2. APPROACHES AND INNOVATIONS IN POLICY-ORIENTED MIGRATION AND POPULATION DISTRIBUTION RESEARCH

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2.1. INTRODUCTION

The chapters in this book present results of recent Dutch policy-oriented spatial-demographic research, in particular migration research. To appreciate the research results, the context in which the research is carried out should be understood. In Chapter 1, Ter Heide distinguished three contexts: the statistical context, the conceptual and methodological context and the policy context. He described the main features of the spatial policy context in the Netherlands. The statistical context will be described in Chapter 3. In this chapter, Dutch migration research is placed in the context of recent theoretical and methodological developments in migration research. Since the emphasis will be on policy-oriented research, we first discuss the interface between demographic research and spatial policy.

Generally speaking, spatial policy aims at a balanced distribution of population and activities over space. The interpretation of this aim however differs from one country to another. In many countries, in particular developing countries, efficiency considerations underly the spatial policy process. The distribution of population and activities is subordinate to economic development goals. In the Netherlands, equity and environmental considerations dominate spatial policy. The goals and objectives of spatial policy were reviewed by Ter Heide in Chapter 1. The equity consideration is translated into a reduction of regional differences in the accessibility of facilities and employment opportunities.

The realization of a balanced spatial distribution of population and activities calls for two types of policy measures: population-
responsive measures and population-influencing measures. The provision of additional infrastructure, employment, and educational, cultural and health facilities for an expanding population falls under the first type. Policy measures of the second type are measures intended to influence the size, composition and/or distribution of the population.

Research requirements differ for each type of policy. For population-responsive policies, it suffices to know the number of people per category at consecutive points in time. The relevant population categories are determined by the facilities to be provided. Population-influencing policies call for a quite different type of information, namely information on the components of demographic change (fertility, mortality, migration) and on the events (childbearing, death, migration) that are associated with these components of change. In addition, information is required on the degree to which the occurrence of demographic events may be affected by policy measures.

This chapter elaborates the framework for policy-oriented migration research presented by Ter Heide in Chapter 1, and reviews recent research on migration in as far as it is directly relevant for spatial policy-making. The core of the framework is the spatial population system (SPS), representing the distribution of the resident population. It is the object of spatial population policy. Three sections are distinguished, paralleling the sections of the book. The first section deals with the identification and the measurement of the SPS. The statistical context of migration research in the Netherlands is placed in a broader perspective of migration measurement. The results of the measurement process may be placed in an accounting framework. Although solid demographic accounting techniques were among the first results demographers ever obtained, they have frequently been treated subordinately to a more formal mathematics of population and an explanatory analysis of trends. Good demographic accounting may however not only reveal data inconsistencies that may otherwise be covered up, but may also provide a proper approach for integrating the direct measurement, the indirect estimation and the analysis of demographic data.

The second section focuses on the exploratory and explanatory analysis of the SPS. The aim of exploratory analysis is to identify the relations between the elements of the SPS at a given point in time and the patterns of change of the elements and their relations. The essence of exploratory analysis is the identification of a structure in a given data set (cross-sectional and/or time series data). Frequently, the analysis of the data structure may be enhanced by the application of models. Particularly relevant for the analysis of SPS's are spatial interaction models which have been developed and are widely used in geography, regional science and
transportation science.

In the explanatory analysis, causal relations come to the fore. The position of the SPS at a given point in time and/or the pattern of change are linked to causal factors. These factors may be demographic, socio-economic, cultural, environmental or political in nature. The causal factors may be studied at the level of the individual or household (micro-demography) or at the aggregate level (macro-demography). A typical illustration of micro-demography is the study of individual migration histories. In such longitudinal studies, the occurrence of a demographic event (e.g. migration) may be associated with characteristics of the event, of previous events (e.g. time elapsed since previous event), of the person experiencing the event and of the environment or context in which the event occurs. In other words, the micro-approach relates an individual's demographic behaviour at a given instant, manifested by the occurrence of an event or a decision leading to the occurrence of an event, to his or her past experiences, current condition and expectations regarding the future. The established theories of human capital, search for job and home as well as environmental stress all belong to this micro-level approach.* Macro-demography deals with aggregates (regions, groups of people) and their characteristics. A typical illustration of macro-demography is the description and the exploratory and explanatory study of interregional migration flows. In micro-demography, a proper question to ask is whether a person with given characteristics may be expected to migrate in a given year. The analogous question in macro-demography is what proportion of the population is expected to migrate in a given year. The micro-macro dichotomy is a useful way to structure spatial demographic research. It was recently also used by Clark (1982) in his review of recent research on migration and mobility.

The subject of the third section of this chapter is regional and local (small area) population projection. The development of projection models is basically situated in macro-demography. The variable of interest is the number of people in a given geographical area at a given point in time. Micro-demographic analysis may however contribute to improved forecasting by providing the theoretical basis for the design of projection models (e.g. micro-simulation models) and the understanding of demographic processes that is useful to formulate hypotheses concerning expected changes in parameters of macro-demographic models. Most models used today for population projections distinguish the components of

* For a review of micro-level approaches to studying migration, see De Jong and Gardner (1981).
demographic change; namely, fertility, mortality, internal migration and international migration. Area reclassifications and/or boundary changes are generally not accounted for in projection models. A major issue in the design of regional and local population projection models is the treatment of the migration component. The problem of an adequate integration of the migration variable in demographic projection models consists of two subproblems. The first is the definition of the migration variable to be used (e.g. net vs. gross migration; number of migrants vs. migration rate). The second subproblem relates to the prediction of migration for population forecasting purposes. Migration may be predicted by the user without reliance on any model or the future migration pattern may be derived from a descriptive and/or explanatory migration model.

2.2. IDENTIFICATION AND MEASUREMENT OF THE SPATIAL POPULATION SYSTEM

The reference to the spatial population system implies that the population is viewed as a system, consisting of elements and relations between the elements. In spatial-demographic analysis, the elements consist of population categories defined by demographic variables (e.g. age, sex, family relationship) and geographic variables (e.g. place of residence). The relations between the elements are represented by the movements of people from one population category to another category. The movements, which in this chapter are also referred to as transitions, are directly related to the occurrences of demographic events such as childbearing, death, migration and marriage.

The identification of the spatial population system consists of the definition and delineation of the relevant population categories and of the demographic events that generate the transitions between categories. Of particular importance in the identification of the SPS is the definition of the concept of "resident population" and of the derived concepts of "change of residence" and "migration". In many countries, the definition problems are near unsurmountable (see e.g. Willekens 1982a). In the Netherlands with its population register, the place of residence is uniquely defined for more than 99 per cent of the population (Chapter 3). A person's place of residence is the municipality where the civil record (personal card) of the person is kept. Persons without a fixed residence are registered in the Central Population Register, which in many statistical publications forms a separate "region". A migration occurs if the personal card is transferred to a different municipality. The migration concept, and also the migration measurement, thus has an administrative content. The municipality is the migration-defining area, i.e. the areal unit used for the measurement of migration.

The identification of migration as a change of residence across
municipal boundaries leads to a narrow view of the SPS. As Van der Erf points out in Chapter 3, many persons change residence within municipal boundaries. In addition, migration is only one of the forms of spatial movements shaping the human settlement system. The importance of other forms of spatial movements has recently been realized (see e.g. Morrison 1983). Because of the interrelatedness of different forms of spatial movements, Zelinsky (1983, p. 36) argues for a comprehensive study of all forms of territorial mobility. Of particular relevance in developed countries is the relation between migration and commuting. Verster in Chapter 10 presents an accounting framework that encompasses place of residence and place of work and is consequently a useful instrument for the integrated analysis of migration and commuting. The analytical framework presented by Verster is consistent with the theoretical framework proposed by Termote (1979). A framework which is similar to the one presented by Verster is being developed at the University of Groningen (Van der Veen and Evers 1983).

Although differences in the migration concept are negligible in the Netherlands, there are substantial differences in the way migration is measured. In the population register, migration is recorded as it occurs. This direct measurement of the event of migration differs substantially from the indirect measurement in the Census and the bi-annual Labour Force Survey, for instance. What is recorded by retrospective surveys of this type is not the occurrence of a change of residence, but the place of residence at a previous point in time, e.g. one year prior to the enumeration date. Multiple migrations during a one year time interval escape the indirect measurement, but are revealed by the register. The distinction between direct and indirect measurement of changes of residence is generally useful. Ledent (1980) refers to the approaches as movement and transition approach, respectively. The movement approach, in which the occurrence of events is recorded, is followed in population registers and in migration history surveys. The transition approach is generally adopted in censuses and retrospective surveys in which migration is not the focus of attention (e.g. labour force and household surveys).

The critical evaluation of the data base for migration and spatial population analysis is receiving the growing attention of researchers (Rees 1977, Rees and Willekens 1981, Findley 1982, Isserman et al. 1982, Courgeau 1983, Poulain 1984). A main concern of these studies is the comparability of migration data between sources and between countries. The need to develop a strategy for comparative migration analysis is emerging, and there are a few indications as to the direction in which the strategy should be sought. A fruitful strategy to follow is to focus on the underlying mobility process which is manifested by the available migration statistics, and to design estimators of the parameters of the underlying process for the
different types of migration data. This strategy was proposed by Ginsberg (1983) and was spelled out by Willekens (1983a). The strategy may also be useful for combining migration data from different sources, a topic studied by Courgeau (1982a) and Long (1983) among others.

The combination of data from different sources is one way of generating a complete, although synthetic, data base for the analysis of migration and spatial population systems. The data estimation and analysis may be enhanced by arranging the available data in an account. An account is a multidimensional contingency table designed to check the data for internal consistency, to handle the data, to estimate the missing data and to further prepare the data for analysis. It reflects both the data availability and the data requirements of the analyst. The development of formal accounts goes back to the Belgian statistician Quetelet in the nineteenth century and was given a major impetus by the work carried out by Stone (1975). Stone's research was a point of departure for the design of spatial demographic accounts by Rees and Wilson (1977); for a simple exposition of the principles, see Rees (1980). The usefulness of the accounting framework for data-handling in spatial analysis was illustrated in a book edited by Masser and Brown (1978). Masser suggests ways of grouping the basic data in the account (multi-criteria aggregation) and of partitioning the account to reduce the number of elements (multi-level specification) without a loss of consistency in the data and with a minimum loss of information (see also Masser 1983). Much of Masser's research on aggregation and specification was carried out while he was with the University of Utrecht. Techniques for estimating missing data in an accounting framework were described by Willekens (1982b).

Several chapters in this book adopt at least some accounting principles to establish the data base of the spatial population system. The essential component of the spatial information system presented by Scheurwater in Chapter 4 is a three-dimensional data block or account with municipalities, calendar years and demographic or other variables ranged along the three dimensions. Van der Knaap and Sleegers in Chapter 6 also view their data, a time series of place-to-place migrations, in an accounting perspective. Verster in Chapter 10 presents a formal account of the population by place of residence and place of work at two consecutive points in time. Demographic accounting is also the point of departure adopted by Willekens and Drewe for the development in Chapter 15 of a model of multiregional demographic change. The model equations are derived from accounting equations. The chapters illustrate the usefulness of applying accounting principles in macro-demographic research.
2.3. EXPLORATORY AND EXPLANATORY ANALYSIS OF THE SPATIAL POPULATION SYSTEM

2.3.1. Exploratory data analysis

Exploratory analysis aims at identifying a structure or a regular pattern in a given data set, which may be presented as an account. Until recently, formal models were not used in exploratory data analysis. The analysis was limited to the calculation of indices (e.g. percentages) and the grouping of units with similar indices on the basis of visual inspection or a more advanced clustering technique (e.g. factor analysis) or classification algorithm.*

In exploratory data analysis, two major issues may be distinguished. The first relates to the transformation of the raw data and the second to the comparison of the transformed data. The structure or regular pattern that is imbedded in a data set may be revealed more easily after data transformation. Common transformations are logarithmic and logit transformations. The transformation may also involve the decomposition of each element of the data set into components. Such a transformation is adopted by Van der Knaap and Sleeers in their search for stability in the interregional migratton flows in the Netherlands during the period from 1967 to 1978 (Chapter 6). They found that by decomposing migration between and within urban systems into three components, remarkably stable patterns can be identified. The three components are a level component representing the total number of migrations in the country in a given year, a generation component representing the share of each region in the total migration, and a distribution component which relates to the allocation of out-migrants to regions of in-migration. Whereas the level component changed substantially during the observation period, the generation and the distribution components have remained remarkably stable. Similar results were obtained by Baydar (1983) for the Netherlands and Stillwell (1983) for the United Kingdom.

The decomposition of migration flow data in these three components is not new and its relevance is not limited to exploratory data analysis. In 1970, Brown and Moore (1970) proposed such a decomposition for the analysis of migration decisions. The rationale was that the migration decision consists of two related but distinguishable subdecisions, each of which is determined by its own set of factors (see also De Jong and Gardner 1981, p. 2). Although this decomposition for the study of the migration decision has been

* Interesting reviews of several techniques of data analysis are contained in O'Muircheartaigh and Payne (1977).
a subject of debate ever since, it is a convenient analytical instrument. The decomposition into a generation and a distribution component is also adopted by Op 't Veld et al. in Chapter 9, Verster in Chapter 10, and, implicitly, by Heida and Gordijn in Chapter 8.

The second issue that arises in the exploratory data analysis relates to the comparison of the transformed data. When can one conclude that two migration matrices are similar? The quantification of the degree of similarity of two matrices is one of the more tricky problems in data analysis. The statistical literature remains relatively vague on this issue and many authors in applied research present different distance measures. Illustration of the difficulties encountered in selecting a proper distance measure in spatial research are papers by Smith and Hutchinson (1981), Baydar (1983) and Knudsen and Fotheringham (1983). In evaluating the stability of migration patterns in the Netherlands, Van der Knaap and Sleegers choose for the Somermeijer index.

2.3.2. Explanatory analysis of migration: the micro level

The explanatory analysis of spatial population systems aims at identifying the underlying causes of spatial population change. In this book, the focus is on migration as a component of spatial population change. The explanatory analysis of migration may be carried out at two levels: namely, the level of the individual or household (micro level) and the level of aggregates (population subgroups, regions, number of events in a period) (macro level). The levels of analysis are discussed in this and the next section.

This book contains two illustrations of a micro-level analysis of migration. The first focuses on the relation between the occurrence of a migration and the household's preference with respect to the place of residence. This is the cross-sectional study of migration intentions (Chapter 8) by Heida and Gordijn. The second focuses on the timing of migration and the relation between the timing of migration and the timing of other demographic events, such as marriage. This is the longitudinal study of migration histories (Chapter 7) by Hingstman and Harts.

To study the determinants and consequences of migration at the micro level, a model of the migration decision process is needed. The decision to migrate has its roots in the fundamental motive to improve the quality of life of the individual or household. Studies concerning the migration decision involve concepts such as economic maximization, place utility, opportunities elsewhere, expectancies, environmental stress, and community ties. Basic in all these studies of the migration decision is that migration is a response to a perceived spatial disparity of opportunities and the expected improvement in the quality of life resulting from migration. An overview of research on migration decision-making is
beyond the scope of this chapter. The interested reader is referred to De Jong and Gardner (1981). We limit our attention to the cognitive-behavioural approach to the study of the migration decision, since it is the approach adopted by Heida and Gordijn in Chapter 8.

The cognitive-behavioural approach to the study of migration situates the migration decision within the confines of the migrant's cognitive or mental map. This is the picture of the world in the migrant's mind and it is an outcome of his knowledge of his living environment and of other places. On the basis of his preferences and of the mental map of all residential sites, a migrant accords a place utility to each residential site in his mental map. The number of alternative sites considered is generally small because of lack of information. The migration intention is an outcome of the comparison of different place utilities. The theoretical framework of the cognitive-behavioural approach was presented by Brown and Moore (1970; see also Brown and Sanders 1981). The operationalization of the framework and the applications were stimulated by the book by Speare et al. (1975) and by the work of Zuiches, Fuguitt, De Jong and others (see references in Chapter 8). Zuiches (1980) provides a systematic review of major studies on residential preference and expected and actual mobility.

In the cognitive-behavioural model of migration, the migration decision is divided into three phases (Zuiches 1980, p. 184). The first phase is the evaluation of one's current residence, in which a threshold of dissatisfaction may be reached, bringing the household to consider the possibility of a move. In the second phase, an alternative location is searched for, on the basis of locational preferences. In the final phase, the decision to actually move is reached, dependent on the ability to achieve a preferred destination (this property of a potential migrant is referred to by Zuiches as locational flexibility). Heida and Gordijn report in Chapter 8 on a survey held in the Netherlands in 1975-1976 among 2500 households and they propose a formal model for the explanation of residential preferences.

The theoretical framework presented above and the associated type of cross-sectional survey focus on a single migration decision. But a decision to migrate is made within the context of other decisions that have been made or have to be made. To gain insight into the sequence of migration decisions and migrations and into the relation between migration and other events in life, life course analysis is needed. The point of departure for a theoretical framework of an individual's mobility dynamics may be life course and life cycle models, and the data base may be provided by longitudinal surveys (see e.g. DaVanzo and Morrison 1982).

Longitudinal surveys on mobility behaviour are still scarce, but are gaining in importance. Mobility histories may be recorded either
prospectively by a registration system or a multi-round or panel survey or retrospectively. Techniques for analysis of life history data are only recently being developed. Migration history data however have several advantages over other more conventional types of data collected in censuses and surveys. DaVanzo (1982, p. 98) names three:

1) most of the person's moves are recorded;
2) the time interval over which migration is measured can be chosen to best suit the purpose at hand;
3) migration patterns and correlates can be studied in different time periods, and changes over time can be assessed and analysed.

The third advantage makes migration history data particularly useful for the dynamic analysis of the mobility decision, in particular when in addition to migration history data, life history data are collected on variables that may affect or be affected by the migration decision, such as occupation, marital status and fertility. Such a complete life history survey was recently held in France (Courgeau 1982b).

Special techniques for the analysis of life history data have only recently become available. These techniques, developed in reliability engineering and biometrics, focus on the timing of events and on the interpretation of sequences of related events. The probability of occurrence of an event (e.g. migration) is related to the characteristics of the event and of the person experiencing the event, to previous events and to the environment or context in which the events occur. The models are generally referred to as hazard models (see e.g. Kalbfleisch and Prentice 1980). The application of these new techniques to migration analysis is as yet very limited.

The chapter by Hingstman and Harts presents some of the results of the first migration history survey held in the Netherlands. For the marriage cohort they study, a strong relation is found between residential mobility and marriage.

2.3.3. Explanatory analysis of migration: the macro level

The second level at which the explanatory analysis of spatial population systems, in casu migration, may be carried out, is the macro level. In this case the level and direction of migration in a (sub)population is generally associated with characteristics of the population, of the region of residence of the population and of other regions, and with proxies of the accessibility of regions.

There are various types of macro-level explanatory models of migration. An overview is given by Greenwood (1975) and Clark (1982). Recent innovations in migration modelling are taking place in three directions. Firstly, gross origin-destination-specific
migration flows constitute the dependent variable instead of net migration. Secondly, migration, change of employment, and sometimes even commuting and change in labour force participation are linked together in an integrated analytical framework and are solved simultaneously (see e.g. Gordon and Ledent 1980). Thirdly, traditional models of spatial interaction are extended to include a range of explanatory variables of migration (see e.g. Greenwood 1977). Some authors use the micro-level random utility theory as a basis for such extended spatial interaction models (see e.g. Horowitz 1980). Others adopt Alonso's macro-level mobility theory as a point of departure.

Extensions of spatial interaction models are presented in this book by Op 't Veld et al. (Chapter 9) and Van Delft and Suyker (Chapter 12). The extension by Op 't Veld et al. is based on Van Est (1981). Bartels and Liaw (1983) describe a spatial interaction model including several explanatory variables of spatial labour mobility in the Netherlands.

2.4. PROJECTION OF THE SPATIAL POPULATION SYSTEM

2.4.1. Aspects of the projection process

In Section 2.2., we viewed the population as a system, the components of which may be divided into elements and relations between the elements. The elements are denoted by the population categories defined by demographic variables such as age, sex and region of residence. The relations between the elements are represented by population movements between categories, which can be associated with the occurrence of demographic events.

The systems perspective on population is also useful in the projection and/or forecasting process (for the distinction between projection and forecasting, see Section 1.3.2.). Population projection is a process, which may be decomposed into six steps (Willekens and Baydar 1983):

1) systems identification;
2) systems measurement;
3) systems analysis;
4) systems modelling;
5) hypotheses formulation and projection;
6) validation and monitoring of projections.

The steps may be distinguished in any type of projection, and thus also in forecasting and in contingency projections.

The systems identification and the systems measurement were discussed in Sections 2.2. and 2.3., respectively. In order to define and delineate the categories of the population to be projected, three considerations may be helpful (see also Willekens 1983b, pp. 234-
235). The first is the use of the projection in the planning and policy-making process. For instance, household categories may be most useful for housing policy. The type of regions distinguished is frequently also determined by the user. The second condition, derived from demographic theory, requires a population category to be as homogeneous as possible as regards its demographic behaviour, and to have a high degree of regularity in the pattern of change of the demographic behaviour. The third condition is derived from statistical theory and states that the number of observations (events) in each population category should be sufficiently large to estimate the parameters of the projection model. The third condition constrains the acceptable level of disaggregation of the SPS.

The population categories and their interrelations constitute the internal structure of the SPS. Elements that do not belong to the SPS, but which are relevant because they affect the SPS, are said to belong to the environment of the SPS. The population in the "rest of the world" and the socio-economic context in which demographic change takes place, are situated in the environment. These elements and the relations between these elements and the SPS are denoted as the external structure of the SPS.

The analysis of the SPS is a direct preparation for the design of the projection model. The subject of the systems analysis is the study of the internal and external structure of the SPS, and in particular the search for regularities in the patterns of change of the population structure and of the demographic processes (fertility, mortality and migration) that generate the changes in the population structure. An aim of demography as a science is the identification and explanation of regularities in demographic processes. A review of the demographer's search for regularity is presented by Brass (1974). This knowledge provides the theoretical basis for the design of the projection model and for the formulation of hypotheses with respect to the evolution of the model parameters. "Demographic forecasting is seen as the search for functions of population that are constant through time, or about which fluctuations are random and small" (Keyfitz 1972, p. 347). The optimal projection model and the procedure to be followed in the formulation of hypotheses are determined by the outcome of the search for stability (Chapter 17).

The search for regularities involves both exploratory and explanatory analysis. The study of the temporal stability of migration patterns referred to above, is one illustration of this type of research. Another illustration is the search for constant relations between population categories. This research forms the basis of the design of distribution formulae used to distribute a national projection of population development over regions or other functional population categories. Distribution formulae are discussed by Eichperger in Chapter 11 and extensive overviews are
provided by Pittenger (1976) and Ter Heide (1981).

A further illustration of the search for stability is the development of parsimonious models of age-specific schedules of fertility, mortality and migration. The application of model schedules leads to what has become known as parametrized demographic projections. Rogers (1982) reviews several model schedules of fertility, mortality and migration and demonstrates their application in projections. In the Netherlands, Drewe and Rosenboom (1983, 1984) studied model schedules of interprovincial migration.

2.4.2. The migration variable in projection models

The design of projection models for subnational populations received much attention in the literature. The main issue in model design has been the integration of the migration variable. This issue may be divided into two sub-issues. The first relates to the specification of the migration variable in the demographic model. The second relates to the mechanism of incorporating changes in migration during the projection period.

The specification of the migration variable in demographic projection models follows one of three approaches: net migration, gross in and outflows and gross place-to-place flows (see Chapter 15). Few authors support the use of a net migration variable. Even Pittenger's (1978) treatment of net migration is derived from the underlying directional (in and out) migration patterns (see also Schroeder and Pittenger 1983). The specification of in and outflows is common practice, frequently in combination with a variable denoting the total number of migrants in the country ("migrant pool"; see Chapter 15). The "migrant pool" concept is introduced as an intermediate variable to avoid the definition of in-migration rates, which are improper demographic measures because they do not associate the events with the population at risk. Recently, multiregional demographic models have been developed in which the number of in-migrants in a particular region is calculated from destination-specific out-migration rates of all other regions (Rogers 1966, 1975; Willekens and Rogers 1978).

The multiregional demographic projection model may be viewed as an extension of the classical demographic cohort-survival model to include place-to-place migration. It may also be viewed as an extension of the Markov chain model of regional population change, commonly used in geographical analysis, to include the age variable (for a discussion of the classical Markov chain approach to regional population projection, see Rogers 1968 and Salkin et al. 1975 among others). The multiregional demographic model developed by Rogers has been extensively tested in empirical settings. As part of the Comparative Migration and Settlement Study of IIASA, demographic
projections were prepared for all of IIASA's 17 member countries; (see various country reports, Rogers 1983, Rogers et al. 1983, and Rogers and Willekens forthcoming). Much has been learned, resulting in the introduction of a number of methodological innovations in demographic models. Willekens and Drewes in Chapter 15 present a new version of the multiregional demographic projection model.

Population forecasts require the prediction of the components of demographic change. The prediction of migration is particularly difficult. Two approaches may be adopted. The evolution of migration, specified as migration rate, migration probability or number of migrants may be specified either by the user or by a formal migration model. In specifying future migration trends, the user applies a mental migration model that integrates his knowledge, experience and intuition. The endogenization of migration leads to demo-economic models for regional population projection. Migration models generally combine, on the right-hand side, variables that represent constancies (systems inertia) and variables representing change. This is most clearly illustrated by the migration model presented by Brouwer et al. in Chapter 14. The authors decompose migration into two components: a structural component, which is largely determined by the systems inertia, and a housing market component which is sensitive to policy measures and which is the least stable and hence uncertain component of the projection model (see also Ter Wee in Chapter 13).

The endogenization of migration may lead to different formal relations between migration and explanatory variables. Three groups of models may however be distinguished. The first is the extended spatial interaction model discussed in Section 2.3.3. The second group encompasses the simultaneous equation models, in which a set of variables are defined that not only affect migration but are also affected by migration; the variables must be solved simultaneously. The relation between these two groups of models was discussed by Greenwood (1977). The third group of models are derived from an accounting perspective on population change and economic change. The demographic model is complemented by an economic (input-output) model which describes economic change in terms of linkages between sectors of the economy (trade). Such an accounting framework was presented by Schinnar (1976) and further developed by Madden and Batey (1980) and by Gordon and Ledent (1980).

The endogenization of migration poses the problem of specification of the migration variable. In the spatial interaction and the accounting frameworks, migration is specified as place-to-place migration. A recent illustration of a model of net migration flows, which includes relevant characteristics of all regions, is presented by Milne (1981). Birg (1981) developed a demographic-economic forecasting model that incorporates in and outflows. Which specification of the migration variable to choose is a
debatable question which also received attention in the Netherlands. In a recent comparison of the three different specifications, Ledent (1983) concluded that for forecasting purposes the place-to-place flow model ("stream model") outperforms explanatory models of net migration and of in and outflows. In the Netherlands, the migration submodel of the hybrid projection models discussed by Eichberger in Chapter 11 is a model of net migration disaggregated as to sex and age (see Van Delft and Suyker in Chapter 12). The model specification and explanatory variables considered have been shown to be more reliable in predicting net migration than a comparable gross migration model would be.

2.5. CONCLUSION

The aim of this chapter was to present a broad overview of the state-of-the-art and of recent developments in migration and population distribution research. The chapter provides the research context in which the Dutch research described in this book is carried out.

The object of spatial policy-making is the spatial distribution of people, of economic, social, cultural and recreational activities and of infrastructure. The concept of a spatial population system (SPS) was introduced to denote the demographic dimension of the object of spatial policy-making. In investigating the SPS for forecasting purposes, a number of steps may be distinguished. In this chapter, three steps are highlighted.

The first step is the identification and the measurement of the SPS. The identification relates to the definition and delineation of the relevant population categories and of the demographic events that cause the population system to change. Spatial population research is handicapped by conceptual and measurement problems, in particular with respect to migration. Recently, the migration concept and the migration measurement have been under attack since they cover only a relatively small portion of the spatial population movements. Although this problem is not as severe in the Netherlands as in other countries, it warrants a detailed study of migration concepts and measurement procedures and a sensitivity analysis of the research results.

The critical evaluation of the commonly available data bases for migration and spatial population analysis may be enhanced by the adoption of an accounting framework. It has been asserted that the accounting framework has also been shown to be useful for the analysis of the consistency of the data, for the estimation of missing data (e.g. by combining different data sources), for data handling (aggregation and multi-level specification), for further exploratory data analysis and for the derivation of the parameters of demographic models.
The second step in the study of the SPS is the exploratory and explanatory analysis. Exploratory analysis aims at identifying a structure or a regular pattern in a given data set. To identify a regularity in the data, data transformation is frequently required. In addition to traditional data transformation techniques, such as log and logit transformations, decomposition was discussed. A decomposition of migration flow data into a level, a generation and a distribution component may shed light on a structure which would otherwise remain hidden. A major problem in exploratory analysis is the evaluation of the degree of similarity of two data sets (e.g. two migration matrices). Most authors adopt a pragmatic approach to this problem by presenting a set of similarity measures, some of which describe different parts of the data (partitive measures). The selection of the measure of similarity may remain an issue for a long time, but calls for fundamental statistical research if one wants to provide a solid basis for assertions regarding the similarity of two tables and regarding the goodness-of-fit of models describing the tables.

The explanatory analysis may be carried out either at the level of the individual or household (micro-demography) or at the level of the population or subpopulation (macro-demography). In the micro-demography of migration, the migration decision process is of central concern. Of the various possible approaches to the study of the migration decision, we reviewed the cognitive-behavioural approach since it is directly relevant for empirical research presented in this book. Most of the behavioural analysis of migration focuses on a single migration. Recent research has shown the importance of studying migration sequences and links between migration and other events experienced by an individual or a household. The study of migration histories, if possible in conjunction with other life histories, is becoming feasible with the organization of longitudinal surveys and shows great prospects for an improved understanding of the migration decision process.

In the macro-level explanatory analysis of migration, the relative or absolute number of migrations in a given period is associated with characteristics of the population, of the region of out-migration, of other regions and of the separation of the regions. This analysis is popular in the literature and therefore a very brief overview in this chapter was thought to be sufficient.

The third step in the analysis of the SPS for policy-making purposes is the projection of the SPS. Projection includes much more than the design of a projection model. In this chapter, we viewed population projection as a process and discussed a few steps of this process. The identification, measurement and analysis of the SPS to a large degree determine the model design. Criteria for identifying demographic categories for projection purposes were given. They are derived from user requirements, demographic theory and
statistical theory. The analysis of the SPS involves the search for regularities. The outcome of the search for regularities is a major input in the specification of the projection model. An additional issue in modelling is however the integration of the migration variable. Two sub-issues are distinguished. The first is the specification of the migration variable in the demographic model. Recent research focuses on gross place-to-place migration flows. The second issue is the treatment of migration as an exogenous or endogenous variable. The endogenization of migration in projection models leads to demo-economic models. Demo-economic models may take different forms: extended spatial interaction models, simultaneous equation models and accounting models. These models received much attention in the literature. The endogenization of the migration variable does not automatically improve population forecasts. An improvement would entail satisfying three conditions (Brass 1974): the relationship between migration and the explanatory variables must be close, the close relationship must persist over time, and the explanatory variables must be easier to predict than migration. The forecasting performance of demo-economic models is a challenging subject for policy-oriented research.
REFERENCES


