	(0.05)
ρ_1 (tension on market)	0.20	0.23	0.03	0.31
	(0.03)	(0.05)	(0.02)*	(0.04)
ρ_2 (scale)	−0.01	0.06	0.01	0.02
	(0.01)*	(0.02)	(0.01)*	(0.02)*
ρ_3 (assortment)	0.29	0.15	0.19	−0.06
	(0.07)	(0.14)*	(0.04)	(0.06)*
σ_p	0.05	0.12	0.09	0.11
	(0.01)	(0.01)	(0.01)	(0.01)
Demand parameters				
δ_0 (intercept)	13.35	7.54	6.92	7.94
	(1.47)	(0.58)	(0.51)	(0.54)
δ_1 (advertising expenses)	0.08	0.14	0.39	0.27
	(0.03)	(0.04)	(0.06)	(0.04)
δ_2 (service)	0.65	0.93	1.18	0.64
	(0.08)	(0.12)	(0.17)	(0.08)
δ_3 (selling area)	0.96	0.85	0.75	0.61
	(0.06)	(0.08)	(0.13)	(0.06)
δ_4 (assortment)	0.92	−0.49	0.82	0.02
	(0.31)	(0.36)*	(0.32)	(0.14)*
δ_5 (price)	−7.64	−2.37	−1.90	−2.61
	(1.24)	(0.37)	(0.34)	(0.30)
δ_6 (location)	0.03	0.07	−0.00	0.06
	(0.08)*	(0.08)*	(0.10)*	(0.05)*
δ_7 (region)	—	—	−0.05	0.25
			(0.11)*	(0.06)
σ_d	0.29	0.35	0.32	0.31
	(0.03)	(0.04)	(0.04)	(0.03)
Supply parameters				
β_0 (intercept)	0.71	0.14	3.15	0.46
	(0.26)	(0.41)*	(0.60)	(0.26)
β_1 (assortment)	1.68	0.06	−0.66	−0.46
	(0.20)	(0.33)*	(0.22)	(0.13)
β_2 (occupancy costs)	0.67	0.71	0.28	0.60
	(0.05)	(0.08)	(0.11)	(0.06)
π (distribution parameter)	0.72	0.70	0.38	0.77
	(0.04)	(0.04)	(0.09)	(0.03)
ε (homogeneity parameter)	0.82	0.93	0.82	0.96
	(0.03)	(0.06)	(0.09)	(0.06)
σ_s	0.07	0.18	0.26	0.15
	(0.03)	(0.02)	(0.03)	(0.02)
Number of observations	208	189	138	176
ln L (log likelihood)	506.64	202.58	141.99	217.07
Average Pr[Exc. Capacity]	0.91	0.65	0.52	0.82

Note Table VI: An asterisk (*) is printed next to the standard error of $\hat{\theta}$ if $|\hat{\theta}| < 1.645\ \hat{\sigma}(\hat{\theta})$, that is, if $\hat{\theta}$ does not significantly differ from zero at a 10% level of significance.

Considering the parameters of the demand equation the most important results are:

— $\hat{\delta}_5$ (*price*): The price level has a significantly negative effect on demand. The parameter estimates imply for the average stores the following values of the estimated price elasticity of demand:[21]

  −9.55 (supermarkets and superettes)

  −3.72 (clothes stores)

  −2.89 (stationary stores)

  −4.33 (furniture stores)

  At first these values seem to be rather high in absolute value, but one has to bear in mind that this may be due to the fact that $1 + M$ is used as a proxy for prices. It appears that consumers, in general, are more price sensitive with respect to food products than with respect to the products sold in the other types of stores considered.

— $\hat{\delta}_1$ (*advertising*): Advertising expenses have a significantly positive effect on store demand. The estimated values are in fact elasticities of I^d with respect to the advertising variable. Especially for stationary stores and furniture stores the impact of advertising expenses is relatively large.[22]

— $\hat{\delta}_2$ (*service*): The estimated elasticities of I^d with respect to service level are significantly positive for all types of stores considered. The values vary from 0.64 for furniture stores to 1.18 for stationary stores.

Finally, the following can be concluded considering the parameters of the supply capacity equation:

— $\hat{\beta}_2$ (*occupancy costs*): The estimates for β_2 are all significantly positive. Higher occupancy costs per unit of floorspace result in higher efficiency of the use of floorspace. The values of $\hat{\beta}_2$ are of the same order of magnitude, except for stationary stores where $\hat{\beta}_2$ is considerably lower. This means that in stationary stores, occupancy cost differences result in smaller efficiency differences than in the remaining types of stores.

— $\hat{\pi}$ (*distribution parameter*): For three out of the four types of stores considered, $\hat{\pi}$ is significantly larger than 0.5, which indicates that the selling area is relatively more important than remaining space in the determination of supply capacity. For stationary stores the value of $\hat{\pi}$ is 0.38. This may be caused by the repairing and other service activities performed in this type of stores.[23]

— $\hat{\varepsilon}$ (*homogeneity parameter*): The values of $\hat{\varepsilon}$ vary from 0.82 to 0.96. This indicates that there are no economies of scale in the types of stores considered. However, in two cases the parameter estimate is not significantly smaller than 1.

It is interesting to compare the parameter estimates to those in our earlier paper where the focus was on explaining sales (see Bode *et al.*, 1988a, p. 113). Clearly the results can only be compared allowing for differences between the model specifications. It appears that the price elasticity estimates in Bode *et al.* (1988a), $\hat{\delta}_2$, are generally lower in absolute value than the estimated price elasticities for the average stores presented above. There are no significant differences between both studies concerning the effect of occupancy costs on store supply capacity, although for stationary stores the effect has decreased considerably. The distribution parameter estimates, $\hat{\pi}$, do not differ significantly between both studies. Finally, the homogeneity parameter estimates, $\hat{\varepsilon}$, are also comparable, although significant differences between the results in Bode *et al.* (1988a) and the present study exist for supermarkets and superettes and for furniture stores.

VI. Summary

In this paper a quantitative model to explain differences in average store price levels was developed. We assumed that stores may operate under different economic regimes, that is, under excess capacity or excess demand. Prices are expected to be higher than average in the case of an excess demand regime and lower than average in an excess capacity situation. Actual information regarding the regime that applies to each individual store was not available. Therefore, we proposed to use a so-called 'switching model' with endogenous regime choice to analyse the store price differences. The model developed in this paper was estimated on four largely differing types of stores from Dutch retail trade.

The main conclusions of this study are:

- A switching model seems to be a good instrument to analyse store price differences properly. In addition, the effects of several marketing mix variables on the volume of demand, are better estimated using a switching model than using a classical regression approach.[24]
- Support is found for the presence of mark-up pricing practices in retail stores.
- The 'tension' on the local market (measured by the difference of the volumes of store demand and store supply capacity) has a (significantly) positive effect on the store price level.
- According to the estimation results of this paper, there are virtually no effects of scale on the store price level.

A further step has been made in the development of a micro model of small business. The causal model described in Thurik (1990) in this issue of the *Journal* has been given a specified interpretation and satisfactory results have been obtained both statistically and in terms of plausibility. The results will be used in further developing a model of small firm diagnostics in retailing.

Appendix. Derivation of the likelihood function

Let us rewrite (10) as follows:

$$\begin{aligned}\varepsilon^p &= 1 + M - \rho_1(\ln I^d - \ln I^s) - \\ &\quad - \rho_2 \ln I - R^p(X^p)\\ \varepsilon^d &= \ln I^d - \delta_5(1+M) - R^d(X^d)\\ \varepsilon^s &= \ln I^s - R^s(X^s)\\ \ln I &= \min(\ln I^d, \ln I^s),\end{aligned}$$

where the observational indices are left out for convenience sake, and where $R^p(X^p)$, $R^d(X^d)$ and $R^s(X^s)$ stand for the exogenous parts of the model equations, respectively.[25] Let $f(\varepsilon^p, \varepsilon^d, \varepsilon^s)$ be the joint density function of ε^p, ε^d and ε^s, and $g(1 + M, \ln I^d, \ln I^s)$ the joint density function of $1 + M$, $\ln I^d$ and $\ln I^s$ derived of it. Then the joint density of $1 + M$ and $\ln I$ reads:[26]

$$\begin{aligned}h(1+M, \ln I) &= h^{es}(1+M, \ln I) + \\ &\quad + h^{ed}(1+M, \ln I), \qquad \text{(A1)}\end{aligned}$$

where

$$h^{es}(1+M, \ln I) = \int_{\ln I}^{\infty} g(1+M, \ln I, \ln I^s)\, d\ln I^s$$

and

$$h^{ed}(1+M, \ln I) = \int_{\ln I}^{\infty} g(1+M, \ln I^d, \ln I)\, d\ln I^d.$$

It can be shown that in our situation (where ε^p, ε^d and ε^s are independently normally distributed) $h^{es}(1 + M, \ln I)$ and $h^{ed}(1 + M, \ln I)$ equal:[27]

$$\begin{aligned}h^{es}(1+M, \ln I) &= \frac{|1-\delta_5(\rho_1+\rho_2)|}{(2\pi A^{es})^{1/2}\sigma_p\sigma_s} \times\\ &\times \exp\left\{-1/2\left[C^{es} - \frac{(B^{es})^2}{A^{es}}\right]\right\} \times\\ &\times n(\ln I - \delta_5(1+M) - R^d(X^d); \sigma_d) \times\\ &\times \left\{1 - N\left((A^{es})^{1/2}\left[\ln I - \frac{B^{es}}{A^{es}}\right]\right)\right\} \qquad \text{(A2a)}\end{aligned}$$

and

$$\begin{aligned}h^{ed}(1+M, \ln I) &= \frac{|1-\delta_5\rho_1|}{(2\pi A^{ed})^{1/2}\sigma_p\sigma_d} \times\\ &\times \exp\left\{-1/2\left[C^{ed} - \frac{(B^{ed})^2}{A^{ed}}\right]\right\} \times\\ &\times n(\ln I - R^s(X^s); \sigma_s) \times\\ &\times \left\{1 - N\left((A^{ed})^{1/2}\left[\ln I - \frac{B^{ed}}{A^{ed}}\right]\right)\right\}, \qquad \text{(A2b)}\end{aligned}$$

respectively, where $n(.; \sigma)$ stands for the normal density function with zero mean and variance σ^2; where $N(.)$ is the cumulative standardized normal distribution function; and where

$$\begin{aligned}A^{es} &= \frac{\rho_1^2}{\sigma_p^2} + \frac{1}{\sigma_s^2}\\ B^{es} &= -\frac{\rho_1[1+M-(\rho_1+\rho_2)\ln I - R^p(X^p)]}{\sigma_p^2} + \\ &\quad + \frac{R^s(X^s)}{\sigma_s^2}\end{aligned}$$

$$C^{es} = \frac{[1 + M - (\rho_1 + \rho_2)\ln I - R^p(X^p)]^2}{\sigma_p^2} + \\ + \frac{[R^s(X^s)]^2}{\sigma_s^2}$$

and

$$A^{ed} = \frac{\rho_1^2}{\sigma_p^2} + \frac{1}{\sigma_d^2}$$

$$B^{ed} = \frac{\rho_1[1 + M + (\rho_1 - \rho_2)\ln I - R^p(X^p)]}{\sigma_p^2} + \\ + \frac{\delta_5(1 + M) + R^d(X^d)}{\sigma_d^2}$$

$$C^{ed} = \frac{[1 + M + (\rho_1 - \rho_2)\ln I - R^p(X^p)]^2}{\sigma_p^2} + \\ + \frac{[\delta_5(1 + M) + R^d(X^d)]^2}{\sigma_d^2}.$$

The likelihood function $L(\bar{\theta})$ now is

$$L(\bar{\theta}) = \prod_t h(1 + M_t, \ln I_t) = \\ = \prod_t [h^{es}(1 + M_t, \ln I_t) + \\ + h^{ed}(1 + M_i, \ln I_i)]. \qquad \text{(A3)}$$

The regime probabilities according to Kiefer (1980) can be derived as:[28]

$$\Pr[\text{Excess Capacity}]_t = \\ \Pr[\ln I_t^d \leqslant \ln I_t^s \mid 1 + M_t, \ln I_t] = \\ = \frac{h^{es}(1 + M_t, \ln I_t)}{h(1 + M_t, \ln I_t)}$$

and

$$\Pr[\text{Excess Demand}]_t = \\ = \Pr[\ln I_t^s \leqslant \ln I_t^d \mid 1 + M_t, \ln I_t] = \\ = \frac{h^{ed}(1 + M_t, \ln I_t)}{h(1 + M_t, \ln I_t)}.$$

The likelihood function (A3) tends to go to infinity for certain parameter values. This problem, which is dealt with in Maddala (1983) and Kooiman *et al.* (1985), is suppressed by restricting the average Pr[Excess Capacity] to the interval $[\varphi_0, \varphi_1]$, where $0 < \varphi_0 < \varphi_1 < 1$. In this study $\varphi_0 = 0.05$ and $\varphi_1 = 0.95$ for all types of stores.

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Notes

1 In their study Nooteboom *et al.* refer to Kalecki (1971), Eichner (1979) and Wood (1975).

2 Smith (1948, pp. 130, 180; and 1949, p. 24) comes to a similar conclusion. Hood and Yamey (1973) present a critical examination of attempts to use the theory of imperfect competition to explain competition in retailing, but they 'do not wish to make issue with Smith or Hall on the question whether retailing is or is not a textbook example of perfect competition' (p. 116).

3 Cf. Hall *et al.* (1961), and Arndt and Olson (1975).

4 In retailing the initiative for the use of capacity lies on the side of the consumer (see also Nooteboom (1986, p. 234)).

5 In a cross-section survey held among Dutch confectioner's stores with respect to the year 1985, about 61% of the 170 respondents answered to be in a situation of excess capacity (i.e., one could have produced more products at given capacity, but demand was not sufficient); about 32% was in an excess demand regime (i.e., one could have sold more products at given demand, but production capacity was not sufficient); and about 7% answered that there was equilibrium between demand and supply capacity.

6 Apart from possible exceptional cases, every store will have excess capacity during some periods of opening time, and shortage of capacity during some other periods. But our regime concept should be interpreted as describing the 'average situation' during a longer period of time, say, one year.

7 In view of the difference made between 'actual supply' and 'supply capacity', it might be confusing to use here the term 'excess supply'. Therefore, the term 'excess capacity' will be used throughout the paper.

8 Switching models with endogenous regime choice have mainly been used to analyse markets in disequilibrium, where transactions are assumed to equal the minimum of supply (capacity) and demand. See, for example, Rosen and Quandt (1978), Fair and Jaffee (1972), and Laffont and Garcia (1977), for an analysis of the labour market, the housing market and the credit market, respectively. All these models make use of aggregate time series data. In Kooiman *et al.* (1985) a switching model is presented to analyse differences in floorspace productivity among retail stores in the grocery

trade. Recently we finished a paper in which we used a switching model to estimate the effects of retail marketing instruments on annual sales in retail stores (see Bode *et al.* (1988a)). The model presented in the present paper is an extension of this model: We want to endogenize the store price level.

[9] See, for example, Hall and Hitch (1951), Kaplan *et al.* (1958) and Haynes (1964).

[10] See Koutsoyiannis (1975, Ch. 11 and 12).

[11] In Nooteboom and Thurik (1985) the effect of the business cycle is taken into account. The mark-up relationship has also been tested for the hotel and catering sector (see Van der Hoeven and Thurik (1987)), as well as for the manufacturing sector (see Thurik and Van der Hoeven (1989), where differences between small and large firms are investigated).

[12] This specification closely resembles the demand equation in Bode *et al.* (1988a) (cf. eq. (2) on page 109). There are some differences, however. Firstly, the parameter δ_3 in (6) is not made a function of A, S, Fs and Rg. Instead, these variables now have a direct impact on demand. We think that this is more realistic. Secondly, the effect of store price level on demand is now specified by means of $\exp(\delta_5(1 + M))$ instead of $(1 + M)^{\delta_5}$. The reason is explained in Section III. Thirdly, the threshold parameter γ is now left out of our model. In Bode *et al.* (1988a) its estimate was consistently found to be zero.

[13] Condition 5 is not completely met ($\lim_{p \downarrow 0} \partial q^d/\partial p \neq 0$). See also Bode *et al.* (1987).

[14] There is a counter argument: competition may also be higher. The same holds true with respect to the shopping centre effect. However, information about the strength of competition was not sufficiently available in our data sets.

[15] This type of specification is chosen because it is assumed that selling area and remaining space can be substituted for one another. This substitution represents different marketing or operational strategies within a type of stores. A high ratio of C/W is associated with a high share of self-service sales, a low share of own production, and a strategy in which only a few goods are kept in stock and many are displayed.

[16] It can be shown that maximizing eq. (7) with respect to C yields $C = \pi W$. Therefore, π denotes the 'optimal' distribution between C and $W - C$.

[17] Logarithm variables are used because in estimating the model, equations (6) and (7) (and therefore I^d and I^s) will be written in logarithm form.

[18] For example, if demand is 10% below store capacity (i.e., $I^d/I^s = 0.9$) then $\ln I^d - \ln I^s = -0.105$, and if demand is 10% above capacity (i.e., $I^d/I^s = 1.1$) then $\ln I^d - \ln I^s = 0.095$. So, $|-0.105| > |0.095|$.

[19] We aim at a multiplicative disturbance structure in (6) and (7). Therefore, these equations are written in logarithm form before disturbances are added.

[20] No disturbance term is added to the minimum condition because this equation is considered a definition equation in the model. Kooiman *et al.* (1985, p. 127) use a different argument but end up with the same stochastic specification.

[21] I.e.,

$$\frac{(1+M)}{\hat{I}^d}\frac{\partial \hat{I}^d}{\partial(1+M)} = \delta_5(1+M),$$

evaluated at the average value of $1 + M$.

[22] At this point we want to remark that the use of a switching model not only 'solves' the problem of unobservable demand and supply capacity as mentioned in the introduction, but also results in better estimates of the marketing mix effects in the demand equation. To understand this one should realize that a slight change of advertising expenses will probably not have a large impact on the sales level in case of an excess demand situation. In case of an excess capacity situation, however, store capacity is large enough to meet store demand, and a change in advertising expenses almost surely will change sales level. Therefore, due to the presence of both excess capacity and excess demand observations in the samples, the marketing mix effects are understimated when a single equation (describing sales level as a function of several variables from the marketing mix) is used. The application of a switching model, on the other hand, takes into account that different economic regimes are possible. For a further discussion on this matter see again Bode *et al.* (1988a).

[23] See for example Thurik (1984) where in a supply side model also varying values of π were found for different types of stores.

[24] In future research we want to gain more insight into the behavioral characteristics of switching models. For example, what is the connection between the average probability of excess capacity and the fraction of stores in the sample that actually is in an excess capacity situation? We hope to analyse this and other kinds of aspects of switching models by means of a data set that contains prior-information with respect to the regime under which a store operates. It may then also be possible to construct a better store price index using individual product prices, which was not possible in this study.

[25] Note that the cost variable $(I + K)/I$ is considered exogenous. The first reason is economic: K may reasonably be assumed proportional to I, since the reward for storekeeper's labour is excluded from total annual operating costs K. The second reason is technical: it simplifies the Jacobian of the transformation from $(\varepsilon^p, \varepsilon^d, \varepsilon^s)$ to $(1 + M, \ln I^d, \ln I^s)$.

[26] See for example Maddala (1983, p. 297) or Kooiman *et al.* (1985, Appendix).

[27] The complete derivation is given in the original manuscript (see Bode *et al.* (1988b)).

[28] See for example Kooiman *et al.* (1985, Appendix).

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