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DYNAMIC MODEL OF HOUSEHOLD RELOCATION
FOR THE AMSTERDAM REGION

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DYNAMIC MODEL OF HOUSEHOLD RELOCATION

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1. Introduction

In this paper some empirical results arising from the application of a operational dynamic model for household relocation on Amsterdam and its surroundings are presented. On previous occasions we have already presented theoretical parts and preliminary results of the model (see for instance, Nijkamp et al., 1985; Van Wissen et al. 1986), but now this project is reaching its final stage, we can give some final results.

The paper is based mainly upon chapters 5, 10 and 11 of Rima and Van Wissen (1987), and due to space limitations only global results with respect to total population, households and migration can be given. For more detailed outcomes for specific zones, household classes, etc. the interested reader is referred to Rima and Van Wissen (1987). The paper is organized as follows. Firstly, in section 2 the definitions of the study-area, the dwelling and household classes are given, since the results presented in section 3 and 4 cannot properly be understood without knowledge of these definitions. Secondly, in section 3 the relocation model is tested for the period 1971-1984 and some results for this validation period are given, while in section 4 some results regarding two scenarios for the period 1985-2000 are presented. The paper ends with some concluding remarks in section 5.

2. Definitions Used and Selection of the Study Area

The city of Amsterdam is divided into 11 zones. Since the housing market of Amsterdam cannot be studied in isolation from the surrounding region (because of both functional and institutional relationships), the housing market of surrounding municipalities, clustered into 9 zones (defined as the Region), have also been taken into account (see figure 1).

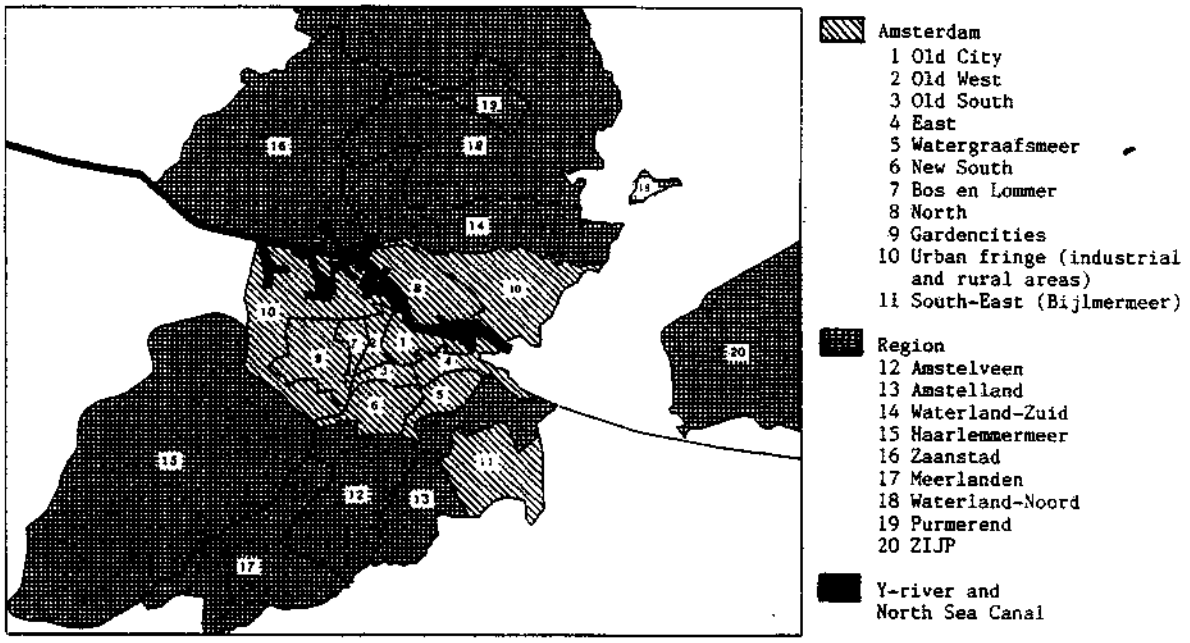

Figure 1. The study area divided into 20 zones

Demographic developments and migrations are distinct, but interrelated phenomena. The relation between demographic changes of an individual and the behaviour of that individual on the housing market has been the subject matter of much research (see for instance, Clark, 1982; Clark and Van Lierop, 1986; Hårsman, 1985). However, the decision of this individual cannot be seen independently from the decisions of other

individuals with regard to the housing market. In the last decades it was recognized that the basic decision unit on the housing market is the household (Wegener, 1983; Fisher and Aufhauser, 1986, Clark et al., 1985). For our purpose, the household is defined as a group of individuals who live together in a dwelling and make a decision to move together. There may be one or more households in a dwelling. Also households can be formed and disappear. The households in the study area are aggregated into 24 household types (see table 1) with significant large numbers and different behaviour on the housing market.

Table 1. The definition of the 24 household types

hh. size / age class	1	2	3	4+
1) <25	1	2	3	4
2) 25-34	5	6	7	8
3) 35-44	9	10	11	12
4) 45-54	13	14	15	16
5) 55-64	17	18	19	20
6) 65+	21	22	23	24

The consideration of sufficiently large cells is also valid for the classification of the dwellings into 11 dwelling types (see table 2), but in addition a clustering is chosen for which the outcomes can be aggregated into policy relevant classes.

Table 2. The definition of the 11 dwelling types

number of rooms / dwelling characteristics	1 or 2	3	4	5+
rented flats	1	5	6	9
owner occupied flats	2	2	2	2
rented single family units	3	3	7	10
owner occupied single family units	4	4	8	11

For the sake of understanding the empirical outcomes presented in the subsequent sections, the general structure of the dynamic model for household relocation is depicted in figure 2 by means of an accounting framework. The relocation model consists of different submodels in which different models, simulation and estimation techniques are used. For instance, the demand model is based upon a three level nested logit model, whereas the household model can be seen as part of the family of mulitistate demography models (see for more details Rima and Van Wissen, 1987). Starting point at time period t is the occupancy matrix: the number of households per household type and dwelling type. Next, in the household model the transition matrix of household types is modelled, i.e., the number of households moving from one household type to another is estimated. Multiplication of these two matrices gives the occupancy matrix before migration. This matrix is the major input in the housing demand model, in which the potential or notional demand per dwelling type and household type for every zone in the study area is

calculated. Finally, in the allocation model, housing demand is allocated to the housing supply. The resulting occupancy matrix forms the input for the next time period t+1.

Having described the definitions used and the overall design of the model we will now turn to the testing of the model for the validation period in section 3.

3. Modelling Results for the Period 1971-1984

In this section a validation test is conducted using observed data in the period 1971-1984. This validation test will determine whether the model is capable of reproducing observed developments in household number and relocation behaviour in the study area. A small set of aggregate data for the year 1982 is given that contains in a nutshell the most important information to determine the overall model performance.

In practice a number of model alternatives with different parameter values has been tested, but in this section only the final model which gives the most satisfactory results is presented. This model is also used in section 4 for the simulation of two housing market scenarios.

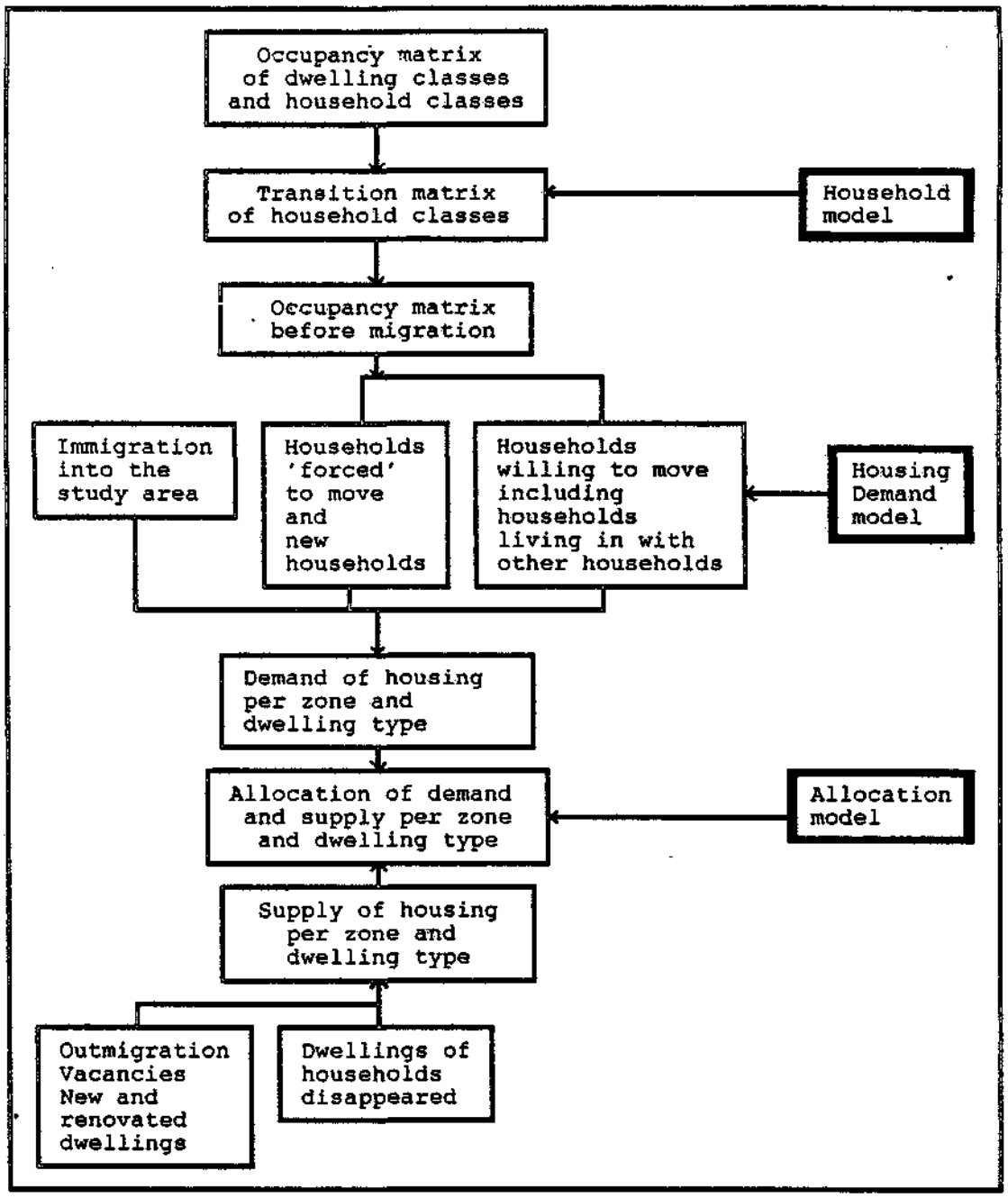

Figure 2. The accounting framework for the relocation model

In tables 3 to 5 the global results of the final model for the 1982 are compared with the observed values. The performance in terms of total numbers of households and population levels for both Amsterdam and the Region are satisfactory (see table 3). The total population estimate is

slightly below the observed figure and there is only a gap of 5000 households in Amsterdam. The household estimate for the Region indicates a modest overestimation of households generation in this area. Calculated total household level for the total study area is approximately equal to the observed total of 515,000 in 1982.

Table 3. Calculated and observed persons and households in Amsterdam and the Region in 1982

Household size	Amsterdam		Region		Total	
	Model	Obs.	Model	Obs.	Model	Obs.
Population	697	701	537	534	1235	1235
Households	325	330	188	185	513	515

Table 4. Calculated and observed size distribution of households in Amsterdam and the Region in 1982

Household size	Amsterdam		Region	
	Model	observed	Model	observed
single	43	42-44	23	17
2 persons	29	31-33	25	29
3 persons	15	12-13	22	16
4+persons	12	12-15	30	39

In table 4 the model results for household size are reported. The results for Amsterdam are very good. All predicted percentages are close to the observed shares. Two person households are underestimated by two percentage points and three person households are slightly overestimated. The regional outcomes are less satisfactory. Singles are overestimated and large households are underestimated.

The age distribution of households is shown in table 5. The youngest age category is somewhat overpredicted and households in the one but youngest age category are underestimated. The remaining age categories are closely approximated by the model. For the Region there is a larger variation around the observed data. The youngest age category is highly overestimated.

Table 5. Calculated and observed age distribution of households in Amsterdam and the Region in 1982

Age of head	Amsterdam		Region	
	Model	observed	Model	observed
0 - 24 Y.	13	9	13	4
25 - 34 Y.	19	25	21	25
25 - 44 Y.	15	15	19	23
45 - 54 Y.	14	13	17	17
55 - 65 Y.	14	15	14	15
65 + Y.	24	24	16	16

Household data are only available in Amsterdam and the Region for a small number of years (for instance for the year 1982 the household figures can be derived from the large sample on dwelling preferences (WBO, 1982)), but figures on total population are available for the whole validation period. Figure 3 presents the total observed and calculated population developments in Amsterdam and the Region. The two curves for both areas almost exactly mirror each other, with Amsterdam losing 120,000 inhabitants and the Region increasing with almost the same number after 1971. Calculated trends for both Amsterdam and the Region conform very well with the observed pattern, although there is some divergence after 1982.

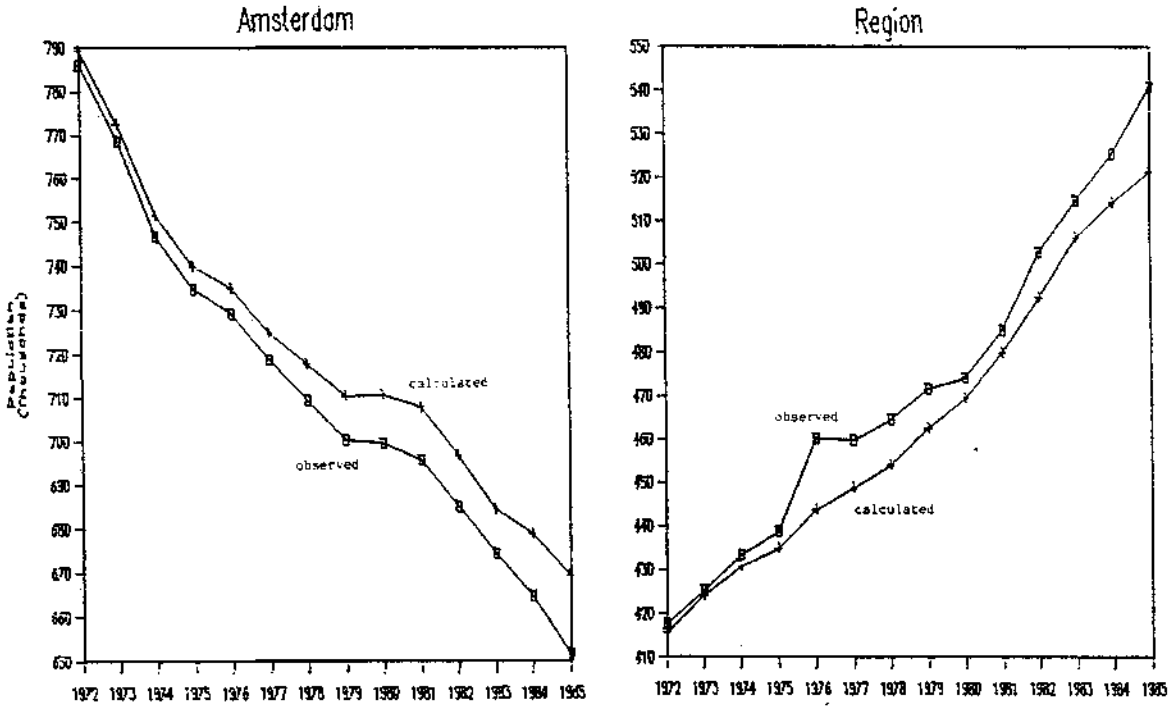

Figure 3. Total calculated and observed population developments in Amsterdam and the Region, 1972-1984

In addition to the comparison of the calculated results for the "stock" variables on households and population with the observed values, also the outcomes of the "flow" variable of migrations can be compared with real world data. In figure 4 to 7 the total migration flows from and to Amsterdam and from and to the Region for the period 1971-1984 are shown. Especially the calculated flows of total intra-zonal migration within Amsterdam correspond very well with the observed outcomes and the observed flows between Amsterdam and the Region and the intra-zonal migrations in the Region are not that good but still acceptable taking into account the fact that these outcomes are solely the result of the allocation model and not constrained by observed values. The observed trends in the migrations flows can also be found in the calculated flows, although the yearly fluctuations in the observed flows are not reproduced by the model outcomes, which show a more smooth pattern.

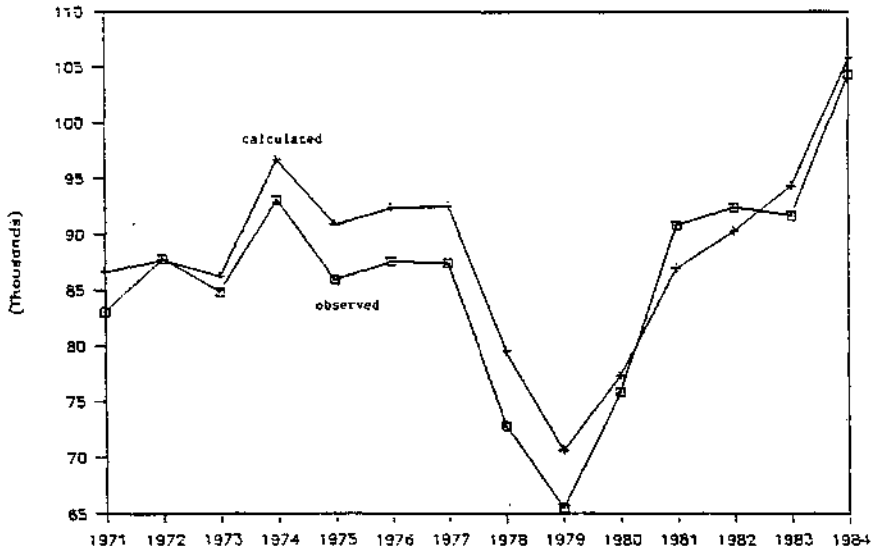

Figure 4. Intra-zonal migration within Amsterdam, 1971-1984

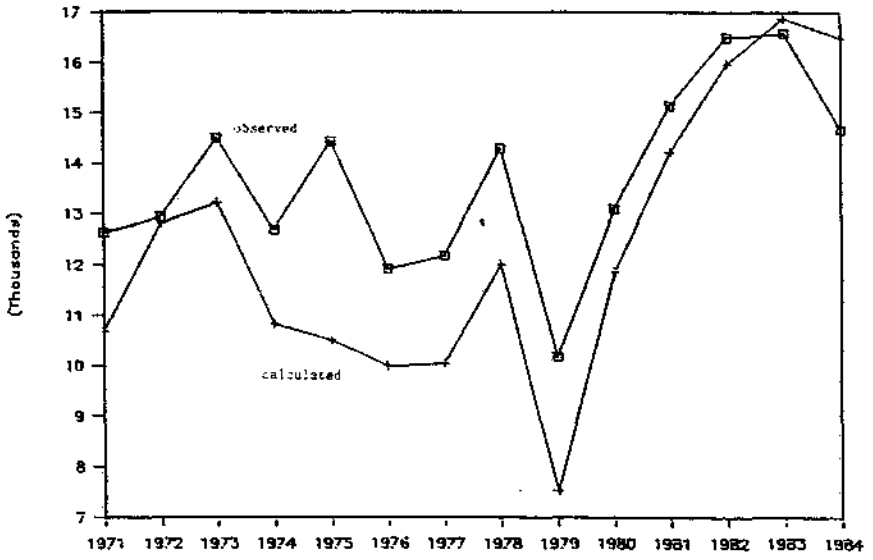

Figure 5. Migration flows from Amsterdam to the Region, 1971-1984

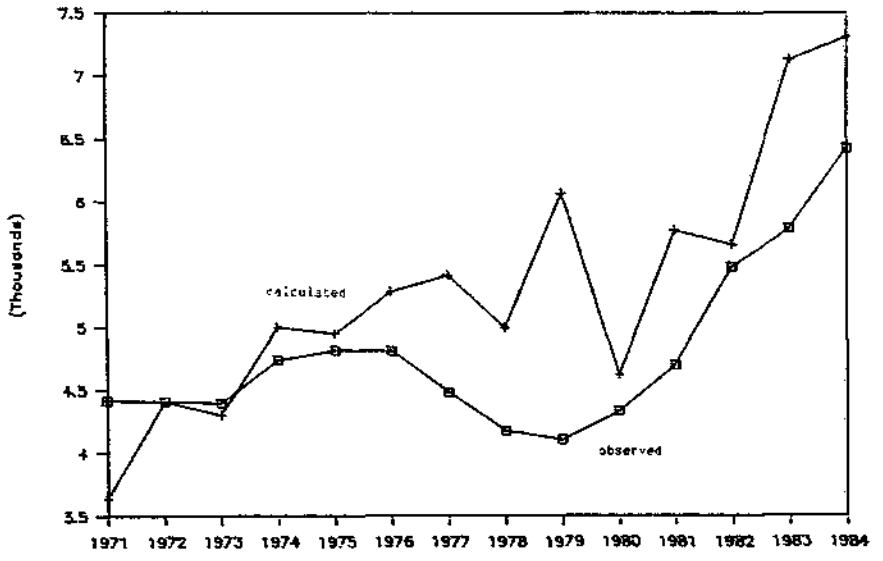

Figure 6. Migration flows from the Region to Amsterdam, 1971-1984

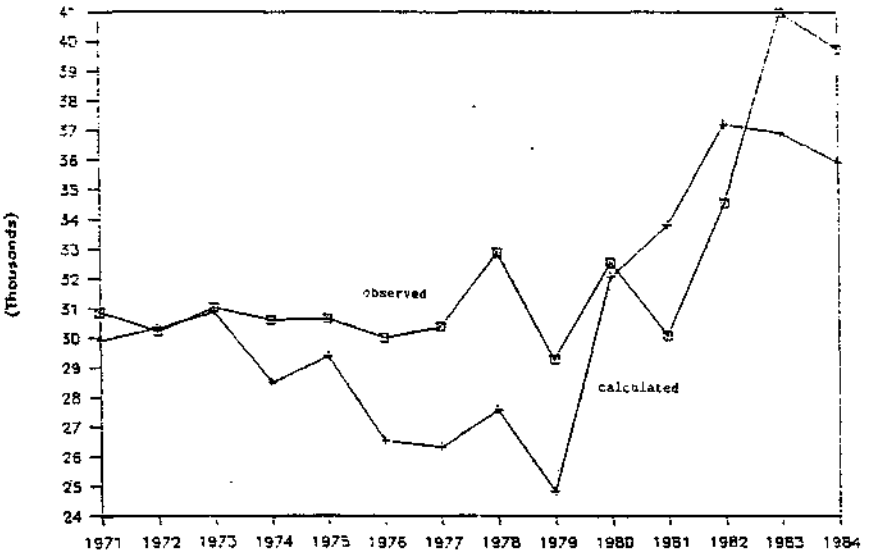

Figure 7. Intra-zonal migration within the Region, 1971-1984

In the period 1979-1983 all migration flows increased, but since 1983 in both the observed and calculated values a marked change occurred where the mobility within Amsterdam and the migration to Amsterdam started to increase, with a corresponding downward shift in the Region. In section 4 it will be examined whether these initial trends are continued after 1984.

From this section we can concluded that the total outcomes of the relocation model are satisfying and give insights in the components of change in the household structure and the housing market in Amsterdam in the period 1971-1984. From the figures presented in this section and more detailed outcomes (not presented here), it is also concluded that the model results are good enough to use the model for realistic scenario building with respect to the housing market developments in the Amsterdam region. This will be the subject of section 4.

4. Housing Market Scenarios for the Period 1985-2000

In this section the model validated in the previous section is used for the forecasting of population and dwelling stock developments in the period 1985-2000. The two scenarios presented in this section are based upon existing ideas of local and central governments regarding the future housing market developments in Amsterdam (see Bosch, 1986; Bestuursinformatie, 1984). The first scenario, the so-called 'Yuppie' scenario, is based on the assumption that the policy goal of decreasing suburbanization will be realized through the building of new dwellings in Amsterdam and agrees more or less with policy goals of the central government for the development of Amsterdam (the so-called 'high' alternative). The second scenario, the 'Family' scenario, is based on the assumption that the number of houses built in the Region will diminish in favour of building new dwellings in Amsterdam and can be seen as reflecting the ideas of the local government of Amsterdam with respect to the future of this city (the 'normative' alternative).

Central element in both scenarios is the governmental policy on the housing market. Attention is focussed on the building of new houses as a policy instrument to influence population development. Therefore the demographic components will be the same for both scenarios and will not change in time. This means that the demographic coefficients are kept constant during the period 1985-2000 and equal to their values in 1984. The assumptions of the two scenarios on the housing market are listed in table 6. The distribution for new dwellings in Amsterdam and the Region over the dwelling types is in the 'Yuppie' scenario is equal to the observed distributions. This holds also true for the distribution

of new dwellings for the Region in the second scenario, but for Amsterdam the distribution over the dwelling types is changed in favour of more single family units.

Table 6. Housing market figures for the scenarios (between brackets the numbers after 1996)

Housing market figures	'Yuppie' scenario	'Family' scenario
- number of dwellings built in Amsterdam	4500	6500 (4500)
- number of dwellings built in the Region (excl. the ZIJP)	5300	4000
- number of dwellings build in ZIJP	3000	3200
- number of dwellings withdrawed in the study area	-1700	-2000
increase of dwellings in the study area per year	11100	11700 (9700)

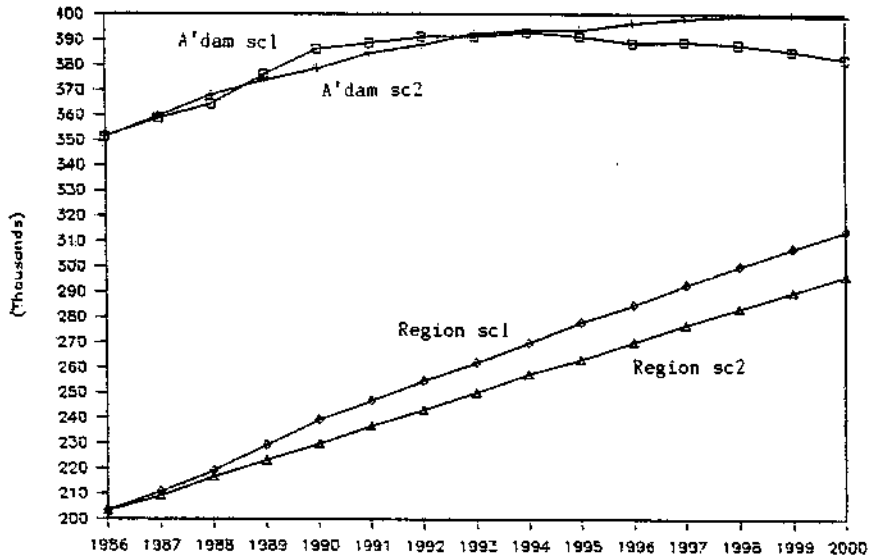

Figure 8. Predicted number of households in Amsterdam and the Region for the two scenarios, 1985-1999

The predicted number of households and inhabitants in Amsterdam and in the Region for the two scenarios are given in figure 8 and figure 9 respectively. As can be seen from these figures there are considerable differences in number of households and persons between the scenarios on the 1st of January in the year 2000.

In the 'Yuppie' scenario the total population in Amsterdam increases in the period 1985-1999 with 30600 households and only 6800 persons. For the 'Family' scenario this figures are 47300 households and 32300 persons.

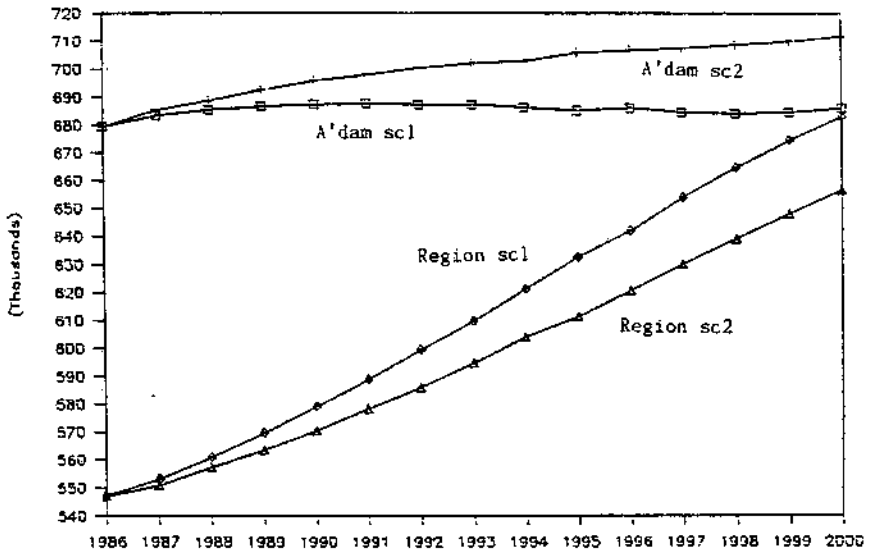

Figure 9. Predicted number of persons in Amsterdam and the Region for the two scenarios, 1985-1999

In table 7 the results of the population figures for Amsterdam are compared with the outcomes of the alternatives mentioned above. From this table it can be noticed that the number of persons in the starting year 1985 of the alternatives is too low compared with the realized number. After correcting for the base-year (figures between brackets) a number of interesting phenomena can be observed.

Table 7. Comparison of alternatives and scenarios for Amsterdam (between brackets the corrected figures for the 1985 starting values)

year	'high' alternative	'Yuppie' scenario	'normative' alternative	'Family' scenario
1985	666.1 (675.6)	675.6 *	666.1 (675.6)	675.6 *
1986		679.4 *		679.4 *
1990	653.6 (663.1)	687.0	666.4 (675.9)	695.8
1995	670.1 (679.6)	685.1	696.4 (705.9)	705.9
2000	-	686.2	719.4 (728.9)	711.7
	numbers x 1000		*: observed	

The decrease of population until 1990 in the 'high' alternative does not occur in the 'Yuppie' scenario. The reason for this is that the projections with the 'high' alternative are made in 1984 when it was not foreseen that the shift in the trend from decrease to increase of population occurred already in 1985 instead of 1990. As a result the population according to the 'high' alternative is lower than that of the 'Yuppie' scenario. For the same reason the results for 1990 of the corrected 'normative' alternative are much lower than those of the 'Family' scenario, while for 1995 they are the same for both projections. However, the alternative of the municipality of Amsterdam predicts far more population growth between 1995 and 2000 than the 'Family' scenario. This is caused by the fact that one of the main assumptions of the 'normative' alternative is that the population number is equal to 720,000 in 2000; so this policy goal is implicitly brought into the projection. But even when we compare the outcomes of the uncorrected 'normative' alternative and the 'Family' scenario it can be concluded that this policy goal is not met according to the

'Family' scenario. However, it can also be concluded that the growth of population in Amsterdam started in 1985 will continue at least until the year 2000.

Given some global results of the 'Yuppie' and 'Family' scenarios, we can conclude that the results of the scenarios calculated using the relocation model look very convincing and realistic compared to existing projections/alternatives on the housing market of Amsterdam

5. Concluding Remarks

The goal of this project was to develop an operational model for household relocation in the Amsterdam housing market, which can be used for planning and policy processes. Since not all processes modelled can be observed in reality, not every outcome of the model could be tested, so the simulation remains at least partially speculative. At the most aggregate level the total population and total number of households could be compared with observed figures and other estimates. At the micro level migration flows could be compared even at the level of age distributions per year. In general the results on a lower level of aggregation (not presented in this paper) remained quite satisfactory. Moreover, the differences in fit over the years are relatively small, indicating that the model is capable of reproducing intra-urban housing market behaviour under various exogenous circumstances. To our judgement the results achieved for the validation period 1971-1984 and the realistic outcomes of the scenarios for the period 1985-2000 show that the model is a valid instrument for empirical housing market analysis.

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