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DISEQUILIBRIUM IN DUTCH RETAILING: THE IMPACT OF DEMAND FACTORS

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Abstract

In this paper we use a disequilibrium model to explain differences in floorspace productivity, measured as sales per square metre, among individual retail establishments. In the earlier stages of our research in this area, demand was usually assumed to be high enough for a shopkeeper to maximise his profits. In the present paper we assume that situations may occur in which demand is not high enough. As a result, an endogenous switch (unknown sample separation) between supply and demand regimes is incorporated in the model. The purpose of this paper is to reformulate the demand relation of an existing model in this area to account for important variables from the marketing mix. Furthermore, we study the sensitivity of the results for two different demand specifications. Finally, we broaden the empirical basis by examining four different shoptypes from the Dutch retail trade instead of supermarkets alone.

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1. Introduction

This paper is an extension of the analyses of Thurik and Koerts (1984[a,b], 1985) and Thurik (1984), where models are developed to explain differences in floorspace productivity among retail establishments. The most recent development in this area is the modelling of disequilibrium, which implies that at a certain moment in time (i.e. the moment of data collection) demand for and supply of goods do not necessarily coincide. In fact, it is our assumption that some shops operate in a situation of excess demand, while others are troubled by excess supply. Recently, Kooiman, Van Dijk and Thurik (1985) presented a disquilibrium model aiming at the explanation of differences in floorspace productivity, measured as sales per square metre, among individual retail establishments of the same shoptype. The model served as an application of likelihood diagnostics and Bayesian analysis. Moreover, it served as a starting point for a renewed attempt to establish the influence of environmental factors on floorspace productivity.
The purpose of the present paper is to formulate a more realistic specification of the demand side of the model proposed by Kooiman et al. (1985) by including important variables from the marketing mix. Specifically, we are interested in the effects of advertising, composition of assortment, service level and certain environmental characteristics. Furthermore, we study the sensitivity of the estimation results for two different specifications of the demand relationship. Finally, we broaden the empirical basis by examining four different shoptypes instead of supermarkets alone.

2. The model and the likelihood function

In this section we shall give a short description of the model, which is estimated in section 3. The basic equation of the model is a production technology which mirrors the thought that the level of sales an entrepreneur wants to supply must also be within his reach, given the available production factors. Every entrepreneur is supposed to operate according to this supply equation. The specification is as follows:

(2.1) $Q^s = \beta(X^s)(C - \gamma)^{\pi\varepsilon}(W - C)^{(1-\pi)\varepsilon}$

where Q^s : possible sales level, supply capacity
C : floorspace specifically for selling
W : total amount of floorspace
X^s : exogenous supply variables.

In the parameter β additional exogenous variables X^s can be incorporated. Detailed description of (2.1) is deferred until section 3.
Given that the entrepreneur aims at maximising profits, he can make use of two instruments to accomplish his goal: selling space C and remaining space R ($W-C$). By definition selling space and remaining space add up to exogenous total floorspace. This implies that, in fact, only one instrument remains: the partitioning of total floorspace. For a discussion on the relevance of sales maximisation versus profit maximisation in retailing, we refer to Thurik and Koerts (1985).
At this point we distinguish between two possible situations. The first situation corresponds to the assumption that demand is always high enough to sustain any level of supply. This assumption is made earlier work in this area (see e.g. Thurik, 1984). It allows us to derive the optimal partitioning of floorspace by examining the first order conditions for maximising $Q^s(C;W,X^s)$ with respect to selling space C. Differentiating equation (2.1) with respect to C and fixing the result at zero, leads to the following optimal amount of selling space in a situation of excess demand, C_{ed}:

(2.2) $\dfrac{C_{ed} - \gamma}{W - \gamma} = \pi$

On the other hand demand may <u>not</u> be high enough to absorb the optimum level of sales $Q^s(C_{ed};W,X^s)$, resulting in a situation of excess supply. Although the observed level of sales Q must be feasible in the sense that $Q \leq Q^s(C;W,X^s)$, it is also restricted by the amount of goods customers are willing to consume. The level of demand Q^d is supposed to depend on selling space: more selling space implies a wider variety of commodities offered, which stimulates demand. It is specified as:

(2.3) $Q^d = \delta(X^d)(C-\gamma)^{\nu}$

where Q^d : level of demand

C : amount of selling area

X^d : exogenous demand variables.

Again the parameter δ allows for additional explanatory variables X^d. The demand elasticity with respect to selling space is assumed to exceed the supply elasticity, $\nu \geq \pi\varepsilon$, to secure a unique point of intersection between Q^s and Q^d. The optimal amount of selling area in a situation of excess supply C_{es} follows from the point of intersection between Q^s and Q^d:

(2.4) $Q^s(C_{es};W,X^s) = Q^d(C_{es};X^d)$

It is not difficult to see that the distinction between the situations of excess supply and excess demand results in the following discrete switch:

(2.5) $C = max(C_{ed},C_{es})$.

When C_{es} is less than C_{ed} the intersection between Q^s and Q^d occurs to the "left" of the maximum of Q^s; to the "right" of this point of intersection, demand is always larger than supply, which results in a situation of excess demand. In the same way it is shown that if C_{es} exceeds C_{ed}, this implies a situation of excess supply. The disequilibrium model can now be written as:

(2.6) $Q = Q^s(C;W,X^s)$

$C = max(C_{ed},C_{es})$

where C_{es} and C_{ed} are given by equations (2.4) and (2.2), respectively.

The model is estimated by the method of maximum likelihood. The likelihood function is a joint density function of Q and C, conditional on the unknown parameters, over all observations. For each individual the joint density function of Q and C consists of two parts (cf. Maddala, 1983): one part is related to the excess demand situation and is called $f^{ed}(Q,C)$; the other part, $f^{es}(Q,C)$, is related to the situation of excess supply.

In order to derive the functional form of each of the density functions, use is made of equations (2.1), (2.2) and (2.3) including error terms. In equation (2.1) and (2.3) the multiplicative error terms $exp(\varepsilon^s)$ and $exp(\varepsilon^d)$, respectively, have log-normal distributions. In equation (2.2) π is replaced by $exp(-\varphi)$, where φ has a gamma distribution with parameters α and ψ; the mathematical expectation of $exp(-\varphi)$ is equal to π. According to Kooiman et al. (1985) this results in:

$$\text{(2.7)}\quad \begin{aligned} f^{ed}(q,c) &= \frac{C}{C-\gamma}\, g(p;\alpha,\psi)\; n(e^{s};\sigma_s)\; \left[1 - N(\frac{e_d}{\sigma_d})\right] \\ f^{es}(q,c) &= \left[\frac{(\nu-\pi\varepsilon)C}{C-\gamma} + \frac{(1-\pi)\varepsilon C}{W-C}\right] n(e^{s};\sigma_s)\; n(e^{d};\sigma_d)\; \left[1 - G(\frac{p}{\psi};\alpha)\right] \end{aligned}$$

where q,c : natural logarithms of Q and C, respectively;

$n(\cdot;\sigma)$: normal density function with zero mean and variance σ^2; $N(\cdot)$ is the standardised cumulative normal distribution function;

$g(\cdot;\alpha,\psi)$: gamma density function with parameters α and ψ; $G(\cdot;\alpha)$ is the standardised cumulative gamma distribution function (ψ=1) with form parameter α.

Furthermore, e^{s}, e^{d} and p are given by:

$$\text{(2.8)}\quad \begin{aligned} e^{s} &= q - q^{s}(c;W,X^{s}) \\ e^{d} &= q - q^{d}(c;X^{d}) \\ p &= ln(W-\gamma) - ln(C-\gamma). \end{aligned}$$

The likelihood function is written as:

$$\text{(2.9)}\quad L(\theta|q,c) = \prod_{i=1}^{N} \left[f^{ed}(q_i,c_i) + f^{es}(q_i,c_i)\right]$$

where θ is a vector of unknown parameters.

According to Kiefer (1980), the regime probabilities, for i=1,...N, are derived as:

$$\text{(2.10)}\quad \begin{aligned} \Pr(Excess\ Supply)_i &= f^{es}(q_i,c_i)\ /\ \left[f^{ed}(q_i,c_i) + f^{es}(q_i,c_i)\right] \\ \Pr(Excess\ Demand)_i &= f^{ed}(q_i,c_i)\ /\ \left[f^{ed}(q_i,c_i) + f^{es}(q_i,c_i)\right] \end{aligned}$$

The likelihood function (2.9) tends to infinity for certain values of the parameters. Maddala (1983) and Kooiman et al. (1985) deal quite extensively with this matter so we only mention it here. In the optimisation procedure a barrier function is used to suppress the problem of completely one-sided samples; the average probability of excess supply, $\frac{1}{N}\sum_i \Pr(Excess\ Supply)_i$, is restricted to the interval $[\alpha_0,\alpha_1]$, where $0<\alpha_0<\alpha_1<1$. Moreover, we use a penalty function to handle the restriction $\nu \geq \pi\varepsilon$. For more information regarding penalty and barrier functions, we refer to Luenberger (1983).

3. Estimating the model

The data we use for estimating the model are available from surveys conducted by the Research Institute for Small and Medium-Sized Business in the Netherlands. The data involve four shoptypes: supermarkets and superettes, textile shops, stationer's shops and furnishing shops. In appendix A we give a short impression of these data.

A necessary condition for a demand relationship to be realistic is the occurrence of elements from the marketing mix. From the available data we construct the following marketing variables:

- *assortment composition*, ac_i (i=1,2,3): for all shoptypes we are able to define three separate assortment groups. The influence of each of these groups is measured by the ratio of sales with respect to each assortment group and total sales value. Since the resulting fractions ac_i add up to one, we substitute for assortment group 3, ac_3. Table 1 shows the assortment composition for the four shoptypes.

Table 1: **Partitioning in assortment groups**

Supermarkets:	ac_1	fresh products: meat and meatproducts, vegetables, bread, etc.
	ac_2	non-foods
	ac_3	other foods (except fresh products)
Stationer's shops:	ac_1	kernel assortment: paperware, writing and drawing materials, machine supplies, etc.
	ac_2	complementary assortment: typewriters, calculators, office furniture, etc.
	ac_3	books, periodicals, newspapers, printingworks, copy service, etc.
Furnishing shops:	ac_1	furniture
	ac_2	floorcovering, carpets
	ac_3	other furnishing, like curtains
Textile shops:	ac_1	men's wear
	ac_2	women's wear
	ac_3	children's wear

- *selling price*, $1+M$: for each establishment selling price is approximated by the ratio of total sales value Q to purchasing value of the goods I, which is equal to one plus the fractional gross margin M ($=\frac{Q-I}{I}$). The role of selling price is two-fold. Firstly, it serves to transform the volume of sales into its value. Secondly, it represents the traditional price effect: the price elasticity of demand δ_2 is expected to be negative. The justification of $1+M$ as a proxy for prices is the following. Since the volume of goods sold is equal to the volume of goods purchased, the ratio $\frac{Q}{I}$ approximates the proportion of selling price to purchasing price. Furthermore, the definition of a shoptype requires, among other things, that retailers within the same shoptype are homogeneous with respect to the goods sold. We therefore assume that retailers within a shoptype meet the same purchasing price, resulting in $1+M$ being proportional to selling price.

- *advertising*, A: advertising efforts are measured by expenditures on advertising. So, no distinction is made with regard to all possible sorts of advertising such as radio and television commercials, newspaper, door-to-door distribution of pamphlets, etc., because the relevant data are not available. A further refinement by taking into account these different types of advertising might yield a deeper insight in the effectiveness of each of them. Advertising is expected to stimulate demand.
- *service level*, S: the service level of each establishment is approximated by average weekly working hours per square metre of total floorspace. More average weekly working hours are interpreted as a higher service level provided. Service is assumed to have a positive effect on demand.
- *environment*, Fs and Rg: some shop types allow modelling of environmental characteristics, like shopping centre Fs and region Rg in which an establishment is situated. Shops in densely populated areas (Rg=1) or large shopping centres (Fs=1) are confronted with more potential buyers, which has a positive effect on demand.

To preserve the basic functional form of the demand relationship (2.3) and the distributional assumptions regarding ε^d, the marketing variables enter the relationship either through shift-parameter δ or demand elasticity ν.
The demand relationship is most easily extended through δ. Hence:

$$(3.1)\quad Q^d = exp\left[\delta_0+\delta_{01}ac_1+\delta_{02}ac_2\right]\,(1+M)^{1+\delta_2}\,A^{\delta_A}\,S^{\delta_S}\,exp\left[\delta_R Rg+\delta_F Fs\right]\,(C-\gamma)^{\nu}$$

However, the additional explanatory variables may not effect the level of demand in a direct multiplicative way, but indirectly through ν. In this case the influence of marketing variables depends on the amount of selling area; vice versa, the impact of larger selling area on demand depends on the marketing mix. Following this line of reasoning, we come to our second demand specification:

$$(3.2) \quad Q^d = exp\left[\delta_0+\delta_{01}ac_1+\delta_{02}ac_2\right] (1+M)^{1+\delta_2} (C-\gamma)^{\nu^*}$$

$$\text{with } \nu^* = \nu_0 + \nu_A{\cdot}A + \nu_S{\cdot}S + \nu_R{\cdot}Rg + \nu_F{\cdot}Fs$$

In equation (3.2) the selling area elasticity ν^*, which represents the effect of a relative change in $C-\gamma$ on demand, has become a function of advertising, service and environmental characteristics. From a theoretical point of view we have no preference for either of the two specifications of the demand equation. We therefore make a decision on empirical grounds.

Finally, the supply relationship is specified as

$$(3.3) \quad Q^s = exp\left[\beta_0\right] (1+M)\, H^{\beta_1}(C-\gamma)^{\pi\varepsilon}(W-C)^{(1-\pi)\varepsilon}$$

where H: occupancy costs per square metre

The price indicator $1+M$ again transforms the value of sales into its volume. The occupancy costs H in (3.3) serve as a proxy for efficiency. The idea is that higher factor costs necessitate more efficient management of production factors. Since the only relevant production factor in the supply function is housing, we include occupancy costs per square metre of total floorspace H; obviously, the impact of occupancy costs on supply β_1 is expected to be positive. From the first and second order conditions for a maximum of supply equation (3.3) with respect to selling area C, it follows that the distribution parameter π is restricted to the interval [0,1], cf. equation (2.2), and that the scale parameter ε is strictly positive. Values of ε larger than one imply increasing returns to scale with respect to the production factors $C-\gamma$ and $W-C$. The parameter γ is interpreted as the minimum required amount of selling area (cf. Nooteboom, 1980).

In accordance with the work of Kooiman et al. (1985) some observations are eliminated from the analyses to obtain sensible results. Given the fact that all shops should satisfy supply condition (3.3), irrespective the prevailing regime, some observations show up as outliers from estimation of (3.3) in logarithmic form. Additionally, a few shops are considered as outliers on the basis of their very low contribution to the value of the likelihood function.

Estimation of the model with (3.1) as the demand equation led to several unexpected results. In some cases parameter values, like the distribution parameter π, ended up at their lower– or upperbound, while the likelihood function remained finite. In other cases the likelihood tended to infinity.

We tried several starting points but the estimation procedure did not converge to sensible results. Furthermore, we improved the demand relationship by using an exponential instead of a constant elasticity type of price effect: $(1+M)^{\delta_2} \rightarrow exp\left(\delta_2(1+M)\right)$. However, the likelihood function still did not converge.

Contrarily, estimation of the model with (3.2) as the demand equation led to convergence for three out of four shoptypes. Only in the case of textile shops this version of the model did not converge, for which we have no explanation. The results are shown in Table 2. In appendix B estimation results are given for the model without additional marketing variables.

The average probability of being in a situation of excess supply strongly increases when additional explanatory variables from the marketing mix are considered. For supermarkets and superettes this probability rises from 21% to 52%; for stationer's shops from 17% to 30%; and for finishing firms from 4% to 27%.

From the point estimates of the supply side parameters it is seen that, although the value of the scale parameter ε slightly increases, the value of the distribution parameter π substantially decreases as compared to the restricted model (see appendix B). This implies that by neglecting potential explanatory variables the optimal level of selling area, considered as a fraction of total floorspace, tends to be overestimated. Comparing the three shoptypes, stationer's shops have the smallest fraction of selling area 0.5, whereas furnishing shops have the highest fraction, which is quite plausible. All three shoptypes have decreasing returns to total floorspace, $\varepsilon<1$. From the estimates of β_1, the supply elasticity with respect to occupancy costs, it follows that supermarkets make more efficient use of total floorspace than stationer's and furnishing shops.

Table 2: **Estimation results for the extended model**

		Supermarkets & superettes	Stationer's shops	Furnishing shops
	Supply side parameters:			
β_0	*intercept*	0.391 (0.276)	1.523 (0.464)	0.493 (0.294)
β_1	*occupancy costs*	0.806 (0.056)	0.472 (0.089)	0.542 (0.060)
γ	*threshold selling area*	0.000 (–)	0.000 (–)	0.000 (–)
π	*distribution parameter*	0.569 (0.027)	0.499 (0.022)	0.658 (0.028)

ε	*scale effect*	0.879 (0.028)	0.843 (0.048)	0.768 (0.030)
σ_s	*standard deviation*	0.230 (0.012)	0.373 (0.023)	0.307 (0.016)
	Demand side parameters:			
δ_0	*intercept*	4.829 (0.196)	3.610 (0.613)	4.839 (0.670)
δ_{01}	*assortment group* 1	0.067 (0.303)	1.976 (1.020)	–1.337 (0.503)
δ_{02}	*assortment group* 2	–0.780 (0.726)	1.382 (0.972)	–1.326 (0.621)
δ_2	*price effect*	–1.741 (0.873)	–0.585 (1.626)	–1.533 (0.774)
ν_0	*constant selling space elasticity*	0.411 (0.070)	–0.123 (0.117)	0.417 (0.039)
ν_A	*advertising effect*	0.019 (0.007)	0.132 (0.089)	0.019 (0.005)
ν_S	*service effect*	0.409 (0.069)	0.693 (0.312)	0.995 (0.353)
ν_R	*region*	–[1]	0.558 (0.350)	0.105 (0.048)
ν_F	*shopping centre*	0.062 (0.070)	0.098 (0.339)	–0.003 (0.027)
σ_d	*standard deviation*	0.186 (0.018)	0.488 (0.089)	0.319 (0.054)
α[2]	*form parameter Gamma distribution*	5.733 (0.039)	3.976 (0.030)	4.520 (0.064)
	Log – likelihood	126.011	–65.543	24.520
	Likelihood Ratio test[3]	30.477	23.404	11.957
	Prob.(Excess Supply)	0.518	0.304	0.265
	Number of observations	208	138	176

1. Information on the region is not available for supermarkets and superettes.
2. Form parameter of the gamma density. An estimate of ψ can be obtained from $\pi=(1+\psi)^{-\alpha}$ as $\psi=\pi^{-(1/\alpha)}-1$.
3. Likelihood Ratio test with respect to the model without marketing variables (see appendix B).

Inspecting the demand side parameters, the first noticeable change is the estimate of the price elasticity δ_2. In the extended model it has the classic negative sign and differs significantly from zero for supermarkets and furnishing shops. From the estimates of the assortment effects δ_{01} and δ_{02} we find that demand is higher for shops with a relative large share of fresh products and other foods and a lower share of non-food products in case of supermarkets; with a relative large share of kernel and complementary assortment and a lower share of books and periodicals in case of stationer's shops; with a relative large share of furnishing textile and a lower share of furniture and floorcovering in case of furnishing shops. The effect of advertising ν_A on the demand elasticity ν^* is positive for all shoptypes. This result is very interesting from the marketing point of view. It is well known that it is hard to find any significant effects from advertising on sales when using information on individual business units. The effect of advertising is smallest for supermarkets, whereas stationer's shops seem to benefit most from their advertising efforts. The service level also plays a positive role in determining the effect of a relative change in selling space: $\nu_S>0$; furnishing shops profit most from additional working hours. The estimates of the environmental characteristics show a positive influence of being situated in densely populated areas, $\delta_R>0$. The effect on demand of a location in a larger shopping centre δ_F is positive, yet insignificant, in case of supermarkets and stationer's shops.

For completeness, we test the extended model against the restricted version of the model, i.e. without the additional explanatory variables in the demand equations, except price. In view of the likelihood ratio test, which is χ^2-distributed with as many degrees of freedom as there are additional parameters, the hypothesis that the newly introduced parameters are zero is rejected for all three shop types. The level of significance for this test is 0.5% in case of supermarkets and stationer's shops and 10% for furnishing shops.

4. Conclusions

In this last section we conclude with some striking findings of our study.

Firstly, the extended model yields economically plausible results. From Table 2 it is clear that supermarkets and superettes operate more efficiently than the other shoptypes in terms of sales per square metre (cf. $\hat{\beta}_1$). None of the shoptypes is confronted with increasing returns to scale (cf. $\hat{\varepsilon}<1$). Stationer's shops make more intensive use of their remaining space than other shop types (cf. $\hat{\pi}$). The price elasticity for supermarkets and furnishing firms is higher (in absolute value) than that for stationer's shops. This may be caused by the type of commodities they sell. Stationer's shops sell more luxury goods, while supermarkets sell products for daily use. The effect of advertising on the floorspace elasticity of demand is highest for stationer's shops and lowest for supermarkets. The impact of service on the floorspace elasticity of demand is highest for furnishing firms. For stationer's and furnishing shops the floorspace elasticity is higher for establishments situated in densely populated areas. Being situated in large shopping centres has a positive, but not significant, effect on the floorspace elasticity of demand.

Secondly, the values of the parameter estimates are sensitive to the specification of demand. Specifically, the price elasticity δ_2 is consistently less than zero and significant for two shoptypes in the extended model, as is expected from economic theory. This result is due to the extension of the model. Without the introduction of additional variables δ_2 could not be meaningfully estimated.

Thirdly, the model is sensitive to the specification of the demand function. While the model with (3.1) as demand equation did not lead to convergence of the likelihood function, the model with (3.2) as demand equation did converge and led to plausible results. Moreover, the model is sensitive to outliers in the data.

Fourthly, improvement of the demand specification by introducing additional variables from the marketing mix leads to a strongly increased average probability of excess supply. The regime classification resulting from a disequilibrium model with endogenous regime choice heavily depends on the adequateness of the regime specifications. Therefore, care should be taken when interpreting the reported probabilities of excess supply.

Finally, we note that the assumption of profit maximising behaviour of the retail entrepreneur plays a dominant role in the structure of the model. Furthermore, it requires a great deal of computational efforts, i.e. the optimisation of the likelihood function is rather computer intensive. Dropping the assumption of profit maximising considerably simplifies both theoretical and numerical excercises. Further research in this area is going on. An example of a disequilibrium model, in which profit maximising behaviour is not presupposed, is found in Bode, Koerts and Thurik (1988). They examine the influence of marketing mix variables on pricing, demand and supply of retail services against the background of possible different economic regimes.

Appendix A. Data

To estimate the parameters of the model we use of four samples from surveys conducted by the Research Institute of Small and Medium-Sized Business (EIM) in the Netherlands. The surveys are available for the following shoptypes: supermarkets and superettes (1979), stationer's shops (1980), furnishing shops (1981) and textile shops (1979). In this section we present a summary of some characteristics of the variables we used.

In the tables, which are presented below, total floorspace W and selling area C are measured in 100 m^2; annual sales Q, purchasing value I and expenditures on advertising A are measured in 10.000 Dutch guilders of the respective years. The variable H is measured as annual housing costs per square metre total floorspace and the level of services S as the average weekly working hours per square metre total floorspace.

	Supermarkets and superettes (208 observations, 7 outliers)			**Stationer's shops** (138 observations, 4 outliers)		
	Mean	Min	Max	Mean	Min	Max
W	4.143	0.730	16.900	3.407	0.520	16.180
C	2.871	0.380	10.000	1.843	0.250	9.000
Q	218.751	47.504	749.588	117.929	22.952	611.604
I	174.684	37.727	595.767	78.552	12.351	400.095
H	172.682	48.396	319.361	190.074	57.001	444.612
A	2.826	0.029	10.829	1.703	0.037	17.204
S	0.900	0.324	1.899	0.845	0.273	2.692
$1+M$	1.247	1.151	1.338	1.516	1.293	1.986
ac_1	0.399	0.050	0.630	0.475	0.170	1.000
ac_2	0.084	0.010	0.200	0.156	0.000	0.740
ac_3	0.517	0.320	0.810	0.367	0.000	0.780
Fs	0.077	0.000	1.000	0.623	0.000	1.000
Rg	–	–	–	0.413	0.000	1.000

	Furnishing shops (176 observations, 10 outliers)			**Textile shops** (189 observations, 11 outliers)		
	Mean	Min	Max	Mean	Min	Max
W	12.740	1.200	47.500	3.714	0.650	20.400
C	9.339	0.500	34.000	2.720	0.500	13.600
Q	121.483	18.939	420.074	106.596	27.843	495.182
I	73.889	10.119	277.262	67.868	17.867	308.872
H	100.137	22.406	256.242	223.504	59.407	980.330
A	4.173	0.112	26.565	3.219	0.010	24.341
S	0.251	0.034	0.808	0.628	0.192	1.449
$1+M$	1.661	1.389	2.165	1.565	1.307	0.061

ac_1	0.481	0.000	1.000	0.431	0.000	1.000
ac_2	0.228	0.000	1.000	0.499	0.000	1.000
ac_3	0.291	0.000	1.000	0.069	0.000	0.490
Fs	0.511	0.000	1.000	0.772	0.000	1.000
Rg	0.392	0.000	1.000	–	–	–

Appendix B. Estimation results for the restricted model

Below we present estimation results for the model without additional explanatory variables in the demand relationship.

Table B.1: **Estimation results for the restricted model**

		Supermarkets & superettes	Stationer's shops	Furnishing shops	Textile shops
	***Supply side parameters*:**				
β_0	*intercept*	0.592	1.588	0.490	1.425
		(0.263)	(0.466)	(0.298)	(0.280)
β_1	*occupancy costs*	0.758	0.457	0.536	0.437
		(0.052)	(0.089)	(0.060)	(0.051)
γ	*threshold selling area*	0.000	0.000	0.000	0.153
		(–)	(–)	(–)	(0.085)
π	*distribution parameter*	0.644	0.537	0.706	0.725
		(0.014)	(0.024)	(0.010)	(0.014)
ε	*scale effect*	0.862	0.837	0.761	0.732
		(0.026)	(0.051)	(0.030)	(0.043)
σ_s	*standard deviation*	0.223	0.372	0.306	0.281
		(0.011)	(0.022)	(0.016)	(0.014)
	***Demand side parameters*:**				
δ_0	*intercept*	4.880	4.330	3.468	4.170
		(0.347)	(0.993)	(0.882)	(1.190)
δ_2	*price effect*	–1.212	0.896	0.999	1.632
		(1.581)	(2.357)	(1.658)	(2.885)
ν_0	*constant selling space elasticity*	0.866	1.476	0.594	0.545
		(0.067)	(0.386)	(0.104)	(0.268)

σ_d	*standard deviation*	0.227 (0.035)	0.679 (0.022)	0.419 (0.163)	0.425 (0.369)
$\alpha^{1.}$	*form parameter Gamma distribution*	5.772 (0.037)	3.875 (0.056)	3.834 (0.044)	3.759 (0.246)
Log-likelihood		110.772	-77.245	18.542	68.164
Prob.(Excess Supply)		0.206	0.174	0.044	0.014
Number of observations		208	138	176	189

1. Form parameter of the gamma density. An estimate of ψ can be obtained from $\pi=(1+\psi)^{-\alpha}$ as $\psi=\pi^{-(1/\alpha)}-1$.

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