Volume 62 Number 4 Winter 1986

Research Note: Modelling Retail Floorspace Productivity

ROY THURIK
Department of Basic Research
Research Institute for Small and Medium-Sized Business
Zoetermeer, The Netherlands

PETER KOOIMAN
Department for Statistical Methods
Netherlands Central Bureau of Statistics
Voorburg, The Netherlands

This research note presents a "switching regime" model to investigate the impact of environmental factors on floorspace productivity of individual retail stores. The model includes independent supply and demand functions, which are incorporated within a sales maximizing framework. Unlike previous models, the switching approach allows the model to determine first whether sales are determined by demand or supply side constraints. The appropriate regime is then chosen to estimate space productivity. The model is estimated with data on individual stores collected by the Dutch Research Institute for Small and Medium-Sized Business.

The Dutch Research Institute for Small and Medium-Sized Business (Economisch Instituut voor het Midden- en Kleinbedrijf, EIM) and the Econometric Institute of the Eramus University Rotterdam cooperate in a research project of econometric analysis of the behavior of retail firms. Sales level, labor volume, floorspace, price and financial structure are, or will be, the subject of analysis. Individual store data used for this purpose are gathered from surveys that have been conducted by EIM for a large number of retail categories. This research note presents some results obtained with a switching regime or disequilibrium model where retail sales

This note is a concise, easily accessible version of a more technical paper published in the *Journal of Econometrics* (Kooiman, van Dijk, and Thurik 1985). It benefits from discussions at the Fifth World Congress of the Econometric Society, Boston, 1985, and the European Research Seminar: "Concepts, Measurements and Improvements of Productivity in the Services," Leuven, Belgium, 1985. We are grateful to two anonymous reviewers and to Avijit Ghosh for helpful suggestions The views expressed in this article are those of the authors and do not necessarily reflect the policies of their institutes.

per store are either supply determined or demand determined. Independent supply and demand functions explaining sales capacity and demand are employed in a framework which is based on the objective of maximizing annual sales. Under excess supply the model allows for so-called "trading-down," that is, an increase in the share of selling area and, hence, a decrease in service level. For each observation (i.e., store) the model indicates whether there is excess supply or excess demand. Additionally, the model provides estimates for the parameters of both the supply and the demand function for retail sales. The main purpose of the switching regime model is to help build a framework for further research into the influence of environmental factors on floorspace productivity. More knowledge is needed in this field in view of the desire of EIM to build and maintain a decision support system for retailers and consultants. The presence of both, a supply-side and a demand-side in the model, also allows us to estimate the degree of overcapacity for retail categories. This may be valuable from a policy point of view.

The disequilibrium model we present is an extension of a model developed to explain differences in floorspace productivity, measured as sales per square meter, among individual retail establishments (Thurik 1984; Thurik and Koerts 1984a, 1984b, 1985). In the latter model, floorspace productivity is related to a partitioning of the floorspace into selling area and nonselling areas. Both selling area and nonselling space are treated as inputs in a production technology for retail services. This model has been applied to a wide variety of Dutch and French supermarkets and supermarket-like establishments and to several other Dutch retail categories.

A weakness of the Thurik and Koerts model is that it ignores the demand side. Sales, hence floorspace productivity, is determined by the interplay of supply and demand, and cannot properly be analyzed from the supply side alone. In leaving out the demand side, as Thurik (1984) does, one implicitly assumes that demand is always large enough to fill capacity. This is not always the case in practice. Therefore, we extend the model with an explicit demand side. The extended model is discussed in the section "A Disequilibrium Model of Retail Services." The model is empirically tested using data from 208 independent supermarkets and superettes in the Netherlands. Although our model provides satisfactory results, it is only a partial model of retail behavior. Further extensions are discussed in the concluding section of the paper. Our primary goal is to introduce the disequilibrium modelling technique to retailing and to demonstrate its application.

A SUPPLY CONSTRAINED MODEL OF RETAIL BEHAVIOR

The original supply-constrained model of Thurik and Koerts builds on four basic assumptions. First, total available floorspace of a retail establishment can be partitioned into selling area and nonselling space. Shopkeepers have a certain flexibility in choosing the partitioning of total available floorspace. This partitioning is assumed to be flexible before as well as after the founding of the store. So we have

$$W \triangleq C + R \tag{1}$$

where:

W = total available floor space
C = selling area
R = nonselling space

Second, total available floorspace is exogenous. The shopkeeper's present "plant size" is the result of a long-term decision made in the past and cannot be easily changed without considerable costs.

Third, in a given retail category the potential volume of annual sales depends on the size of its selling area and of its remaining space:

$$Q^s = \beta(X)\,(C - \gamma_1)^{\pi\epsilon}(R - \gamma_2)^{(1-\pi)\epsilon} \text{ with } \beta > 0,\ 0 \leqq \gamma_1 < C,\ 0 \leqq \gamma_2 < R,\ 0 < \pi < 1 \text{ and } \epsilon > 0 \tag{2}$$

where:

Q^s = volume capacity of annual sales
X = summary of further (unknown, exogenous) factors
γ_1 and γ_2 denote threshold space requirements (see below)

Equation (2) must be considered as a basic relationship between the value of annual sales and floorspace. The influence of the remaining heterogeneity within a retail category, X, will be dealt with below. Specification (2) is a Cobb-Douglas production function with two inputs: $(C - \gamma_1)$ and $(R - \gamma_2)$; an unambiguous level of output Q corresponds to each combination of these inputs.

Specification (2) is chosen because in retailing both selling area and remaining space contribute to establish the value of annual sales. Moreover, these inputs can be substituted for one another. This substitution represents different marketing or operational strategies within a retail category. A definition of a retail category (a group of stores which has a certain homogeneity regarding assortment composition, extent of own production, and type of organization) is flexible enough to permit such strategies.

A low ratio R/W is associated with:

- a high share of self-service sales and a low share of counter service sales
- a low share of own production, since this production is performed in the nonselling space as is usual in retailing
- a strategy in which only few goods are kept in stock and many are displayed
- a strategy in which most handling of goods and most activities of employees are performed in the selling area.

Of course a high ratio R/W is associated with the opposite strategies. A multiplicative specification is chosen because such a specification enables the effect of a change of one input factor on the value of annual sales to depend on the level of the other.

The coefficients of (2) can be interpreted as follows. The coefficient $\beta(X)$ is a function of the remaining heterogeneity X, which is related to the efficiency of the shopkeeper, which will be further discussed in our section on Estimation Results. Obviously, specification (2) is not homogeneous in C and R. However, it is homogeneous of degree ϵ, if $C - \gamma_1$ and $R - \gamma_2$ are regarded as input factors. A value of $\epsilon = 1$ indicates constant returns to scale, and increasing or decreasing returns are indicated by values greater or less than unity. The coefficient π indicates the degree to which stores of a certain retail category are selling area intensive. It will be called distribution coefficient of the partitioning of total floorspace.

The coefficients γ_1 and γ_2 denote certain threshold space requirements. A minimal amount of floorspace has to be present in every establishment of a shop type. We assume that this size is equal for all establishments, and it is used for activities which are indispensable for retailing. The concept of threshold space is appealing. Nooteboom (1982) uses threshold labor in his analysis of labor productivity. He provides a theoretical justification of the value of threshold labor using queuing theory. He analyzes floorspace productivity along the same line of thought. In this journal Thurik and Van der Wijst (1984) used the concept of threshold labor in their study of part-time labor in retailing. (See Nooteboom [1987] for a survey of studies using threshold labor in retailing.)

Equation (2) is based upon the concept of "space which determines sales." This concept is also encountered in spatial interaction models explaining total sales or market shares of shopping centers. See Lichfield (1970) for an extensive summary of these models, and Ingene and Lusch

(1981) for a review of follow-up models analyzing spatial marketing and the determinants of the retail structure. Furthermore, it is encountered at an entirely different aggregation level—the relationship between shelf space and sales per product. See Leone and Schultz (1980) for an extensive review. Finally, this concept is used in the work of Corstjens and Doyle (1981, 1983), who not only introduce cross-effects between products (product groups), but also the dynamic aspects of the market in their retail space allocation models.

Equation (2) summarizes constraints of a technical (operational) nature. Economic behavior (the shopkeeper's decision) determines how available total floorspace will be partitioned. This leads us to the fourth assumption: A shopkeeper tries to maximize the volume of his or her annual sales by appropriately partitioning the total available floorspace. The first order condition $dQ/dC = 0$ gives, after substitution of (1) into (2), the following condition:

$$C = \gamma_1 + \pi(W - \gamma_1 - \gamma_2) \tag{3}$$

Also, equations (1) and (3) give

$$R = \gamma_2 + (1 - \pi)(W - \gamma_1 - \gamma_2) \tag{4}$$

Equations (3) and (4) can be viewed as the linear shop design expansion path. It is easy to show that the solution defined by (3) and (4) refers to a maximum indeed.

We choose to assume the maximization of annual sales as opposed to profits because individual shopkeepers concentrate on sales or market share rather than on profits. Market share is indicative of this market power towards customers and suppliers. Furthermore, there are circumstances in which the continuity of a shop depends on the increase of sales rather than on that of profit, for example, if a certain market share or sales volume (scale economies) is necessary to be economically viable. Moreover, sales is an entity easy to observe continually, whereas profit is a result given, so to speak, by the auditor once a year. Furthermore, maximization of annual net profit involves not only the analysis of the factors influencing sales, but also those pertaining to the percentage margin and costs. Some empirical evidence also supports the use of sales maximization in favor of profit maximization. (See Thurik and Koerts [1985], who use material from large French supermarkets.) It is true, however, that larger, and hence more professionally managed, stores tend to become profit-driven. The French evidence does not reject this tendency, but at least suggests that it is weak.

A DISEQUILIBRIUM MODEL OF RETAIL BEHAVIOR

Under the assumption that sales capacity, Q^s, equals actual sales, Q, the model presented in the preceding section has been estimated for a large number of Dutch retail categories: independent supermarkets, independent superettes, chain supermarkets, chain superettes, greengrocers, baker's shops, confectioner's shops, independent clothes shops, small chain clothes shops, women's underwear shops, shoe shops, hardware stores, photographer's shops, florist's shops, and electrotechnical retailers. Additionally, several French supermarket-like retail categories have been investigated. The influence of a large number of exogenous variables has been studied: occupancy costs; assortment composition; weekly opening hours; presence of a gas station, cafeteria, and so forth; year of observation; and many other influences which only have a meaning for specific shop types. See Thurik and Koerts (1984a and 1984b) or Thurik (1984) for extensive reports on these exercises.

The assumption $Q^s = Q$ implies that demand is always large enough to sustain sales maximization constrained by the technical, supply-side opportunities represented by equation (2). This may not always be true, actually. Sales, and hence floorspace productivity, are determined by the interplay of supply and demand and cannot properly be analyzed from the supply side alone. Therefore, we introduce an explicit demand side in the model.

When demand is large enough, sales will be supply determined and the approach of the preceding section applies. With demand too small, however, sales will be demand determined, and we have to substitute another approach. Thus, we end up with a switching model, where sales, and the partitioning of the floorspace, are either supply determined or demand determined. As we do not know which of the two "regimes" applies to each one of the available observations (stores in our case), we have to include both possibilities in the model, leaving the data to decide on the most likely regime distribution. To the extent that sensible results can be obtained, the model may serve as a framework for a further investigation into the influence of environmental factors on floorspace productivity. Without an explicit demand side, these influences cannot be properly established. The model that we shall discuss assumes that shopkeepers partition their available floorspace in such a way that sales are maximized, but now we also take into account a demand constraint. Analytically, the level of annual sales Q and partitioning of available floorspace W in selling area C and remaining area $R = W - C$ are determined by solving the following problem:

$$\left.\begin{array}{l} \max\limits_{C} Q; \\ \text{subject to supply restriction:} \\ \qquad\qquad Q \leqq Q^s(C, W, X) \\ \qquad \text{and demand restriction:} \\ \qquad\qquad Q \leqq Q^d(C, X) \end{array}\right\} \tag{5}$$

where Q^s (C, W, X) is a condensed notation for equation (2), and a simple constant elasticity function is used as the demand function.

$$Q^d(C, X) = \delta(X)(C - \gamma_1)^{\eta} \tag{6}$$

where: $\eta > 0$, and $\delta(X) > 0$.

Selling area C is taken as an attraction factor rather than total available floorspace because this is what customers observe. We have included the same threshold as in equation (2). The specification of $\delta(X)$ representing other exogenous factors will be dealt with later.

Given supply and demand equations (2) and (6), the solution to the sales maximization problem (5) takes one of two possible forms, depending on the relative position of the two curves.

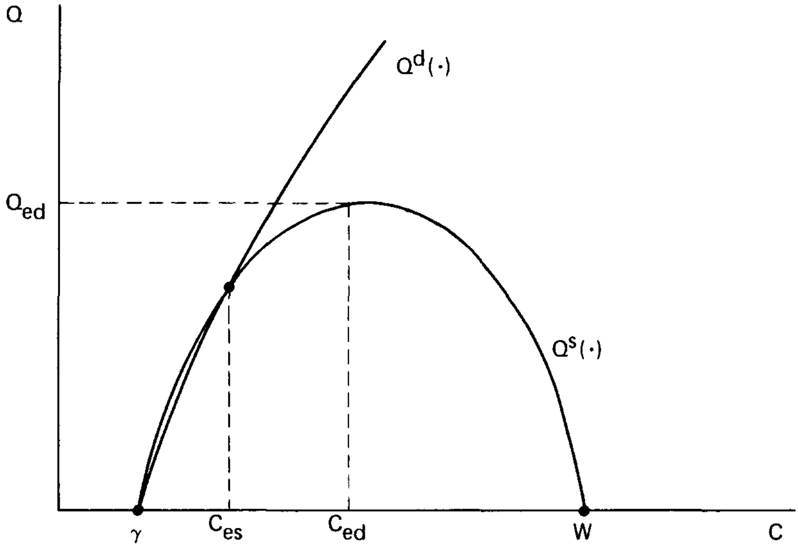
Figures 1 and 2 depict both possibilities. With demand large enough, as in Figure 1, the optimum is obtained at the top of the $Q^s(.)$ curve. When demand is too low to sustain this solution, the optimum is found at the intersection of the supply and demand curves, as in Figure 2. In other words, in situations of excess supply shopkeepers tend to increase the share of selling area, and, thereby, decrease the service level (so-called trading-down). It can easily be seen from the figure that analytically the value of C follows as the maximum of C_{ed} and C_{es}, that is, $C = \max(C_{ed}, C_{es})$, where C_{ed} is the solution (3) to the first-order condition $\partial Q^s(.)/\partial C = 0$, and C_{es} solves the equilibrium condition $Q^s(.) = Q^d(.)$. Moreover, it is immediately clear from the figure that the solution always lies on the supply curve. Consequently, our model for the endogenous variables Q and C reads as:

$$\left.\begin{array}{l} Q = Q^s(C, W, X); \\ C = \max(C_{ed}, C_{es}); \\ \partial Q^s(C_{ed}, W, X)/\partial C_{ed} = 0; \\ Q^s(C_{es}, W, X) = Q^d(C_{es}, X), \end{array}\right\} \tag{7}$$

where the last two equations only serve to define the latent variables C_{ed} and C_{es} figuring in the maximum condition for C.

FIGURE 1

Excess Demand; $Q = Q_{ed}$, $C = C_{ed} \geqslant C_{es}$



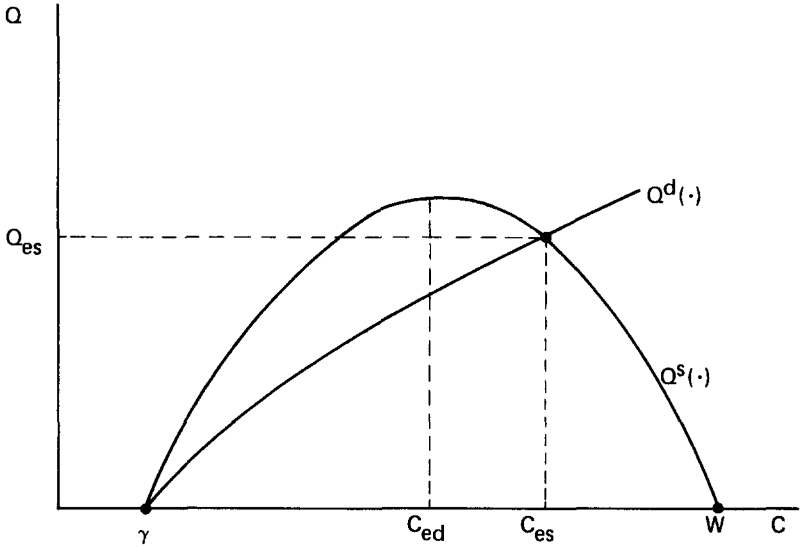
The type of model that we have obtained is known in the econometrics literature as a switching or minimum-condition model. See Kooiman, van Dijk, and Thurik (1985) for details on the estimation methodology. In the next section we shall discuss the main results obtained with this type of model.

Before discussing these results, we want to make four clarifications concerning our model:

1. There are many factors that can be influenced by the retailer in order to obtain a certain goal: in the short run one may think of pricing policy, service level, advertising policy, and so forth. In the long run we have store size, assortment composition (type of business), and so on. We do not intend to develop a long-run model for individual stores, because such a model would involve the modelling of competition, spatial consumer behavior, and so forth. (Cf. Knee and Walters [1985] for a general discussion of strategic concepts in retailing.) Such a long-run model exceeds by far the state of our actual knowledge in the light of our primary goal, which is the construction of a decision support system for individual retailers. (See Ingene and

FIGURE 2

Excess Supply; $Q = Q_{es}, C = C_{es} > C_{ed}$



Lusch [1981] for an attempt to build a partial [i.e., single store type] equilibrium model of retail structure involving both storekeeper and consumer behavior.)

2. In our analysis we employ only one instrumental (control, marketing-mix) variable, that is, the share of selling area. Clearly, this is not intended to do justice to the complex decision structure of retail behavior. However, our analysis must be seen as a first step towards the investigation of the usefulness of disequilibrium techniques when modelling the retail environment.
3. We assume that an increase of the share of selling area and, hence, a decrease of the service level occurs in the case of excess supply. The inverse holds true also in the (ultra) short run: if there are only a few customers at a certain moment (excess supply), store attendants will have more time than usual to service them (high service level). This inverse effect is rather a labor effect than a floorspace effect. Furthermore, it is questionable whether such very short-run effects can be detected from the annual averages that we analyze.
4. We choose to apply a disequilibrium model instead of an equilibrium model because of the low probability that retailers are in equilib-

rium. In a complex world of uncertainties, irrationalities, unexpected shocks, lagged reactions, limited or incorrect information, and so on, equilibrium is a highly theoretical construction. Adjustment speed may not be high enough to sustain equilibrium as a useful approximation in a dynamic reality.

In a cross-sectional analysis one is likely to encounter a significant number of establishments which are considerably out of equilibrium. Equilibrium models cannot properly account for such observations. Moreover, the disequilibrium model is more general than the equilibrium version, which is only one point in a continuum of possible outcomes. Only within the more general disequilibrium framework can we formally test whether equilibrium is the rule or the exception.

ESTIMATION RESULTS

We have estimated our model with data from a survey of Dutch independent supermarkets and superettes conducted in 1979 by EIM. The sample consists of 208 shops with floorspaces ranging from approximately 100 to 1600 m^2. We first discuss the specification of the shift factors $\beta(X)$ and $\delta(X)$ of our supply and demand functions (2) and (6). Some preliminary exercises indicated that the following specification performed rather well:

$$\beta(X) = \exp(\beta_0)(1 + B)H^{\beta_1} \tag{8}$$

$$\delta(X) = \exp(\delta_0 + \delta_1 F)(1 + B)^{1+\delta_2} \tag{9}$$

where B is the fractional gross margin $(P - I)/I$, with selling price, P, and purchase price, I; H is occupancy costs per square meter; and F is the relative share of sales of fresh products, as for example, dairy products, bread, fruits, and vegetables. Meat and meat products are not included in this variable. (The simultaneous influence of the latter variable could not be properly established empirically).

The *volume* of annual sales is not available for this shop type, where thousands of different goods are sold. It is replaced by *value* of annual sales. In (8) the role of B is to transform the value of sales Q into its volume. It serves as a proxy for prices and can easily be computed, because it also equals $(Q - PV)/PV$ where PV is annual purchasing value.

In (9) the factor $1 + B$ is present for the same reason, but also because we expect prices to influence the level of demand. Consequently, we interpret the parameter δ_2 as a price elasticity, expected to be negative. It is customary in retail productivity studies to assume that productivity increases with factor prices. For references see, for instance, *Journal of*

Retailing, Special Issue on Productivity, volume 60, no. 3, Fall 1984. High factor costs urge the shopkeeper to exploit his or her resources efficiently. Housing being a production factor in the retail industry, we have included occupancy costs in (8), where it serves as a proxy for efficiency. We expect the parameter δ_1 to be positive. Occupancy costs are likely to be correlated with the quality of the site, too. Thus, one can argue equally well that H has to be included in (9), where it serves as a proxy for attractiveness, that is, environmental factors influencing demand. We obtained unacceptable estimates including H in (9) instead of (8), or including H in both (8) and (9). We expect the parameter δ_1 in (9) to be positive as the availability of fresh products is likely to exert a positive influence on demand.

The point estimates are reported in Table 1. We have deleted the thresholds, γ_1 and γ_2 figuring in equations (2) and (6), since they invariably ended up at the imposed lower bound of zero. Using his supply-side model, Thurik (1984) reports the same result for this particular data set. The other supply-side parameters take plausible values and appear to be fairly well determined (estimated standard errors are very small when compared to the point estimates of all parameters). There is a strong effect of occupancy costs on sales performance ($\beta_1 = .75$), on which we have already commented. There are slight but significant diseconomies of scale ($\epsilon < 1$), and sales performance is maximal when about two-thirds of the available area is selling area ($\pi = .66$). The demand-side appears to be somewhat less well determined, except for the elasticity with respect to selling area, π, which is close to unity. The price elasticity δ_2 has a very large standard error, probably because gross margin is a bad proxy for selling prices.

TABLE 1

Parameter Estimates

Parameter	Equation	Estimate	Standard error
β_0	8	2.94	(.26)
β_1	8	.75	(.05)
ϵ	2	.87	(.03)
π	2	.64	(.02)
δ_0	9	0.52	(.30)
δ_1	9	1.39	(.54)
δ_2	9	−.36	(1.24)
η	6	.91	(.05)

We have tried to improve upon the specification of our demand equation by including a locational dummy in (9), indicating whether the establishment is located at a large shopping center or not. This proved to be insignificant. We have also included a dummy indicating whether or not the establishment contains a butcher shop, but this consistently ended up at the imposed lower bound of zero.

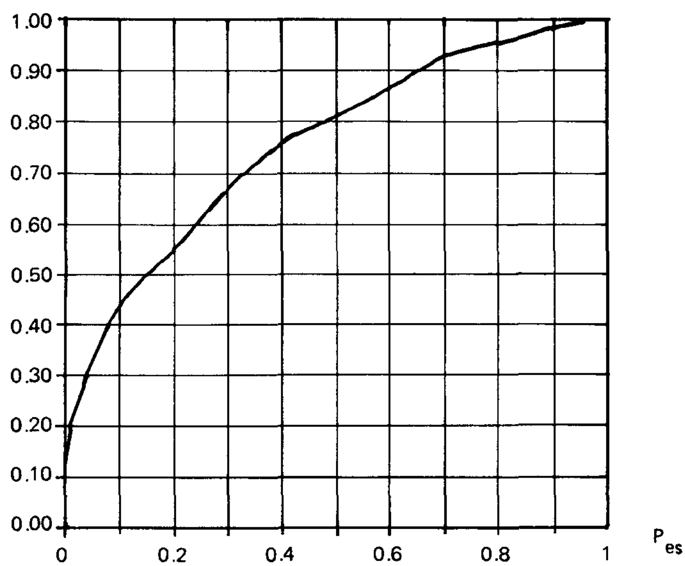
Probability of Excess Supply

Once the parameters have been estimated, we can compute the probability P_{es} that an establishment i in our sample is in excess supply. To be more precise, we evaluate $Pr\ (Q_i^s > Q_i^d \mid Q_i, X_i)$, that is, the conditional probability that supply Q^s is larger than demand Q^d for establishment i, given its observed level of sales Q_i and the values of the exogenous variables X_i. Figure 3 displays the results. The graph gives the fraction of the firms in our sample (on the vertical axis) with an estimated value of this probability of excess supply less than P_{es} (on the horizontal axis).

Clearly for most of the establishments the probability of excess supply is fairly low: 50 percent has a value less than .16. About 81 percent of the

FIGURE 3

Cumulative Distribution of Estimates of P_{es} in the Sample



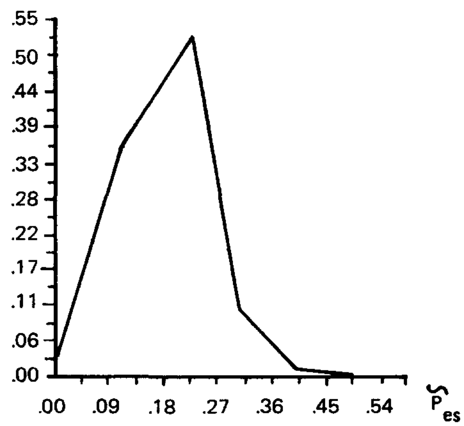
establishments in our sample have an estimated value of P_{es} less than one half, so that only for the remaining 19 percent excess supply is more likely than excess demand.

The probability of excess supply is computed using the point estimates of the parameters of the model. These point estimates have standard errors, though, and one might wonder how precise the estimated probability of excess supply is. Ideally one would like to have a 95 percent reliability interval associated with the graph of Figure 3. As this is far from easy to obtain, we shall concentrate on the average probability of excess supply $\bar{P}_{es}$ in our sample. It can easily be computed as the average of the estimated values of P_{es}. For our sample the value obtained is .24. As, again, this is an estimate, we may wonder how reliable it is. Figure 4 displays the density function of $\bar{P}_{es}$, as it was obtained from a Bayesian analysis of the model using a diffuse prior for the parameters of the model. For details see Kooiman, van Dijk, and Thurik (1985).

Figure 4 essentially shows how likely different values of the "true" $\bar{P}_{es}$ are, given the observations in our sample and the validity of our model. It is clear from the figure that the data reject the excess supply hypothesis fairly strongly: values larger than .5 have a probability (density) essentially equal to zero. We can also compute the standard deviation associated with the distribution of $\bar{P}_{es}$ in Figure 4. It is obtained as .065. This confirms that the data are quite informative with respect to the regime distribution.

FIGURE 4

Marginal Density Function of $\bar{P}_{es}$



According to our estimates, the majority of the establishments experiences an excess demand, so that the level of sales, and the partitioning of the available floorspace, are mostly determined from the supply side. This entails that Thurik's (1984) model, assuming excess demand for all establishments, may be an acceptable approximation.

CONCLUSION

The models discussed above represent a small step towards the creation of a microeconomic decision support system for retailers. The model can be extended in a number of ways:

- inclusion of more retail marketing variables, such as labor, pricing, and advertising, and the modelling of their influence. It is not yet clear whether disequilibria will persist at the theoretical level in such models.
- extension of the demand function for retail sales incorporating theories on spatial shopping behavior. Proceeding in this way, a complete model of the retail structure in the sense of Ingene and Lusch (1981) can be set up. In such a model not only retailers' behavior must be incorporated, but also that of consumers and local authorities. More specifically, for instance, retail labor productivity *and* consumer shopping productivity must be considered (Cf. Ingene [1984].) Such an extension not only has the challenge of making our model more plausible, but also of combining the North American emphasis to study retailing as part of marketing research (interrelationships between consumer and producer) and the European emphasis to study retailing as a "production" industry of its own.

Our present estimation results allow for two further conclusions, which have not been mentioned explicitly in the preceding sections. The first is that occupancy costs appear to be a supply factor rather than a demand factor. It is a supply factor, probably, because the efficiency of the shopkeeper is positively correlated with the factor prices he or she has to pay: only efficient producers can afford to employ expensive resources. It is not a demand factor, probably, because occupancy costs are not a good proxy for environmental factors influencing demand. The second conclusion is that there is no drastic overcapacity in the small Dutch independent grocery trade in 1979. Given the observations in our sample, the average probability of excess supply is estimated as 24 percent. In view of the fact that small independent grocers have the least competitive power in the grocery trade, it is likely that in 1979 no overcapacity occurred in Dutch grocery trade as a whole.

REFERENCES

Corstjens, M., and P. Doyle (1981), "A Model for Optimizing Retail Space Allocations," *Management Science*, **27** (7), 822–833

——— (1983), "A Dynamic Model for Strategically Allocating Retail Space," *Journal of the Operational Research Society*, **34** (10), 943–951.

Ingene, C. A. (1984), "Productivity and Functional Shifting in Spatial Retailing: Private and Social Perspectives," *Journal of Retailing*, **60** (3), 15–36.

Ingene, C A., and R. F. Lusch (1981), "A Model of Retail Structure," *Research in Marketing*, **5**, 101–164.

Knee, D., and D Walters (1985), *Strategy in Retailing*, Oxford. Philip Allan.

Kooiman, P., H. K. van Dijk, and A. R. Thurik (1985), "Likelihood Diagnostics and Bayesian Analysis of a Micro-economic Disequilibrium Model for Retail Services," *Journal of Econometrics*, **29** (1/2), 121–148.

Leone, R. P., and R. L Schultz (1980), "A Study of Marketing Generalization," *Journal of Marketing*, **44**, 10–18.

Lichfield, N , et al. (1970), "Urban Models in Shopping Studies," National Economic Development Office, London

Nooteboom, B. (1982), "A New Theory of Retailing Costs," *European Economic Review*, **17**, 163–186

——— (1987), "Threshold Costs in Service Industries," *Service Industries Journal*, **6** (1), forthcoming.

Thurik, A. R. (1984), *Quantitative Analysis of Retail Productivity*, Delft, The Netherlands: Meinema.

Thurik, A. R., and J. Koerts (1984a), "Analysis of the Use of Retail Floorspace," *International Small Business Journal*, **2**, 35–47.

——— (1984b), "On the Use of Supermarket Floorspace and Its Efficiency," in *The Economics of Distribution*, Milano: Franco Angeli Editore.

——— (1985), "Behaviour of Retail Entrepreneurs," *Service Industries Journal*, **5** (3), 335–347.

Thurik, A. R., and D. van der Wijst (1984), "Part-Time Labour in Retailing," *Journal of Retailing*, **60** (3), 62–80.