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1. Introduction

Unarguably, demographic development - or more specifically household development - and housing market constraints and opportunities are closely linked (Myers, 1990). In the long run, at the national level equilibrium between available housing and demand exists. On short term, and at local levels, however, the availability of housing determines the possibilities of household formation: dependent children can only leave the parental home to start their own households if dwellings are available. These mismatches between demand and supply cause delays in household formation. Not only the number of households is governed by the housing market, but their structure as well.
This paper deals with a simulation model (LOCSIM - local simulation) of the housing market which operates at local levels and on short terms. At the national level and for longer term predictions more robust models have proven their ability to predict household formation, housing demand and aggregate housing market behaviour (eg. see for some Dutch examples Hooimeijer & Linde, 1988; Hooimeijer & Heida, 1992).

Besides household formation and household structure yet another demographic process is very much dependent on housing market situation: mobility. "The changes in the number of new houses built in any period have obvious implications for the overall level of mobility" and "the rise and fall of mobility rates also reflect changes in the housing market" (Short, 1977:429).
Households' decision making regarding mobility and household structure is adaptive to the opportunities and constraints of the housing market system. Such an interactive and adaptive system is very complex, and therefore a simulation approach is very suitable to model it. A simulation model offers the possibility to model and simulate individual behavioural responses to changes at both the macro level (housing market situations) and micro level (housing preferences) (Oskamp, 1994b).

Central issue addressed in this paper is the feedback between the demographic system and the housing market system. The modelling of housing search in LOCSIM has been the subject of various other papers (Oskamp, 1993, 1994a, 1994c), and will not be discussed in detail. The next section will go into some general issues regarding microsimulation in general and LOCSIM in particular. Section 3 will then describe in conceptual terms the feedback between the two systems LOCSIM brings together. Section four will describe the demographic modules and their housing market effects. In section five some simulation results focusing on the housing market effects of demographic behaviour will be presented. The concluding section 6 will show how LOCSIM can be used in housing policy assessment and as a forecasting tool.

2. LOCSIM: an outline

LOCSIM aims at simulating developments both in demographic structures and in housing markets and the interrelation between them. The three main parts of the simulation model are a demographic model, a housing supply model and a housing market model. In the first two

models housing demand and housing supply are generated, which are confronted in the third model. The modelling approach chosen is microsimulation. In this approach behaviour and change of entities is simulated and not that of aggregate groups. The entities in LOCSIM are individuals, households and dwellings.
The LOCSIM model operates on the geographical level of regions, municipalities, or burroughs. In general, the geographical area of which population and housing market development is simulated should be defined as an area with administrative boundaries in which the housing market is a functional region. A functional region is - in housing market terms - a region where the majority of intra-regional moves are triggered by housing preferences, and not by work or study reasons (Goetgeluk, 1993:212). An example of such a region is a municipal housing market.

micro and macro
In contrast to macrosimulation (multi-state) models, the base population of LOCSIM is defined as a list of individuals with characteristics, rather than as an n-dimensional matrix where the cells represent the numbers of individuals in each category. In other words, the population is a database containing each individual as a separate record. The record contains information on each individual. Compared to the matrix representation, the amount of data per record is virtually limitless. In a matrix notation, a large number of dimensions quickly leads to unacceptably large matrices with large numbers of empty cells. A related difference between microsimulation and macrosimulation is that matrix representation of data implies categorisation of all variables. In microsimulation no categorisation a priori is needed. This means that flexible aggregation of continuous variables is possible, and that no information loss occurs (Clarke & Holm, 1987). This feature is important for the demographic side of the model, because duration variables can be fully used and analyzed: duration of marriage, birth intervals, etcetera. It is also of importance for the geographical side of the model. Dwellings and individuals (because the majority of individuals lives in dwellings) have a geographical location. If this location is known in x- and y-coordinates instead of only the area (eg. postal code), it is possible to create geographical areas freely, either on the basis of geographical scale or on the basis of commonalities between dwellings and/or their occupants. X- and y-coordinates also make linkage to GIS possible.

A second reason to choose a micro approach for simulating the interaction between demographic development and housing market behaviour is that housing market decisions can be directly related to demographic events that take place in the household. In a macro approach, only aggregate (groups defined by a limited number of dimensions such as age, sex, marital status) demographic development can be related to aggregate housing market behaviour. Microsimulation uses information on specific households to simulate mobility and housing market behaviour of that same specific household. The housing market model combines heuristics and stochastic modelling approaches. Specifically the use of a heuristic housing search model makes a microsimulation approach essential.

data bases
Because changes and events are recorded at the level of individuals and households, life histories, trajectories and careers can be followed, thus creating a longitudinal data base. Besides data on the individual, each record contains information to link individuals together to form households, and information to link individuals and households to dwellings. Table 1 displays the record structure of LOCSIM.

Table 1. Record structure in LOCSIM

individual		household		dwelling	
IIDNR	individual identity number	HHIDNR	household identity number	DWELLINGNR	dwelling identity number
HHIDNR	pointer to the household number	DWELLINGNR	pointer to the dwelling	HHIDNR	pointer to the household
DWELLINGNR	pointer to the dwelling	HEADIDNR	pointer to the head of the household	HEADIDNR	pointer to the head of the household
SUBHHREF	multi generation household pointer	HHSIZE	size of the household	DWTYPE	dwelling type in 10 categories
HEAD	head=1 non-head=0	HHINCOME	cumulated income of household members	NROFROOMS	number of rooms
SEX	male=1 female=2			CONSYEAR	year of construction
COHAB	cohabiting=1 not cohab=0			OWNERSHIP	1=rental 2=owner-occupied
MARSTAT	unmarried=1 married=2 divorced=3 widowed=4			RENT	monthly rent
EDUC	6 classes of educational status			RESALE	resale value
JOB	5 classes of employment status			QUALITY	quality indication on a scale 1..5
INCOME	Dutch guilders per month			LOCATION	area code / x/y coordinates
YOB	year of birth			OCCUPIED	
YOMA	years of marriage				
YODI	years of divorce				
YOW	years of widowing				
YOC	years of cohabitation				
YODE	years of dehabitation				
YOMO	years of move				

Using the variables of the individual records, households can be constructed. Each household has one head. All members of a household have a variable SUBHHREF which points to the head, or in the case of three-generation households, to the person it 'belongs' to. Table 2 shows this.

Table 2. Excerpt from LOCSIM database of individuals

IIDNR	HHIDNR	DWELLINGNR	SUBHHREF	HEAD	SEX	COHAB	MARSTAT	YOB
17904	4055	834	17904	1	1	0	2	1947
54270	4055	834	17904	0	2	0	2	1950
2356	4055	834	17904	0	2	0	1	1973
40052	4055	834	17904	0	2	0	1	1975
14898	15170	5134	14898	1	2	0	3	1944
43527	15170	5134	14898	0	2	0	1	1972
18637	15170	5134	43527	0	2	0	1	1993

Household 4055 is a very ordinary household. 17904 is the male head, married to 54270. They have two children (girls), born in 1973 and 1975. Household 15170 is a three-generation household. 14898 is the divorced mother of daughter 43527. This daughter has a daughter of her own (18637), who is recognizable as such by the SUBHHREF which does not point to the head of the household, but to 43527.

Monte Carlo

Many of the processes simulated in LOCSIM are stochastic processes. The occurrence of events is based on probability distributions by age, sex and other characteristics. To determine whether an individual experiences a specific event the Monte Carlo sampling method is employed. A random number between 0 and 1 is drawn from a uniform distribution, and is then compared to the probability of the event happening to the individual. If the random number falls in the interval between 0 and the probability, then the event occurs; if the random number falls in the interval between the probability and 1 the event does not occur.

As will be illustrated in section 4, the life histories of individuals are simulated by sequentially exposing each individual to the risk of experiencing all possible life events.

3. Demographic events, mobility and housing market consequences

One of the pillars of the LOCSIM model is that demographic events, mobility and housing market are interrelated. There are three viewpoints from which the relationship and feedback between the housing market system and the demographic system can be looked at.

housing characteristics as demographic determinants: a macro perspective

There are definite relations between housing characteristics (on an aggregate level) and demographic probabilities. Myers (1990:12) states that "demographers engaged in national-scale research have been able to ignore housing variables entirely, because these have little impact on their key concerns of fertility, mortality and migration. But housing variables loom in importance for research of intraurban patterns, because housing types are distributed so unevenly across the urban landscape. Location within the city may not be as important as the key intervening variable: type of housing unit. For example, age-specific fertility rates are likely to be much higher in neighbourhoods of single-family homes than in one-bedroom apartments. Mortality rates are likely to be much higher in nursing homes than in single-family homes. And migration rates within the city consist of residential moves directed for housing reasons, unlike long-distance moves, which are controlled by economic or career decisions".

Certain types of neighbourhoods attract populations with a specific demographic regime. A typical case is presented by Alfert *et al*. (1993). Their data show for Marzahn (a Berlin suburb) the typical suburban population structure and development. At the onset the population is characterized by very many 0-4 and 20-34 year olds. This typical population structure, which is governed by the housing type, can be found throughout Europe and the rest of the Western world, albeit not always as pronounced as it is in the former GDR: here a marriage and a child were the keys to securing a dwelling.
Besides location, tenure is an important discriminating factor: renters move more easily than owner-occupiers. The tenure-mobility interdependence has been analyzed by many authors (eg. Clark, Deurloo & Dieleman, 1984).

family life cycle and mobility: a micro perspective
A second viewpoint is that of the correlations between stage in the family cycle and moving. Since Rossi's (1955) study into the question why families move pointed it out, many studies have "shown the family life cycle to be a major determinant of moving" (Chevan, 1971:451). These correlations can be either state dependent (age of the head, number of children, income, household composition) or event dependent (eg. birth of a child).

Kendig (1984) uses the term 'housing career' and relates household career to housing career and mobility. The concept of interacting parallel careers is also employed by Mulder (1993). Parallel careers can be triggering or conditioning: eg. change in family size and income constraints respectively.

The family life cycle approach has very strong normative elements, which the life course approach does not have. The life course approach yields an analytical framework to study a variety of life paths. The housing career as an element of the life course of an individual is the result of conditions and triggers in parallel careers and housing market opportunities and constraints.

Several authors show that the occurrence of demographic events is an important determinant of moving behaviour. "A change in household composition compels a household to reassess the suitability of its current housing" and "(...) most local moves occur as households attempt to adjust their housing to their changing demographic and economic circumstances" (McCarthy, 1976). Atzema (1991:164) shows that between 30 and 40 percent of suburbanising moves can be directly related to demographic events. The birth of a child is an important event: it significantly increases the propensity to move (Chevan, 1971) and it acts as a trigger (Clark, Deurloo & Dieleman, 1984). Marriage and migration are often synchronized events (Mulder & Wagner, 1992). Clark and Onaka (1983:55-56) state that "(...) a significant number of moves are also generated by changes in household characteristics - changes which are not directly associated with initial housing dissatisfaction. In order to predict future relocation behaviour, therefore, both current housing dissatisfaction and expected changes in household characteristics must be considered."

housing market constraints and demographic events
The use of the family life cycle as an explanatory model for residential mobility has been

criticised. Short (1978:427) states that "for those households (...) with restricted housing choices (...) the proposed life-cycle model is largely irrelevant".

Hooimeijer and Linde (1988:9) criticise the model by pointing out that the model assumes that residential mobility is a reaction to change. However, some changes imply a residential move. In the cases of, for instance, nest leaving and separation the move is not a reaction to change but a condition for it. This type of move is called an 'implied move'. Moves that are not the implied condition for the occurence of a demographic event (eg. birth of a child) are called preferred move. A third type that may be distinguished is the forced move, arrising from reasons outside the household (eg. demolishment, eviction).

A second point of criticism Hooimeijer and Linde (1988) put forward is that family life cycle models are often based on a voluntaristic view on mobility and housing choice: in reality choices and moving are subject to opportunities of the market. For forecasters and modellers, this brings out the third - and perhaps the most interesting - viewpoint: is demographic development (household formation and dissolution) constrained and determined by housing market opportunities and constraints? Hooimeijer and Heida (1992) state: "At the intra-regional level, the housing market will have a decisive impact on residential mobility, not only causing a redistribution of households but also having an impact on household formation rates". Eversley (1983) shows for England and Wales that housing opportunities certainly influence the number of starting households: nest leavers, marriages and cohabitation. Theoretically the same should hold for divorcees starting their own household. Hooimeijer and Heida (1992) tentatively pose that "variation in housing shortages might affect dissolution rates caused by separation", but no empirical evidence can be found to substantiate this. Eversley (1983) claims that there is no evidence to support the idea that fertility is influenced by the availability of housing. Goetgeluk *et al.* (1991) state in regard to nest leavers that "(...) the rate of household formation will be determined by the number of opportunities on the housing market that are accessible to potential households. Faced with a lack of suitable vacancies, young people will be forced to trade-off their housing preferences with their desire to live independent from their parents." The direct short term effect is postponement of household formation.

Housing markets are inelastic: they respond very slowly to changes in demand; "there is practically no price adjustment in short market periods; quantity adjustment is delayed by long construction times" (Wegener, 1983:270). Building programs are based on household projections and housing demand surveys, which leads to medium and long term market adjustments. So, in the short run and at the local level, household formation rates are affected by housing market constraints, but in the long run and on national level, the housing market will adjust to the household formation potential.

From the above, it is evident that housing market conditions constrain housing preferences. This holds not only for preferences instigated by demographic events, but for all preferences. When studying housing market decisions one must take into account that what housing searchers want is not always what they get. In housing demand surveys respondents are asked to state their housing preferences. In their statement they will include an unmeasurable amount of information (subjective and objective) of the housing market. Within their assessment of the housing market they state what they want (preferences). This is not necessarily what is obtainable. This set of wishes is termed *stated preference*. When measuring how households are dispersed over the housing market, the *revealed preferences* are measured. The difference between stated preference and revealed preference is the effect of constraints of the housing market. Constraints can have both quantitative effects (individual who wants to set up his own household, but still living with parents) and qualitative effects (people living in a three-bedroom apartment rather than the aspired - but unobtainable - four-bedroom apartment). The process of accepting a housing situation which does not comply with one's preferences is called substitution.

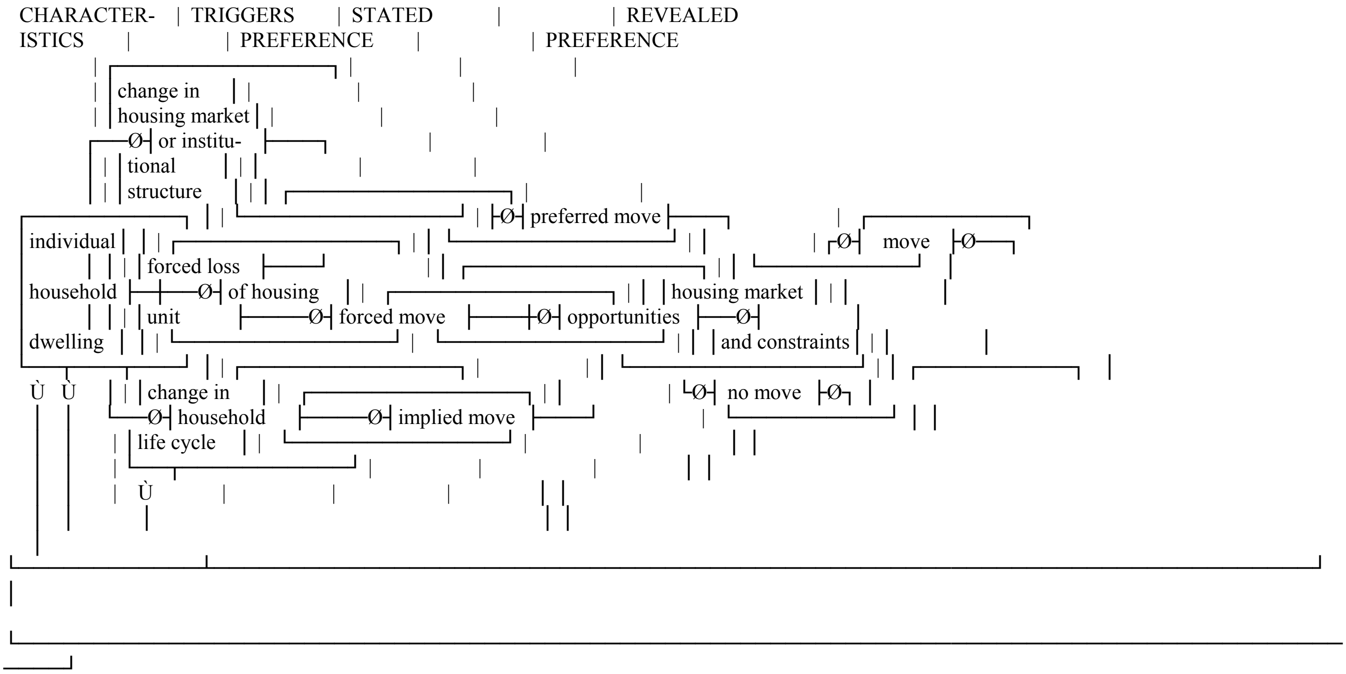
In LOCSIM the interest is in the interrelation between demographic development and the housing market: therefore, we are interested in the stated preferences of households, and how housing market constraints eventually lead to a simulated situation in which revealed preference becomes visible.

An example will clarify this. Say the incidence of nest leaving for 22-years old males is 60% (that is, of all 22-years old males still living at home 60% will have left the parental home before the end of the year). This is a revealed preference parameter: it says nothing on how many dependent children had the desire to move out, only something about those who were successful. If the 60% probability is employed in LOCSIM, it would lead to an underestimation of the incidence of nest leaving, because not all potential nest leavers will be successful in securing a dwelling. In LOCSIM nest leaving is modelled as a process: desire to move out - housing search - success or no success. In other words, the number of dependent children starting out on the housing market must be so large, that at the end of the simulation 60% of all 22-years old males have successfully left the parental home. The estimation of stated preference parameters is not without problems (Van de Vyvere, 1994); the application of such parameters in a microsimulation model of both demographic development and housing market behaviour is without precedent. Detailed stated preference data gathered among serious housing searchers will be used. These searchers were not only asked about their housing preferences but also about their probable substitution behaviour, yielding a wealth of information on the process of housing search (Van Zwetselaar & Goetgeluk, 1994; see Oskamp (1994a) for a tentative exploration of the use of this type of stated preference data).

conceptual scheme

The interaction between demographic events and the housing market, seen from all three viewpoints discussed above, is graphically shown in figure 1. This conceptual scheme is an expansion of that of Clark and Onaka (1983), who divide the triggers for moving in three main types: change in housing market or institutional structure, change in household life cycle, and forced loss of housing unit (p. 49). At the present stage of model building, LOCSIM deals with moving as the result of changes and events in the life cycle. Changes in employment status, income and dwelling characteristics as move triggers will be built into the model. As was shown above, changes correlate with characteristics of both dwellings and their occupants (individuals and households). The housing market and its constraints and opportunities have been added to the conceptual model to capture both the feedback between household formation and the housing market, and the difference between stated and revealed preference.

Figure 1. Conceptual scheme of move triggers, housing market and stated and revealed preference



4. Modelling demographic development and mobility in the LocSim model

In LocSim a number of different demographic events are modelled: mortality, fertility, nest leaving, divorce/dehabitation, marriage/cohabitation and mobility. Individuals are sequentially exposed to the risk of experiencing these different events. Because events are simulated sequentially, the order of events is of importance as is the possible dependence between the occurrences of events. In this section, these problems are discussed before the actual demographic modules of LocSim are presented.

sequencing the events

The reason that the sequence in which the occurrence of events is simulated is important, is twofold. First, the sequence may bias the number of events that occur. If death is simulated before fertility, the number of births is underestimated because those women who died may have had a child before they died. If fertility is simulated before death, the number of births will be overestimated, because births are included of women who would have died before they gave birth.

Second, the occurrence of one event might change the probability of the occurrence of another event. It is well known that fertility varies with marital status. So, if marital status changes (an event occurs), then the fertility probability may change.

Either way the sequencing is important. Several strategies are employed in microsimulation models (Galler, 1992; Hellwig, 1988). The most common approach is using a fixed order of events (Clarke, 1986; Galler, 1988; Klevmarken, 1991; Brunborg & Keilman, 1992; Nelissen, 1993). The reason to take this strategy is that it is easiest. The number of dependencies that have to be taken into account is limited. In this strategy the underestimation of events that occurs because individuals are removed from the database (death) and can longer be exposed to other events has to be accepted.

A second strategy is determining a random order. This is achieved by determining separately for each individual in which order the events will be simulated (Hellwig, 1988). Another way to achieve randomness is using random dates (see e.g. Clarke, Duley & Rees, 1989). This is a two-step process. The first step only determines **if** an event will occur, and, if so on which of the 365 days of the year. The second step then executes the events in the order determined in the first step. In this way someone who according to the dates will give birth and die, can either first die (then the birth is cancelled) or first give birth and then die. This is the method employed by LOCSIM.

Whichever strategy is chosen to deal with the ordering of events, the problem of interdependence between events remains.

If a fixed order is chosen, then the problem is easily solved. Every next simulated event can be made dependent on either the fact that other events already have occurred, or on the state as it is after the occurrence of earlier events. In this way, for instance, marriage probabilities could differ for those women who gave birth earlier in the interval and those that did not.

If the other strategy is employed this is not quite as easy, because the states are only changed after all events - or rather their occurrence dates - have been simulated. A possible solution for the example of marriage and fertility is: if fertility will occur (at any date in the interval), marriage probabilities will be different than when no fertility will occur. The order of selecting dates for the events must make sure that fertility dates are selected before marriage dates. The order of events remains random. Conceptual consequence of this method is that marriage and fertility are treated as synchronized events, which are causally linked, but whose chronological order is irrelevant. First marriage then child birth has the same causality as child birth and then marriage. This is conceptually related to Mulder (1993) who distinguishes in the study of synchronization of marriage and mobility three states: unmarried, marrying and married. This approach will be followed in LOCSIM in those cases were data availability allow it.

Yet another way to deal with dependence between events is to make sure that multiple events do not take place: shorten the length of the interval to such a length that the probability that multiple events occur is very small. The downside of this solution, however, is that it involves an exponential increase in computing time, which in microsimulation models is very large as it is.

residential mobility, in and out migration
Many microsimulation models do not incorporate internal mobility, because they have no geographical perspective. International immigration is often induced: a given number of immigrants is added to the database. International outmigration is often a household based probability. Microsimulation models that do have a geographical perspective have various ways of modelling mobility.

UPDATE (Duley & Rees, 1990) models some of the mobility in the same manner as LOCSIM: mobility is the result of household formation and dissolution by marriage/cohabitation and divorce/dehabitation. All other mobility (including nest leaving) is based on age-specific mobility rates. This means that nest leaving is the implied result of mobility, instead of its trigger.

The Darmstadt model (Wegener, 1983) incorporates intra-regional mobility as a function of (among others) housing constraints and opportunities. There is no direct link between demographic events and mobility at the level of households.

The conceptual framework described in the previous section is applicable to all moves. In the context of the LOCSIM model, it is necessary to distinguish three types of mobility by destination: households moving within the boundaries of the housing market (cf. section 2), households moving from the LOCSIM housing market to another one and households moving into the LOCSIM housing market from the rest of the world. The first type of mobility is termed residential mobility; it is largely caused by housing preferences. The second type of mobility is termed *out-migration*; it can be caused by change of work or related to educational opportunities on the one hand, or lack of housing opportunities on the other. Of these two types LOCSIM simulates for each household the reasons (triggers) of the move, but only for residential mobility the exact destination is simulated. The third type of mobility is *in-migration*. The reasons for in-migration are typically the availability of opportinities: housing, job, educational facilities. Whithin the LOCSIM framework the reason why in-migrating households move, is not known at the household level.

The three types of mobility are treated differently in the model, and three different modelling approaches are chosen. The modelling of residential mobility and out-migration triggered by the occurence of demographic events is described in the following sections as the demographic modules are described. Residential mobility and out-migration which is not linked to demographic events is described seperately as is in-migration.

tagging
As the demographic processes are simulated in LOCSIM, individuals experience events and the households that they are part of are assigned move tags. These tags can be preferred move tags or implied move tags. Of course, households may generate a wish to move because of some reason (state change) outside the scope of the presently simulated processes in LOCSIM (eg. change of work, increase in income). To capture these moves, all households are subjected to a household-specific move rate. These moves are all preferred moves. A third type of move tag is generated in the case of demolition of the dwelling, eviction, etcetera.

Naturally, not all desires to move are equally strong: some searchers have a latent desire to move, only effectuating this desire if the 'perfect' dwelling comes along. Others are in desperate need to move. The differentiation between the urgencies of the different moves is captured by introducing *search intensity*. This is a measure, which is determined for each searching household, and which is based among others on the origin of the move desire. A household wanting to move from a four-bedroom apartment to a five-bedroom apartment because of the birth of a child will have quite a different search intensity than the divorcee who is being kicked out by his ex-wife.

As search continues unsuccesfully, households may change their search intensity, resulting in a different search behaviour, and ultimatly in the acceptance of a dwelling which may not be what they initially wanted: substitution. In the model search intensity is a dynamic variable, tags are just administrative code to keep track of potential movers and their move reasons.

mortality
All individuals in the database are exposed to the probability of dying. Individuals who will turn 100 in the current year have a mortality rate of 1. Death then occurs on January 1st.
If the individual who dies has a partner, this partners characteristics are updated. The partner is - if necessary - made the head of the remaining household. If the couple were married the surviving partner is given the widowhood status. If the couple were cohabiting, the partner is given the unmarried/uncohabiting status. If it is a dependent child who dies, there are no consequences for the statuses of other family members. In either case, there are no direct consequences for the housing market. However, as the size and structure of the household changes due to the death of one of its members, the household is tagged with a preferred move tag.

If the individual who died is a one-person household, the death leads to a vacancy of the dwelling of the deceased. This dwelling is added to the stock of vacant dwellings.

In the case that the deceased individual was the head of a one-parent family, the remaining children are transferred to an orphan-file. This file may be seen as transfers to an institution. The entry into and out of institutions is yet to be modelled.

If the event dates of the deceased indicate that it would experience other events later in the simulation, these are naturally cancelled.

The data needed for the mortality module are age and sex specific mortality probabilities. These can be calculated from NCBS statistics.

fertility
All women aged 18 to 45 are subjected to a probability to give birth. If a child is born, a new person record is created and added to the population file. Using Monte Carlo sampling, the sex of the child is determined and it is then immediately subjected to the infant mortality probability.

The birth leads to an increase in household size, and therefore the household is tagged with a preferred move tag.

The data needed in this module consists of some form of fertility rates. Currently age- and parity-specific fertility rates are used, but the use of marital-status specificity is desired. Married couples have higher fertility rates than cohabiting couples, who in turn have higher rates than women in one-person or one-parent households. The probability of a birth being male is 0.512. Infant mortality rates are derived form NCBS data.

nest leaving
All individuals of age 18 and older who are living with their parent(s) are subjected to a nest leaving probability. Nest leaving is defined in LOCSIM as leaving the parental home to live alone. The process of leaving the parental home to marry or cohabit is treated in the union formation module.

The original household is tagged with a preferred move tag, as it decreases in size. The nest leaver is tagged with an implied move tag. Nest leaving is an event which is conditional on the availability of housing. In other words, the nest leaver is entered in to the housing market, and only when a dwelling is found, the move is actually made. However, if no vacancy is secured, the nest leaver is returned to the original household. The preferred move tag of the original household is then retracted. The original household is only entered in to the housing market after the nest leaver has actually found a dwelling and made the move
.

The reasons for a dependent child to leave the parental home can be of different origins, resulting in different moving behaviour. Many nest leavers leave the parental home for reasons of study and work. As educational opportunities are not always situated in the municipality, nest leaving is often linked to out-migration. This goes to a lesser extent for work reasons too. Other reasons, for instance 'freedom / independence', will not have to coincide with out-migration as much. Nest leaving for reasons of marriage/cohabitation are not treated in the nest leaving module, but in the union formation module.

Administrative problems arise when multiple events occur in the household. For instance nest leaving of a child and divorce of its parents, leads to problems in returning the nest leaver if it is not successful in its housing search.

The nest leaving probabilities that are currently used are derived from Mulder (1993; unpublished preparatory tables). These are age-and-sex-specific nest leaving probabilities. The problem with these data is that they are revealed preference data: they are based on realised behaviour, whereas the LOCSIM model needs stated preference: the probability to try to leave the parental home. Stated preference can be derived from the Dutch WBO's and from data collected by Van Zwetselaar and Goetgeluk (1994). The useability of these data is currently being investigated (Oskamp, 1994a).

For their microsimulation model of residential mobility in Sweden, Fransson and Mäkilä (1994) solve the lack of stated preference data in a different way. In their model all dependent children of 18 and older enter the housing market. Technically this is a workable solution. As long as the demand from nest leavers is larger than the supply of dwellings, housing opportunities will regulate the number of nest leavers. From a perspective of preferences the solution chosen by Fransson and Mäkilä is unsatisfactory, because no differentiation is made between nest leavers of different age and background, nor is reason for the nest leaving a discriminating factor.

union dissolution

All individuals in marital unions or consensual unions are subjected to dissolution rates. These rates are based on duration of the union and are different for marriages and cohabitations. Data collected by Manting (1992) are used. She also shows that the processes of marriage and cohabitation are still very different: governed by different preferences, motives and ideas, and therefore have different parameters.

When a couple breaks up, the next decision is which partner moves out of the current dwelling, and if there are children, with which parent they go. All children have to go with the same parent. Which partner moves out, and with which partner the children go is gender-specific.

A newly created household consists of the leaving partner and children (if any). It is tagged with an implied move tag. The remaining household is tagged with a preferred move tag. As with nest leaving, the preferred move can only be effectuated when the leaving partner has found a dwelling. If the leaver does not succeed in finding a dwelling, it has a very large probability to out-migrate. When the leaver does not find a dwelling, and does not out-migrate, it is moved back to its original dwelling. Empirical research on the incidence of this phenomenon is lacking.

cohabitation to marriage
Union formation is divided in two types: union formation of two individuals currently not in a relationship, and the marriage of individuals currently living together. The next section will deal with the first type. The division is based on the assumption that if two people who are cohabiting marry, they will marry each other.

All cohabiting couples are subjected to the probability of marriage. The cohabitation-to-marriage-rates are derived from Manting (1991a).

In the LOCSIM model the only consequence is that marital and cohabitation status of the individuals are updated. The newly married couple are tagged with a preferred move tag, but with low search intensity because the only thing that really changes is the marital status. The correlation between childbirth and marriage of cohabiting couples will be looked at in a next stage of model calibration.

union formation: the partner market
Van Hoorn (1994) shows that most young singles do not consider themselves to be alone for a long time. People living alone are either looking for a (new) relation or just out of one. Therefore, all singles are considered to be 'in the market' for a relationship all the time. Whether they will be successful depends on their characteristics, and the supply of potential partners. The geographical and spatial structure of the partner market is a field of research where much work is to be done, both in conceptual terms and within the LOCSIM context.

All individuals not living with a partner are copied from the population to a partner market file. In the partner market each individual is first subjected to a search probability to decide whether or not the individual will actively search in for a partner. If search commences it is decided whether the union will be an internal or an external one. Internal meaning, the candidate file is searched through, external meaning a partner from outside the municipality is taken. If an external partner is sought, then it is decided whether the searcher will move out to the partner, or the partner will move in with the searcher.

If the individual searches inside, it sequentially searches through the file until a partner is found that fits the search criteria of the searcher. The search criteria ultimately could include age, race, education, socio-economic group. At this moment only age is considered. Also only unions between two individuals of opposing sex are treated. When a partner is found, LOCSIM decides whether the relationship will be a marriage or a cohabitation. The search method rules out any sex bias, as any individual can be designated as a searcher. If a searcher is not successful in its search, it can still be found by another searcher.

Union formation of different individuals has different consequences for the housing market. The union formation of two dependent children, leaves two households with preferred move tags. The newly formed household is tagged with an implied move tag. If the new household cannot find a dwelling, the members are returned to their previous households.

If a head forms a union with a dependent child, it is assumed that the dependent child moves in with the head. The new household gets a preferred move tag, as does the original household of the dependent child. As the head already had a dwelling, this union formation does not run the risk of cancelation because of lack of housing.

Two heads of households forming a union will vacate one dwelling. Which one is determined randomly. It is added to the vacancy list. The new household is tagged with a preferred move tag.

The data used in this module are derived from Manting (1991b; unpublished preparatory tables).

effectuating the desired moves
The events described above are mostly modelled at the individual level. Even 'cohabitation to marriage' and 'union dissolution' are modelled at the level of the individual. Mobility, however, is a household process. "In migration models, the subjects modelled should be households, as migration decisions are not made by individual household members, but by the households as a whole" (Wegener, 1983:267).

An aggregation from individuals to households has to be made before mobility can be simulated. Naturally, the aggregation is based on the new household structure: dissolved unions are now two households, nest leavers are separate households etcetera. The move tags that were assigned to individuals in the previous modules are copied to households.

All households with tags are copied to a potential movers file. The potential movers are entered in housing search sequentially, each with housing preferences, search intensity and acceptance probabilities. These three parameters determine whether a dwelling is found or not. If a dwelling is found, the previous dwelling (if any) is vacated. If the search is not successful a decision is made whether the household will migrate out of the municipality.

As moves are successful, new potential movers try to move: original households of nest leavers, union dissolvers and union formers. Therefore the housing market is simulated in four cycles each simulation year. A dwelling vacated in the first cycle is available for occupation in the next. Preferred moves are made in the cycle following the one in which the related implied move was made.

in-migration
Two of the three types of mobility are treated using the method described above. Naturally, there is competition on the housing market. Not only are households from inside the housing market looking for dwellings, there is also an unknown quantity of demand from the outside. Housing market competition is incorporated into LocSim using pressure probabilities (Oskamp, 1994c). These probabilities express the amount of competition (pressure) housing segments endure. Competition is expressed as a probability that a dwelling will be taken by

an in migrant rather than as a function of demand, because demand is not known. It is not possible to form a pool of potential in-migrants analogous to the potential movers file. In-migration is thus simulated as follows. First using the pressure probabilities, a vacancy is made available for internal searchers (residential mobility) or to an in-migrating household. If the latter is the case, a random household is formed fitting the dwelling. Several possible ways exist of creating this in-migrating household. The most common method is to create a random household by using the empirical probability distributions of in-migrating households. Another way is to select randomly another dwelling in the database that has the same characteristics as the one at hand, and to make a copy of the household in that dwelling.

6. Concluding remarks

The relationship between demographic development and housing market behaviour is very complex. This is especially caused by the feedback mechanisms that exist between the two systems. The relationship has been looked at from two perspectives. First, a conceptual viewpoint was taken in order to describe the theoretical interactions and feedback mechanisms between the demographic system and the housing market system. Second, a modelling viewpoint was taken: a description was given of the way that the linkages which were conceptually described before are incorporated into the LOCSIM microsimulation model.

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