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PERSPECTIVES OF DISAGGREGATE CHOICE MODELS  
ON THE HOUSING MARKET

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## 1. The Housing Market

Human settlement patterns in a dynamic society are always characterized by a state of flux. They do not display a static pattern, but reflect the changes in economic conditions, the technological developments, the demographic changes, the social developments and the impact of public policy. This also explains the diversity in development patterns of settlement systems all over the world (see Nijkamp and Rietveld, 1981; Van Lierop and Nijkamp, 1981; Chatterjee and Nijkamp, 1981).

Furthermore, contemporary (economic, environmental, energy and social) problems are also sharply reflected in modern settlements: the economic recession has affected the housing market; environmental problems have caused a decline in the quality of life; energy shortages have reduced the spatial mobility; and social friction has led to segregation and social segmentation.

In consequence, an analysis of the housing market and of related settlement patterns is an extremely important issue, as it focuses attention on one of the central elements of a society in transition. In the light of the foregoing remarks, the housing market may be characterized as a multi-dimensional phenomenon marked, among other things by :

- complex search and choice processes of individual households due to multiple motives.
- the emergence of drastic shifts in locational behavior due to structural economic changes.
- the presence of positive and negative social spill-over effects (bandwagon effects, Veblen effects, segmentation effects, e.g.).
- a high public policy impact due to a strong institutional concern with living conditions of families.
- the occurrence of several disequilibrium situations between supply and demand for dwellings, due to land use competition, rigid decision procedures, demographic changes, and resource constraints.

The lack of insight into the direct and indirect consequences of public policy measures on urban housing markets and on the city in general, has led to the development of urban impact analysis (see Glickman, 1980, and Nijkamp, 1981). Though this may be a meaningful instrument in the public policy domain, it does neither offer a profound insight into the complex mechanism of the housing market nor in the way this market can be controlled by public policy.

In the seventies, a wide variety of (mainly urban) housing market models has been developed (see, for instance, Anas, 1976, Bird, 1976, Evans, 1973, Kain and Quigley, 1970, Putman, 1979, Richardson, 1977, Stahl, 1980 and Wilkinson, 1973). A recent extensive bibliography can be found in Porell (1981). Usually the choice of a specific type of model will depend on the research aims, the availability of data, the presence of suitable computer programs and data storage capacity, the research budget and so forth. Consequently, the search for an ideal housing market model is illusory. Only within given limits, an attempt can be made to construct the most appropriate model.

Despite this more modest attitude, several elements of a housing market model can be formulated which ought to be taken into account while designing such a model. These elements are :

- the existence of multiple actors and/or groups (supply and demand) with conflicting interests and preferences.
- the existence of a wide variety of individual motives and attributes of residential and locational behavior.
- the existence of a set of highly diversified objects of choice, so that a homogeneous commodity cannot be hypothesized (each dwelling has its own specific features).
- the existence of various spill-over and neighbourhood effects leading to complicated externality impacts.
- the existence of various links with urban and regional land use and hence with physical planning.

The foregoing elements may be regarded as necessary ingredients for an adequate housing market model aiming at a full insight into the quantitative and qualitative determinants of the choice mechanisms on a complex housing market.

## 2. A Classification of Residential Choices

Several migration studies have demonstrated that the decision to migrate may be the result of various determinants, such as the dissatisfaction with the present housing condition or the local residential climate, better perspectives offered by a labour market elsewhere, social circumstances and so forth.

Without loss of generality, it will be assumed for the sake of simplicity, that only two major determinants for the household's decision to move house can be distinguished :

- the relative dissatisfaction with the present dwelling compared to other dwellings including the quality of residential neighbourhood (in terms of rent, other housing costs, qualitative and quantitative attributes of the house itself and of its neighbourhood, etc.).
- the relative dissatisfaction with the present job compared to other jobs on other labour markets (in terms of income, status, future perspectives, etc.).

Other factors will be neglected for the moment, although they can easily be taken into account.

Another important distinction to be made is between the potential decision to change dwelling caused by a dissatisfaction regarding the present dwelling and/or the present job and the actual decision on the basis of the same factors. In the first case, households only have a drive to move house, but it is not assumed that they will indeed change dwelling. Clearly in the second case (of actual changes), one finds normally only a subset of households willing to move house.

It should also be noted that a change of a job within the same labour market area does not normally imply a drive to change place of residence, so that only a job migration outside the original local labour market area will lead to a stimulus to move house.

Given the two abovementioned, broadly defined determinants for the decision to change dwelling, viz. the housing situation and the labour situation, a classification of choices on the housing market can be made by dealing with the foregoing distinction into potential and actual decisions. The various combinations and implications are exposed in Table 1. The essential idea underlying Table 1 is in fact a conditional probability approach. The probability of a household to actually change its residence is co-determined by its prior inclination to leave its present house. The household's inclination is determined by psychological perceptions and preferences regarding the quality of the dwelling itself (including its neighbourhood quality and all other attributes of the quality of residential properties in relation to other dwellings) and the labour market situation (including future perspectives and qualitative aspects, in relation to other jobs).

		housing situation satisfactory	housing situation unsatisfactory
labour situation satisfactory		no drive to move house	drive to move house
		decision for actual change of dwelling : low probability	decision for no change of dwelling: high probability
labour situation unsatisfactory		decision for actual change of dwelling: low probability within labour market area; intermediate proba- bility for other areas	decision for no change of dwelling: high probability (except for non-local labour market areas)
		decision for actual change of dwelling: high probability within labour market area; low probability for other areas.	decision for no change of dwelling : low probability
		moderate drive to move house	drive to move house
		decision for actual change of dwelling: high probability within labour market area; high probability for other areas.	decision for no change of dwelling : low probability

Table 1 : Classification of choices on the housing market<sup>1)</sup>.

1) Of course, this two-by-two classification is restricted in scope. Further disaggregations might be made according to starters, household phase, etc.

This table constitutes the framework for the empirical analysis presented in the second part of this paper. Before presenting empirical applications however, a set of important analytical aspects of housing market studies will be dealt with.

3. Analytical Aspects of Housing Market Studies

As mentioned before, the 'ideal' housing market model does not exist. However, various aspects of housing market studies can be treated so as to use the best available knowledge and methods, given a concrete real-world situation. The following aspects will be dealt with more thoroughly:

- I. The extent to which the various sectors of the housing market are disaggregated (individuals, groups, society as a whole, etc.).
- II. The extent to which causal motives of choice processes for dwellings are included (preferences and perceptions, e.g.).
- III. The extent to which the variety of dwellings on the housing market are included (multiple housing attributes, etc.).
- IV. The extent to which time dimensions are taken into account (static, comparative-static, dynamic, learning processes, etc.).
- V. The extent to which consequences of choice processes on the housing market are taken into account (filtering-down processes, congestion, energy consumption, etc.).
- VI. The extent to which policy variables are included in the housing market model (regulations, zoning, subsidies, etc.).

In a specific housing market study and with a set of specific data, the six abovementioned aspects can, to a certain extent, be taken into account. This is illustrated in the hexagon of Figure 1.

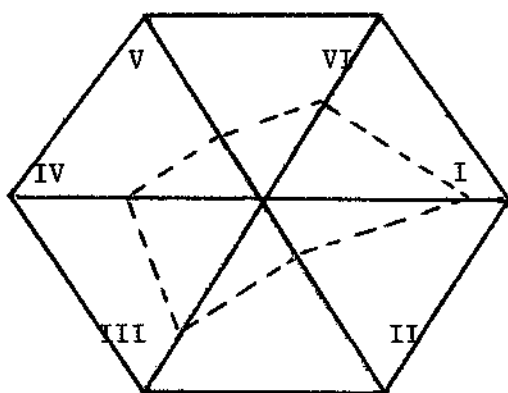


Figure 1. Aspects of a housing market study.



The envelope of the hexagon reflects a maximum fulfillment of the corresponding criterion (the 'best' treatment of a certain aspect). The dashed line may be regarded as an illustrative representation of the characteristics of a certain housing market study in a specific situation. The ratios of both corresponding surfaces represents the degree to which, in a specific situation, the various aspects have been taken into account.

In sections 4-9, the six abovementioned aspects will be discussed in greater detail.

#### 4. Level of Aggregation

During the seventies several discussions have taken place concerning the validity and applicability of disaggregate models of choice for the housing market. Instead of aggregate models based on fairly general utility principles, much attention has been focused on micro approaches to spatial choice behaviour.

Various advantages of disaggregate choice models can be mentioned (see also Hårsman and Snickars, 1976, Van Lierop and Nijkamp, 1980, 1982b, McFadden, 1978, and Van Lierop and Rima, 1982).

- a more adequate orientation toward a behavioural approach including 'maximizer' and 'satisficer' principles (see among others, Burnett, 1973; Clark and Cadwallader, 1973 ; Downs, 1973 ; Golledge and Brown, 1967 ; Gould, 1973 ; Rushton, 1969; Saarinen, 1976 ; Simon, 1957).
- a more precise description of actual spatial interactions, which can also be represented at various levels of aggregation.
- a closer link with recent tendencies to study choice processes on a longitudinal or dynamic basis.
- more possibilities for testing the statistical validity of empirical results from surveys or questionnaires.
- a greater flexibility in specifying choice processes as invalid assumptions about equilibrium trends, competition, homogeneity of land, and absence of neighbourhood effects need not be made (cf. also McDonald, 1979; De Palma and Ben-Akiva, 1981; Smith and Clark, 1981).
- more possibilities to treat qualitative information regarding choice processes on the housing markets (including perceptions and preferences).
- more possibilities to assess the impact of public policy measures on residential location decisions.

A wide variety of disaggregate models of choice for the housing market have been developed (see for a survey Van Lierop and Nijkamp, 1982b);

- deterministic models, in which utility functions are supposed to provide a precise description of the alternatives and pertaining attributes. Examples are:
  - . logit models
  - . gravity and entropy models
- probabilistic models, in which the probability of a certain choice or decision depends inter alia on observable attributes of choice objects.

Examples are :

- . constant utility models
- . random utility models, such as models with independent identically distributed error terms (rational models, multinomial logit models, binary logit models, elimination by aspects models, sequential logit models, e.g.), and closed-form models without independent identically distributed error terms (nested logit models, general extreme value models, prominence theory of choice models, negative exponential distribution models, e.g.), and multinomial probit models.

In the empirical application presented in this study, the multinomial probit approach will be chosen (for a justification see Van Lierop and Rima, 1982).

## 5. Elements of Choice Processes

Choice processes are multidimensional in nature (see Manheim, 1979): they are inter alia multitemporal, multi-problem oriented, multi-sectoral, multi-person and multi-disciplinary. In this respect, it may be meaningful to make a distinction between perceived and preferred elements of a housing situation. This distinction can easily be dealt with by the abovementioned disaggregate models of choice.

Another useful distinction is between the drive to move house and the actual decision to move house (see also section 2 and Van Lierop and Rima, 1982). This distinction will also be made in the empirical application at the end of this study.

It is also meaningful to make a distinction between descriptive and explanatory models of choice for the housing market. Some examples of each of these classes are included in Figure 2.

The design of models including causal motives for choice processes on the housing market requires indeed a precise analysis of the behaviour of households in their search and choice process regarding a house. In addition, such models should offer 1) a better understanding to planners and policy-makers regarding all relevant aspects of the housing market and 2) an adequate basis for forecasting future changes on the housing market (demand for new dwellings, demolition, e.g.). Hence, such models should also be able to encompass various constraints that restrict the fulfilment of residential motives and desires. Examples of such constraints are :

- demand constraints :
  - . consumer income and housing budget
  - . household size
  - . social control (Veblen effects, e.g.)
- supply constraints
  - . total supply of dwellings
  - . information on the housing market
  - . public, semi-private and private regulations on the housing market.

In the empirical part of the study, a disaggregate behavioural model will be presented which aims at taking into consideration the abovementioned aspects (see Van Lierop and Rima, 1982)

## 6. Attributes of Dwellings

Dwellings are heterogeneous commodities with a great deal of variety regarding age, size, quality, rent, neighbourhood quality, accessibility, distance to amenities and so forth. This multidimensional character of dwellings hampers a straightforward assessment of demand functions for dwellings. Instead, a more precise inventory of specific dwellings and of types of dwellings has to be made. This requires a micro analysis of the features of the choice object based on a multi-attribute approach.

The study in the empirical part of the paper uses a broad representative data-set to realize such a multi-attribute approach (see for more details Van Lierop and Rima, 1982). In this study housing types (the dependent variables) have been transformed into so-called dwelling-quality classes. This is done by means of an objective multi-attribute housing evaluation system as defined by the Dutch Ministry of Housing and Physical

Planning and the Ministry of Justice (1979). An integral and standard evaluation procedure has been developed by these Ministeries, based on a great variety of qualitative evaluation points for all relevant dwelling features (such as numbers of rooms, age, quality of bathroom equipment, distance to nearest shopping area, environmental neighbourhood quality etc.). By adding up all points of this objective evaluation profile, a total dwelling-quality-index for each dwelling can be constructed. These indices were originally related to the actual rents in 1977 in the Netherlands. By using various dwelling-quality classes the heterogeneous objects of the housing market can be characterized.

A multi-attribute approach can also be used in a more subjective way in order to define variables or indices which might explain why an individual household chooses a specific type of dwelling. For instance, it should be possible to define a set of important attributes which describe the quality of a house. Perception values of an individual household for these quality-attributes in a specific dwelling choice situation give together a total subjective impression of the housing quality.

#### 7. Time dimensions

Search processes on the housing market are never static, but will always have a dynamic character and also very often demonstrate learning aspects (cf. Weibull, 1978 ; De Palma and Ben-Akiva, 1981 ; and Clark and Smith, 1982). Such dynamic developments may be due to either exogenous shifts (changes in general mobility patterns, e.g.) or to internal (mental) developments of households (saturation effects, e.g.). In this respect, longitudinal analyses are a promising (though expensive) way of observing and analyzing consumer behaviour during a longer period. Especially when one takes into account in such a framework expectations households have about future housing costs versus the development of their income, about the future supply of the types of houses they prefer, about expected family size, etc., such analyses over time might be very powerful.

The temporal aspects of residential location relate to mobility decisions and/or to location decisions. Some existing housing market models study only one of these decisions. Others use a more integral concept, focusing on relocation decisions in a sequential or a simultaneous way. A further classification of all these models can be found in Fig. 2.

LEVEL OF AGGREGATION OF HOUSEHOLDS

		Macro				Micro					
		descriptive		explanatory		descriptive		behavioural explanatory			
		statistical	heuristic/analog	economic equilibrium	disaggregated behavioural input		statistical	survey	non-survey	revealed preference	direct preference
					non-survey	preference					
HOUSING MARKET PROCESSES	mobility	non-dynamic					Butler et al (T) (1969)			Weibull (T) (1978)	
		dynamic				Huff and Clark (T) (1978)				Swish and Clark (E) (1981)	
	location	non-dynamic	Wilson (T) (1970)	Berbert and Stevens (T) (1960)				Alesso (T) (1964)	McFadden (T) (1978)		
		dynamic					Nutz (T) (1969)		Kain et al. (E) (1976)		
	sequential relocation	non-dynamic							Van Lierop and Nijkamp (T) (1982c)		
		dynamic		Ingram et al. (E) (1972)							
	simultaneous relocation	non-dynamic						Porell (E) (1981)			
		dynamic	Simmons (T) (1974)		Wegener (E) (1979)	Van Lierop and Rime (T) (1982)		Wegener (E) (1979)	De Palma and Ben-Akiva (T) (1981)	Van Lierop and Rime (E) (1982)	

Fig. 2. A Typology for Characterizing Housing Market Analyses

Legenda: (T) : the model is theoretically oriented

(E) : the model is empirically oriented

An intermediate approach may be found by making an inquiry among households at two successive periods in time, so that yet shifts in housing qualities and perceptions thereof can be taken into account. A more specific application of such a double inquiry is that the first inquiry can be used to assess the willingness to move house and preferences households have for particular dwelling types, while the inquiry in the second period can be used to assess the real conditional probabilities for decisions to actually move into specific types of dwellings. In the present study we use such an intermediate approach.

#### 8. Impacts of Residential Decisions

Residential decisions do not only have an impact on the household's preference and perception pattern, but also on the whole spatial pattern of a society. Especially when a housing market model is developed for planning and policy purposes, it may be extremely important to encompass also many broader consequences of aggregate residential choices.

Examples of such impacts are :

- distributional effects on the housing market (filtering-down processes, e.g.).
- synergistic mobility effects (congestion and urban density, e.g.).
- resource use and environmental decay (energy consumption and exhaust fumes, e.g.).
- economic and financial implications (a rise in the mortgage rate, e.g.).
- social spill-over effects (segregation, e.g.).

Clearly, all such impacts are relevant for a policy analysis focusing on the housing market as a whole. In regard to the assessment of such effects, spatial impact analysis may be an appropriate tool (see Nijkamp, 1981).

#### 9. Policy Aspects

If the housing model concerned also aims at integrating policy measures for the housing market, relevant policy variables have to be included. Such measures can be sub-divided into nation-wide and region-specific variables. Examples of the first category are tax deductions due to the payment of mortgage rate or general housing subsidies; examples of the last category are zoning regulations, building permissions and urban systems of residential permissions.

The integration of policy variables in disaggregate models of choice can take place at two stages, viz. 1) by inquiring about the sensitivity of individual households regarding the importance attached to public policy measures, and 2) by assessing the effectiveness of public policy measures at a more aggregate level of analysis, once the individual motives have been analyzed by means of appropriate probabilistic demand models.

It should be noted that in general, the role of public policy variables in regional and urban models is far from satisfactory, so that in this respect a lot of work has yet to be done (see also Issaev et al., 1982).

#### 10. A Multinomial Probit Analysis of Choice Processes on the Housing Market

The following hypotheses are normally made for disaggregate choice models:

- Each individual (or household) has to make a choice out of a set of discrete alternatives  $\{i=1, \dots, I\}$  (for instance, dwellings).
- The population (individuals, households) can be partitioned into different (socio-economic or demographic) classes each having the same characteristics and the same choice set.
- A certain alternative is selected on the basis of the maximum contribution to the individual (expected) utility of a choice-maker.
- The utility associated with a certain dwelling is composed of an average (or systematic) utility and a disturbance term for individual differences.
- The average utility is defined as the mathematical expectation of all utility components associated with the attributes of a certain alternative (implying a multi-attribute utility approach).

Consequently, the utility of an alternative  $i$  for a household  $n$  can be written as:

$$U(\vec{z}_{in}) = v(\vec{z}_{in}) + \xi(\vec{z}_{in}). \quad (1)$$

where :

$$U(\vec{z}_{in}) = \text{the utility of alternative } i \text{ for a household of class } n.$$

$v(\vec{z}_{in})$  = the average, or systematic utility, which can be expressed as a - normally linear - function of a vector  $\vec{z}_{in}$  consisting of utility evaluations of  $J'$  attributes from a set of  $J$  possible ones  $\{j=1, \dots, J ; J' \leq J\}$ , which describe both alternative  $i$  and relevant socio-economic features of that household of class  $n$   $\{n=1, \dots, N\}$ . These utility evaluations of the attributes are assumed to be mutually (functionally) independent.

$\xi(\vec{z}_{in})$  = a disturbance representing the differences in preferences among individuals in a market class which have not systematically been quantified as, for instance, 'taste variations' over some observed attributes, individual measurement or weighing errors, possible inconsistencies in the individual household's choice behaviour, influences of missing, omitted or unobserved attributes, and of the restricted assumption normally made that the utility function is linear.

The probability  $P$  of a (random) household  $n$  choosing an alternative  $i$  can now be defined as :

$$P_{in} = \Pr \left\{ [v(\vec{z}_{in}) + \xi(\vec{z}_{in})] \geq [v(\vec{z}_{i'n}) + \xi(\vec{z}_{i'n})] ; i' = 1, \dots, I \right\}$$

$$i = 1, \dots, I ; n = 1, \dots, N \quad (2)$$

with the condition that :

$$\sum_{i=1}^I P_{in} = 1. \quad (3)$$

Formula (2) is the fundamental equation of the random utility approach. It indicates that  $P_{in}$  equals the probability of such a value for the disturbance term in the utility function, that the utility of  $i$  for a household  $n$  exceeds the utility of any other available alternative.

One of the most appropriate disaggregate choice models is the multinomial probit (M.N.P.) model. This model can be derived by assuming that the disturbances in (2) are normally distributed (see, for instance, Hausman and Wise, 1978, and Daganzo, 1979). This leads to the following probability function:



$$\begin{aligned}
 P_{in} = & \int_{\xi(\vec{z}_{in})=-\infty}^{\infty} \int_{\xi(\vec{z}_{In})=-\infty}^{\infty} v(\vec{z}_{in}) - v(\vec{z}_{In}) + \xi(\vec{z}_{in}) \dots \int_{\xi(\vec{z}_{i'n})=-\infty}^{\infty} v(\vec{z}_{in}) - v(\vec{z}_{i'n}) + \xi(\vec{z}_{in}) \dots \\
 & \dots \int_{\xi(\vec{z}_{In})=-\infty}^{\infty} v(\vec{z}_{in}) - v(\vec{z}_{In}) + \xi(\vec{z}_{in}) \dots N(\xi|0, \Omega) \dots d\xi(\vec{z}_{In}) \dots d\xi(\vec{z}_{i'n}) \dots \\
 & \dots d\xi(\vec{z}_{in}) d\xi(\vec{z}_{in}) \tag{4}
 \end{aligned}$$

where the number of integrals is equal to the number of alternatives and where  $N(\xi|0, \Omega)$  is a multivariate normal density function  $(f(\xi(\vec{z}_{In}), \dots, \xi(\vec{z}_{in}), \dots, \xi(\vec{z}_{i'n}), \dots, \xi(\vec{z}_{In})))$ , with mean vector 0 and covariance matrix  $\Omega$ . The structure of  $\Omega$  is defined by the joint distribution of the elements of the residual  $\xi$ .

Besides the possibility of introducing proxy variables, the above described M.N.P.-model provides more possibilities of bringing theory in agreement with reality. The M.N.P.-model allows the introduction of a dependent distribution for the residuals by making specific assumptions about the structure of the variance-covariance matrix  $\Omega$ . In this respect two possibilities exist.

I. A variance-covariance matrix, which is the same for all individuals.

For the binomial case this variance-covariance matrix takes the following form :

$$\Omega = \begin{bmatrix} \theta_1 & \rho \\ \rho & \theta_2 \end{bmatrix} \tag{5}$$

The values of  $\theta_1$ ,  $\theta_2$  and  $\rho$  can be estimated simultaneously with the influences of the specified explanatory variables by means of a single numerical approximation method.

II. A variance-covariance matrix of the Hausman and Wise(H.W.) form.

For the binomial case this variance-covariance matrix has the following form:

$$\Omega = \theta \cdot \begin{bmatrix} E(\text{Alt. 1}) & \rho \sqrt{E(\text{Alt. 1}) E(\text{Alt. 2})} \\ \rho \sqrt{E(\text{Alt. 1}) E(\text{Alt. 2})} & E(\text{Alt. 2}) \end{bmatrix} \quad (6)$$

From (6) it can be seen that the variances of the alternatives are proportional with the alternative-means and that the covariances are proportional with the root of the product of the means. Also here  $\theta$  and  $\rho$  can be derived simultaneously within the framework of the entire estimation procedure.

The benefit of the latter form compared with the first one is that different variance-covariance matrices can be defined for different individual households without a loss of degrees of freedom (caused by the introduction of additional parameters). The appearance of differences of variances of alternatives and of covariances between alternatives for individual households seems intuitively very realistic. It means that 'taste variations' can exist among the individual households concerning various alternatives (see Daganzo, 1979).

So, in conclusion, it can be stated that the possibility of using residuals with different variances, that may be correlated with each other, provides a sound theoretical potential of studying household interactions in search and decision processes on the housing market.

11. Towards an Operational Disaggregate Model of Choice for the Dutch Housing Market<sup>1)</sup>

a. Purpose

The model to be presented here is a part of a bigger research project at the department of Regional Economics at the Free University in Amsterdam. The purpose of this research project is to create an operational disaggregate model for the Dutch housing market. Several articles and papers have already been presented in this framework ; see, among others, Van Lierop, 1981, Van Lierop and Nijkamp 1982b, and Van Lierop and Rima, 1981 and 1982.

The operationalization of the research purpose can briefly be described by means of Fig. 3. In this figure we present the current and future total demand and secondary supply (i.e., the supply induced by filtering processes) on the housing market by dwelling type and for each household class.

1) In association with Annemarie Rima.

Demand and secondary supply		Households inclined to move by class (for instance, defined by income or age)				Starters by class	Total preferred dwellings by type
		I	II	,....., N	$\sum_{n=1}^N n$		
desired supply and actually satisfied demand		old dwelling-type	old dwelling-type		old dwelling-type	I, II, ..., N	
		1, 2, ..., I	1, 2, ..., I		$\Sigma 1, \Sigma 2, \dots, \Sigma I$		
preferred dwelling-type	1						
	2						
	.						
	.						
	I						
total potential secondary dwelling supply by type							
							Total actually chosen dwellings by type
actually chosen dwelling	1						
	2						
	.						
	.						
	I						
total real secondary supply by dwelling-type							

Fig. 3. Research purpose ; overview of housing demand per dwelling-type by households .

Moreover, it aims at giving policy-makers and planners insight into the discrepancies between preferred dwellings of specific types by given household classes and the dwellings actually chosen by these households. Knowledge of this choice process and the reasons why many people move into dwellings of their second or third etc. choice may stimulate policy-makers and planners to undertake actions leading towards a better functioning of the housing market.

b. Model type

In our opinion, the nature of our research project described by Fig. 3 is too complicated to be analyzed by means of a typical aggregate method to study the housing market. Trying to focus on several household classes and dwelling types and including dwelling preferences causes a need for a more disaggregate model. Furthermore, because it is realistic to assume the existence of interrelations between many dwelling types on the housing market, we have chosen a model which is able to cope with interdependencies between the various relevant alternatives. In this respect, we judged the M.N.P. model with a full variance-covariance matrix (H.W. form) to be most promising from a theoretical point of view. Evaluating this model in a first simple empirical case against a M.N.P. model (with the same variance-covariance matrix for all individual households), and against a multinomial logit model gave indeed support to this theoretical idea (for a more elaborate description of this exercise see : Van Lierop and Rima, 1982).

Consequently, all calculations in the first phase of this research project are based on a M.N.P. model with a variance-covariance matrix of the H.W. form. Clearly the usefulness of this kind of probit analysis in more complex practical cases has to be studied in greater detail, but it seems most likely that the probit model will be extremely expensive to estimate in cases with numerous alternatives.

If one can organize in such cases the alternatives in a straightforward nested structure, then the 'nested logit' model might be able to deal effectively with numerous alternatives (see Van Lierop and Nijkamp, 1981b). For the moment, it is not possible to indicate precisely which model will be judged by us at the end as the most suitable one for our study.

c. Data

The data used by us have not especially been sampled within the framework of our study. They were sampled for the sake of a study into dwelling preferences in the Netherlands by means of economic-psychological methods (see Kuylen, 1980) and consist of the results of two home-inquiries. The information has not been derived from one specific and clearly described regional or urban housing market, but has been sampled in a big number of municipalities all over the country. These municipalities did not only differ in geographical location, but also in size, degree of urbanization, growth pattern and tension between demand and supply, and regulations on the housing market. The purpose of this variety was to give a representative description of the entire Dutch housing market.

In the first inquiry, held at the end of 1977, information was gathered about a large number of various characteristics of about 2000 households, about attributes of their current housing-situation and about their housing preferences. It included many elements which could give a better understanding of the priority schedules of households concerning many housing aspects.

The second inquiry was held one year later, at the end of 1978, in order to examine the stability of the household's judgements on housing attributes and to examine the discrepancies between the actual moving behaviour and the dwelling preferences which had been reported in the first inquiry. Those households which had a drive to move house at the time of the first inquiry have been interviewed again in the second inquiry, as well as those which were not inclined to move but yet had been moved at the time of the second inquiry. A special drawback of the data, that should be mentioned here, is that starting households have not been taken into account. This might disturb the importance of our research results as starters form a considerable part of the annual demand for housing (see Ministry of Housing and Physical Planning, 1979).

Fig. 4 gives a brief impression of the 1394 data which were suitable to be used by us. For a more extensive overview, including a description of the screening process and the construction of relevant variables, see Van Lierop and Rima, 1981 .

		drive to move house in 1977		
		yes	no	
actually moved in 1978	yes	112	20	132
	no	281	981	1262
		393	1001	1394

Fig. 4. Households inclined to move in the first home-inquiry and actual behaviour assessed one period later.

d. Research strategy

Fig. 5 gives a short overview of the structure of our research strategy to model the Dutch housing market.

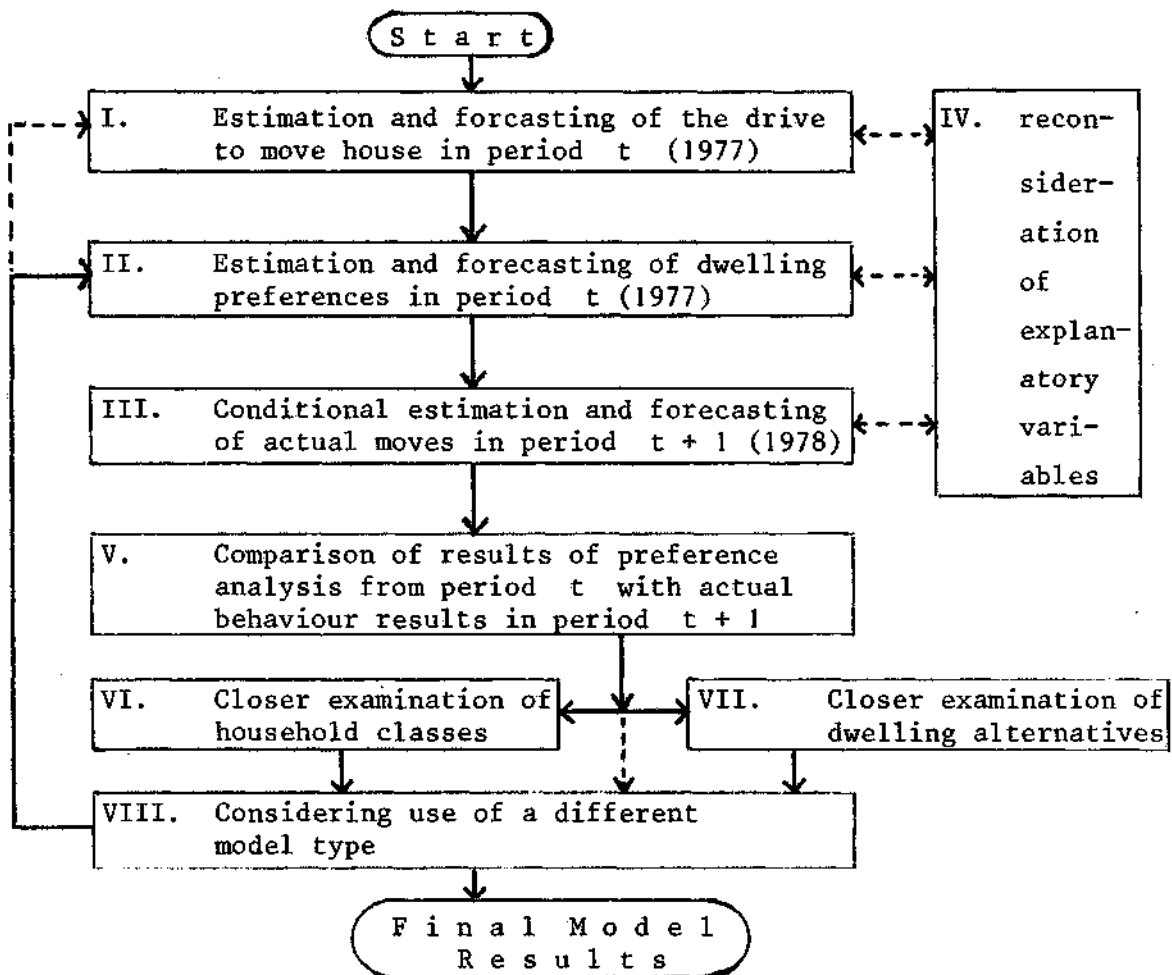


Fig. 5. Structure of research strategy to model the Dutch housing market.

I. In the first phase of the research process in Fig. 5, the inclination, willingness or drive to move house of individual households is analyzed. Then, in the remaining part of the analysis, only the behaviour of those households which actually want or are likely to move is taken into account. The decision to do so is based on former empirical studies (see, for instance, Kuylen, 1980) and on discussions about the analysis of housing search and choice with research fellows of the Dutch Ministry of Housing.

An important consideration in this respect is that households which are not willing to move do not have clear ideas about their dwelling preferences. Data derived from them in a home-inquiry by which they are asked for their priorities are normally rather diffuse and not of much value.

The actual relationship for studying the probability that an individual household is willing to start searching is still quite difficult. We assume the single probability of just the willingness to move does not necessarily have to be connected with the (expected) utility of a new dwelling and even not with the transition costs. If one wants to explain the reason of unfulfilled preferences, and also to discover all households which urgently need another dwelling (for instance, because of housing demolition, change of work, school etc.), the analysis of the willingness to move should start with a focus on aspects describing the relevant households and their present dwelling, plus on other aspects which might push them to move or keep them in their old place.

We assume that probability,  $P_{tin}$ , that a household  $n$  is willing to move from its current dwelling  $i$  in period  $t$ , to be equal to the probability that the expected utility of moving minus the transition costs exceeds the expected utility of staying (conform formula (2)). In our view, expectations are in this respect much more important than actual values of utilities. Often, however, the possibilities to include expectations in the analysis are rather limited due to data problems. Besides, special problems might occur in calculating the necessary present values of expectations (for instance, how to evaluate future profits?).

The relevant utilities of moving versus staying can be defined now as a function of :

1. the 'price/quality' ratio of the current dwelling  $i$  for household  $n$ .
2. the 'income/current housing costs' ratio on household  $n$ .

3. the 'family size/number of rooms' ratio of the current dwelling  $i$ .
4. information on whether the household has to move due to demolition of its current dwelling,
5. the expected utility of moving from  $i$ . We suppose that in this first phase of defining the willingness to move, individual households will not yet have a clear idea about expected utilities they might get from specific alternative dwellings. At this point the expected utility of moving from  $i$  will be mainly influenced by the availability of many (desired) dwellings.

Therefore, we suggest to include in the utility function for the probability that a household  $n$  will move in period  $t$ , a factor representing the perception of the tension (or vacancy rate) on the housing market in period  $t$ .

6. feelings about present distance to work or to school.
7. the desire of household  $n$  of owning a house instead of renting.
8. the transition costs of moving from  $i$  (including the evaluation of the search time). It should be noticed that this variable has a special character. Some evidence exists (see, for instance, Meyer, 1981) that transition costs (or, preferably, perceptions of these costs) play an important role at the beginning of the search process, while - after more information has been gathered about the availability of choice possibilities and the utilities one may expect - in later phases of the process its influence seems to be marginal or even zero. The treatment of this problem is very difficult and cannot be covered in our empirical analysis as, regrettably, data concerning the costs of moving are lacking.

- II. In the second stage we estimate and forecast the probabilities that households in specific classes - given a drive to move - prefer certain types of houses.

The dependent variable is then the sumtotal of dwelling-quality-points of the current (period  $t$ ) dwelling of the individual household. This sumtotal, however, has been adjusted for preference judgements of the household concerning a whole series of housing attributes. This adjustment procedure can be justified given the fact that only few households will have very unrealistic preferences. People tend to define preferences while taking into account the relevant con-



straints.

The following explanatory variables have been taken :

1. the 'price/quality' ratio of the current dwelling  $i$  for household  $n$ .
2. the 'income/current housing costs' ratio of household  $n$ .
3. the 'family size/number of rooms' ratio of the current dwelling  $i$  for household  $n$ .

The probability that a random household from the population will prefer a particular dwelling type is the product of the probability of a drive to move house for households from the same class as this random household with the probability that 'inclined' households from that class prefer that particular dwelling type.

- III. The third part of the model structure in Fig. 5 consists of estimating and forecasting the probabilities that households in specific household classes (given a drive to move in period  $t$ ) actually move into particular types of dwellings in period  $t+1$ . The dependent variable is in this case the sumtotal of dwelling-quality-points of the dwelling into which the relevant households moved in period  $t + 1$ . The variables which should explain why households are pulled to a specific dwelling type are :
1. the 'price/quality' ratio of the new dwelling  $i$  for household  $n$ .
  2. the 'income/current housing costs' ratio of household  $n$  in period  $t + 1$ .
  3. the 'family size/number of rooms' ratio of household  $n$  in period  $t + 1$ .
  4. the perception of household  $n$  of the vacancy rate on the housing market.
- IV. This stage is an intermediate level for the first three phases. In this phase a reconsideration of the explanatory variables takes place.
- V. In this phase of our research, a comparison is made between the results of the preference analyses from period  $t$  (phase II) and the actual behaviour results from period  $t + 1$  (phase III).
- VI. In the sixth phase, the analysis does not focus on the whole population but rather on various distinct household classes.

- VII. The seventh stage makes a more precise distinction among alternatives which can be chosen. This is done by separating into more parts the scale on which the dwelling-quality-point classes are ranked. In this way we can - after a simple bivariate research start - proceed to the analysis of more complex multivariate dwelling choice situations.
- VIII. In the last phase, we have to consider the use of a research model which offers an alternative to the M.N.P.-H.W.type. Various alternatives, modelling problems and/or research budget problems might - in this phase - force researchers into the direction of a 'nested logit' model (see Van Lierop, 1981). In this respect, a generalized loglikelihood test can be helpful to examine whether an alternative model should be preferred.

After phase VIII - but also already after an earlier phase - a return to one of the previous phases of the research structure might be necessary.

## 12. Provisional Empirical Results <sup>1)</sup>

One of the first estimations carried out concerned the calculation (by means of a bivariate probit model-H.W. form) of the probability of the drive to move house for the entire population. Explanatory variables included were - apart from a constant term - : 'price/quality' ratio, 'income/current housing costs' ratio, 'family size/number of rooms' ratio (defined before) and a 'forced moves' dummy . The last variable indicates whether one wants (i.e., almost necessarily has) to move because of reasons related to work or school, or whether one has to move because of, for instance, demolition of the current dwelling. This dummy has a value 1 in case of a forced move and a value 0 otherwise.

The results of this phase I-estimation <sup>2)</sup> are :

1) In association with Annemarie Rima.

2) For the estimation we used the computerprogram CHOMP (see Daganzo and Schoenfeld, 1978).

explanatory variables \ alternative	constant term	'price/quality' ratio	'income/current housing costs' ratio	'family size/'forced moves' number of rooms' ratio	'forced moves' dummy
1 (no drive to move house)	1.32463	1.06101	0.02343	0.78619	-1.68241
2 (drive to move house)	0.48885	1.05174	0.01891	1.11327	1.16366

$\theta = 0.35768$

$\rho = 0.55240$

The corresponding maximum loglikelihood value is : -736.79

As was expected, in the first equation of these estimation results - explaining that household  $n$  will not move from its current dwelling - the coefficient of the 'forced moves' dummy is negative.

Leaving one's house should have a very negative correlation with the willingness not to move.

Based on these results, we predicted <sup>1)</sup> the following probabilities with which households might have a drive to move house or not :

	<u>predicted probabilities</u>	<u>realized choices</u>
alternative 1 (no drive to move house) :	0.69037	0.71808
alternative 2 (drive to move house) :	0.30963	0.28192

Comparison of the predicted probabilities with the realized choices leads to the conclusion that research phase I gives reasonable results. However, a rather high multicollinearity exists between the explanatory variables, which causes the standard deviations to be fairly high. More attention to this problem of multicollinearity will be paid in a next report of this research (consequently in this paper no standard errors will be presented).

A provisional first example of research phase VI in combination with phase I is given by the following estimation and prediction results from separate analyses for two income-classes. As criterium for this separation procedure, the average income (Dfl. 2016,- per month, after tax) is taken.

1) For the prediction of the probabilities we used the computerprogram CONFID (see Sparmann and Daganzo, 1979).

1) Household income > Dfl. 2016; number of households: 490

explanatory variables \ alternative	constant term	'price/quality' ratio	'income/current housing costs' ratio	'family size/ number of rooms' ratio	'forced moves' dummy
1 (no drive to move house)	1.48850	0.73159	0.00932	0.74620	-1.10319
2 (drive to move house)	0.69674	1.02306	0.00207	1.18010	1.13693

$\theta = 0.47355$   
 $\rho = 0.49023$   
maximum loglikelihood = -275.28

	<u>predicted probabilities</u>	<u>realized choices</u>
alternative 1 (no drive to move house) :	0.68735	0.66735
alternative 2 (drive to move house) :	0.31265	0.33265

2) Household income  $\leq$  Dfl. 2016; number of households: 904

explanatory variables \ alternative	constant term	'price/quality' ratio	'income/current housing costs' ratio	'family size/ number of rooms' ratio	'forced moves' dummy
1 (no drive to move house)	1.62347	0.62764	0.01836	0.71191	-1.13039
2 (drive to move house)	0.64080	1.02306	0.01666	1.11248	1.15949

$\theta = 0.38312$   
 $\rho = 0.56178$   
maximum loglikelihood = -459.49

	<u>predicted probabilities</u>	<u>realized choices</u>
alternative 1 (no drive to move house) :	0.71558	0.74558
alternative 2 (drive to move house) :	0.28442	0.25442

As was expected, the coefficients do not differ in a significant way. It is striking, however, that the difference in drive to move house between the income classes is not as large as was expected. One possible explanation for this may be that we have chosen our separation criterium (the average income) too low in this first case. Also a more thorough analysis may show that (expected) increase in income is more important for the willingness to move than the absolute income level.

Further empirical results will be presented in a follow-up of this paper.

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